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THEME

Study of the floristic diversity of the Saharan route in the border area of El Oued

Submitted by:

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Table of Content

Abbreviation list :

°C: Degree Celsius

°K: Degree kelvin.

ACD: Analysis of Relaxed Matches.

AFC : Factorial Analysis Correspondences.

CHA: Hierarchical ascending classification.

CI: Continental intercalary

CP: Class of presence.

CT: Terminal complex

DSA: Directorate of Agricultural Services.

GPS: global positioning system

HR : Relative humidity.

ITDAS: Technical Institute for the Development of Saharan Agriculture.

km²: Square kilometer

M/s: Meter per second

M: Metre.

Mm : millimeter.

mmhos :millimo.

N°: number

O.N.M: National Meteorological Office.

P : Precipitation

PC-ORD : persenel computer-ordination.

Q2 : Rainfall quotient.

R : Survey

RN : National road

T : Temperature

UNESCO : United Nations Educational, Scientific and Cultural Organization

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General introduction

General introduction

The Sahara, the most hostile desert of the planet covering more than eight million km² (Le Houérou, 1990), separates the Mediterranean world from the tropical world. It is the largest hot desert in the world and occupies 10% of the surface of the African continent (Rognon, 1994). The study area is related to the northern part of the Sahara, where precipitation occurs during the winter, feeding a variety of plants that bloom before the hot, dry summer. The flora of the northern Sahara is very poor given the immensity of the ecozone (Ozenda 2004). These species survive with forms of extraordinary and varied adaptations (Le Houérou, 2001).

The Sahara occupies 80% of the surface of Algeria with more than 2 million km² and contains natural resources that deserve great attention. The preservation of these ecosystems requires improved knowledge of the flora, which over thousands of years has developed qualities and adaptations that perfectly harmonize with the extreme conditions of these environments (Fellous, 2003)

Thus, this flora is organized in different landscapes characteristic of Saharan habitats such as ergs, regs, hamadas, djebels, beds of wadis and depressions. Among these habitats are the wadi beds which are the richest and constitute the most diversified routes in species and families. When the soils are salted, the floristic procession becomes impoverished.

Knowledge, classification and conservation of taxa is a global scientific priority for biodiversity assessment and management (Cotterill, 1995). However, many plant species remain unrecognized in biological, taxonomic and ecological terms (Grubb, 1977, Pyšek et al., 2008).

The aim of this study is to improve knowledge of the flora of the El Oued region and its surroundings. In order to answer this question, we carried out a subjective sampling in order to evaluate the phytodiversity and its heritage value. These species belong to the plant associations observed at the different study sites. They are assessed through the most common indicators and biodiversity assessment criteria.

To achieve this, the work plan adopted is structured around four chapters:

- A first chapter is devoted to the description of the study area on the abiotic and biotic plan;
- A second chapter presents a bibliographic overview on biodiversity;
- A third chapter deals with the methodology adopted for carrying out this study;
- A fourth chapter presents the results obtained and their interpretations;

Finally, we conclude with a general conclusion summarizing the main lines of this work.

Chapter I
Framework of study: El-Oued region

Introduction

In this chapter deals with the general description of the wilaya of El-Oued, namely, the geographical situation, environmental conditions through abiotic and biotic factors.

The wilaya of El-Oued has 12 daïras and 30 communes with a total area of 4,458,680 ha of which 1,591,869 ha represent the total agricultural area, is 35%, and has a population of 731,500 according to the statistics dated 31/12/2012 (Statistical Service, DSA of the wilaya of El Oued, 2013).

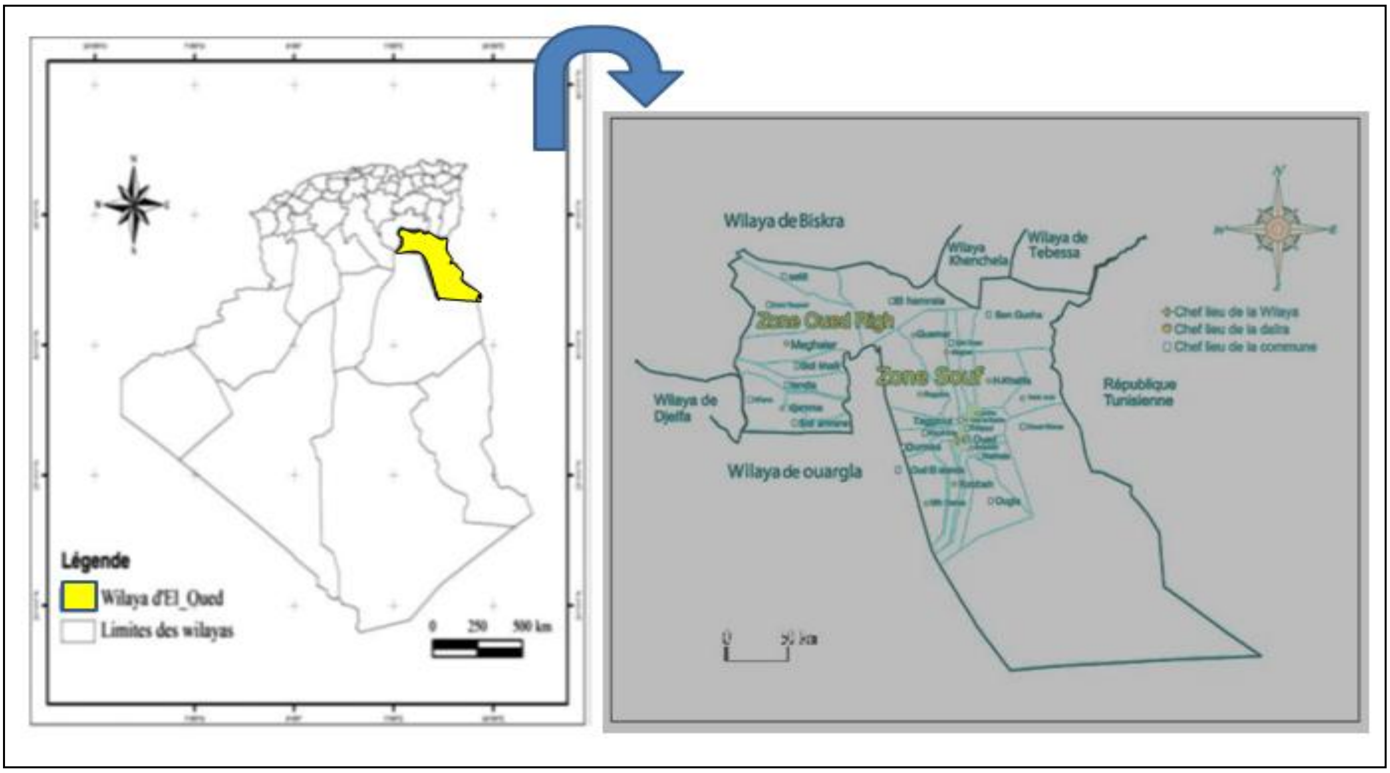
This wilaya is located in a south of Algeria and in full Erg oriental, characterized by an agricultural vocation mainly phoenicultural with almost 3 720 800 date palms and secondarily by the cultures of Primeurs, the production for the year 2010 was 1530928 quintals of dates Statistics, DSA of the wilaya of El Oued, 2010/2011).

1. *Administrative delimitation of the wilaya of El-Oued*

The wilaya of El-Oued is located in southeastern Algeria at a distance of 650 km from the capital Algiers. It is limited by (Pic 1):

- The wilaya of Tebessa to the northeast;
- The wilaya of Khenchela to the north;
- The wilaya of Biskra to the north-west;
- The wilaya of Djelfa to the west;
- The wilaya of Ouargla to the west and south.

The wilaya of El-Oued borders with Tunisia for about 300 kilometers.



Pic 1 : Map of the geographical situation of the wilaya of El-Oued (DGF., 2016).

2. Relief:

The configuration of the relief of the Wilaya is characterized by the existence of three great ensembles namely:

1 Souf Region: A sandy area that covers the whole of the Souf. East and South.

2 Erg: A sandy area occupying 3/4 of the area of Souf; And lies on the lines (80m East, 120m West) This region is part of the great Oriental Erg.

3 .Oued Righ: A form of rocky plateau that run along the R.N 3 to the west of the Wilaya and extends to the south.

4. Area of depression: This is the area of the Chotts, it is located north of the Wilaya and extends towards the East with a depression variant between (-10m and -40m) and among the known chotts there is Milghigh and Merouane, near RN No. 48 which crossed the communes of Hamraia and Still.

3.Ground

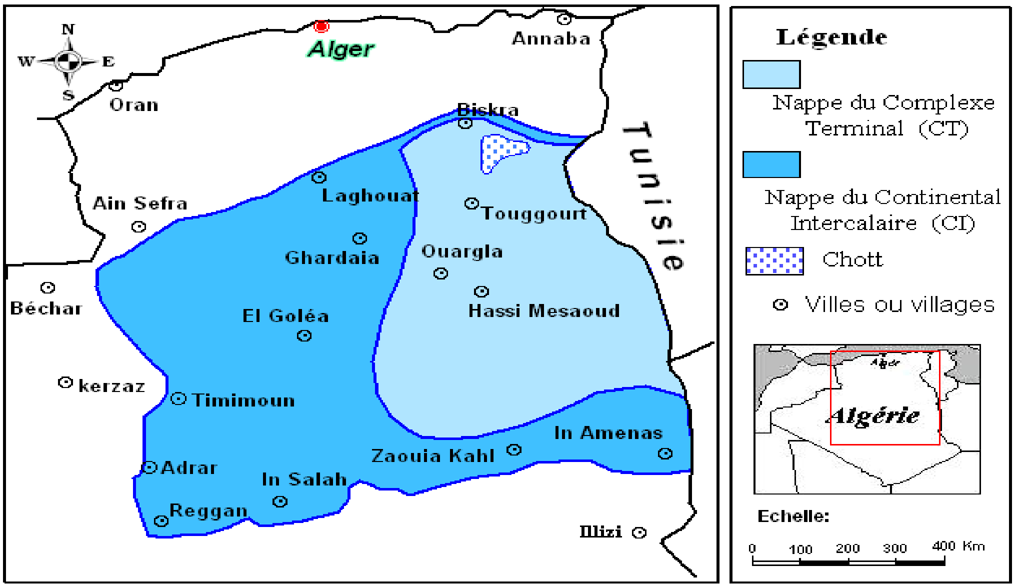
The soil, altered by different atmospheric agents (rain, frost, wind, etc.) or biological (roots, microorganisms, etc.) plays a fundamental role in the distribution of plant species. In the Sahara, the soil-forming factor is mainly water and wind. To this is added the magnitude of the thermal variations, in particular the daily amplitude of the temperature. Water only intervenes incidentally and especially by the phenomenon of runoff and evaporation (Ozenda, 2004).

The soil cover is highly heterogeneous and consists of rough mineral soils, halomorphic and hydromorphic soils (Dubost 1991).

The main types of soils encountered in the study area are gross erosion or input mineral soils, as well as saline soils. According to the nomenclature adopted in the African Soil Atlas (Jones et al., 2013), the soils of the El Oued wilaya are dominated by Arenosol protic, Gypsisol haplic, followed by Leptosol lithic, Undifferentiated Solonchaks and Of the Solonchaks haplic.

4. Hydrogeology

The geological formations of the study area contain two large sets of aquifer formation: the intercalary continental at the base and the terminal complex at the top. A third form of more modest importance is added to the two previous ones: the groundwater or surface water table (Idder, 1998) (Pic 2).



Pic 2: Map of groundwater resources in the Sahara (CI and TC) (Unesco, 1972)

4.1 Table of the continental intercalary (Albien)

Covering the entire region, the intercalary continental is considered one of the largest aquifers in the world and constitutes the largest reservoir of water in the Sahara in volume and extent (Cote, 1998). It covers more than 600 000 km2 and its thickness can reach 1000 m in the Northwest of the Sahara. This aquifer extends between 700 and 2000 m depth (Dubost, 1991). The water content of this water table is very hot, its temperature is estimated between 46 ° C. and 60 ° C. On the surface, with a low salt content, and its exploitation is expensive (Benziouche, 2000). 1.4.2 Nappe du Complexe Terminal

The groundwater of the terminal complex (CT) is localized throughout the northern Algerian Sahara. It covers an area of 350 000 km^2 and its depth varies from 100 to 400 m. It is the oldest used and constitutes the hydraulic reserves on which is based "the irrigation of most of the palm groves of the Lower Sahara" (Dubost, 1991).

The waters of the continental terminal are generally salty and the increase in the number of burials has led to a dramatic drop in the hydrostatic level.

4.2 Water table (open ply)

The water table is contained in the recent formations in the upper part of the continental formation. These are non-captive slicks of 7 to 60 m that increase the hydraulic reserves of the lower Sahara. Fed by rainfall and infiltration of irrigation systems, it is exposed to the surface of the soil in several parts of the valley and these waters are of an excessive salinity (13 g / l) (Durand et al., 1955). The electrical conductivity varies from 10 mmhos / cm to 36 mmhos / cm in the majority of cases (Messahel and Meza, 2003).

5. *Geology*

From a geological point of view, the study area belongs to the Saharan platform, extending over geologically different sets which were planarized at the beginning of the Secondary Era. Our study area is part of the lower Sahara belonging to the northern Sahara. Two sedimentary groups can be distinguished from the bottom to the top:

- The lands of the Mesozoic and Cenozoic, they constitute the essential outcrops of the borders of the lower Sahara**,**
- Continental deposits of the end of Tertiary and Quaternary, they occupy the center of zones of depressions (Debbakh, 2012).

The numerous works of authors such as Bel and Cuche (1969), Busson (1972), Fabre (1976), made it possible to reconstruct a stratigraphic series, as complete as possible. The geological formations will be described from the oldest to the most recent (Pic 3)

The Albian: it presents itself as a very thick series formed by an alternation of sandstone layers with past shales (Fabre, 1976).

The Vraconian: it consists of an irregular alternation of clayey and dolomitic levels, sandy clays and more rarely sandstone with calcareous cement. The Vraconian is waterproof. Its thickness is about 110 m (Debbakh, 2012).

The Cenomanian: it is constituted by an alternation of dolomites, dolomitic limestones, clays and anhydrite (Debbakh, 2012).

The Turonian: the training is calcareous and dolomitic, nearly at the base and dolomitic or limestone at the top. The thickness of the Turonian remains almost constant (Benlamnouar, 2008).

The Senonian: it is individualized into two faces:

-The lower Senonian (Salmonic and Anhydritic Senonian) with lagoon sedimentation characterized by clay and saliferous formations with anhydrite, it is very poorly permeable (Busson, 1972).

-The upper Senonian (carbonate Senonian) is presented by permeable carbonate formations.

The Eocene: it is formed mainly by dolomites and dolomitic limestones with some intercalations of marl, clay and even anhydrite and salt (Bel et Cuche, 1969).

The Mio-Pliocene: there are two lithological ensembles:

-Upper Miopliocene: formation sandy sandstone; It contains the first sheet (CT1).

-The lower Miopliocene: sand and sandstone of the second sheet (CT2) (Serrai, 2009).

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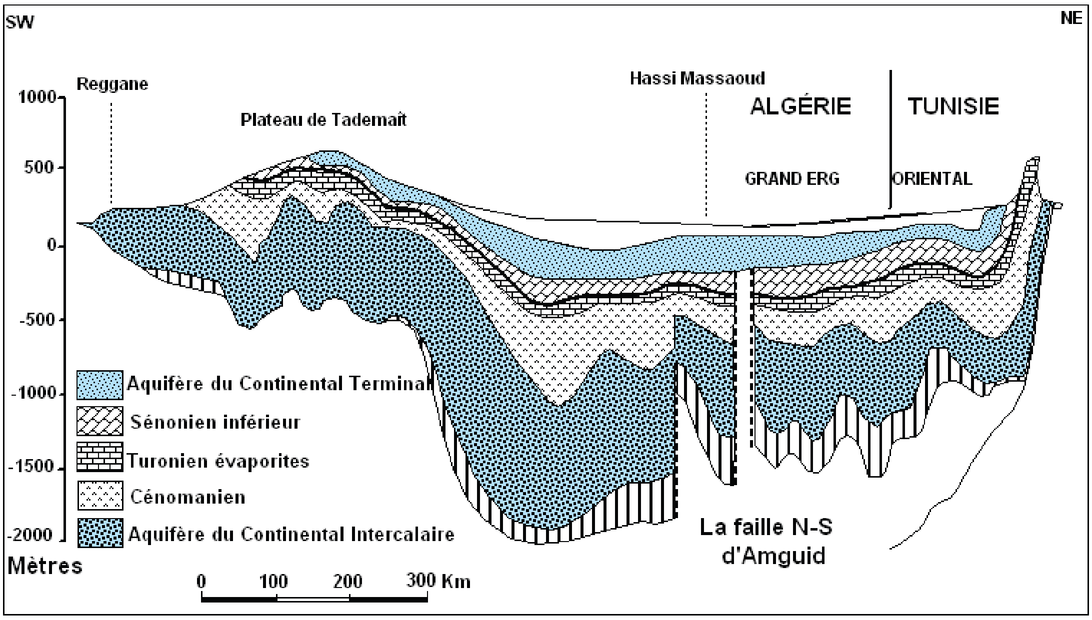
The Quaternaire:

The Quaternary is composed of wind sands and clay sands, resulting from the destruction of the Mio-Pliocene cliff in the south and west of the Oued Righ valley. These sands form enormous accumulations in the great Eastern Erg. It is at this level that one meets the water table which is fed mainly by the infiltration of the deficit waters during irrigation. Its thickness is variable and can reach locally about ten meters (Benabdasadok and Guettiche, 2006).



Pic 3: Geological section of the northern Sahara (Unesco, 1972)

6. *Climate Framework*

Climate plays a fundamental role in the distribution of living beings (Faurie et al., 1980), and in particular for plants (Ozenda, 2004). Among the climatic factors, rainfall and temperature are the main factors. Thus, temperature is an important limiting factor because it controls all metabolic phenomena and thus determines the distribution of all species and communities of living organisms, plants and animals in the biosphere (Ramade, 2003). The combination of temperature and rainfall is a decisive factor in the characterization of plant formations because it determines their distribution and development (Quézel and Médail, 2003).

(Seltzer, 1946).

In general, the climate of the El Oued region is typically Saharan and is characterized by very low, capricious precipitation, high temperature and relatively low humidity

For the present study, we selected the weather data from the weather station of the El Arfiane ITDAS during a period of 36 years (1980-2016), as it is the closest to our study region.

6.1 Temperatures

Temperature data show significant monthly variations and high thermal values typical of the Saharan climate. The temperature data are shown in Table I for the period 1980 to 2013. From this station, the minimum (m), average and maximum temperatures (M) are taken as degrees Celsius.

Table I: Mean, maximum and minimum monthly temperatures (° C) of the El Arfiane station for the period 1980-2013

Month	Jan	Fév	Mars	Avril	Mai	Juin	Juill	Août	Sept	Oct	Nov	Déc	Moy/ an
M (°C)	16,9	18,6	23,1	27,5	32,9	38,3	40,8	40,2	35,5	29,6	22,7	18,2	27,3
m (°C)	4,7	5,6	9,5	13,7	18,9	23,9	26,5	28,7	21,5	16,2	10,2	6,4	15,5
(M+m)/ 2 (°C)	10,8	12,1	16,3	20,6	25,9	31,1	33,6	34,5	28,5	22,9	16,4	12,3	22,1

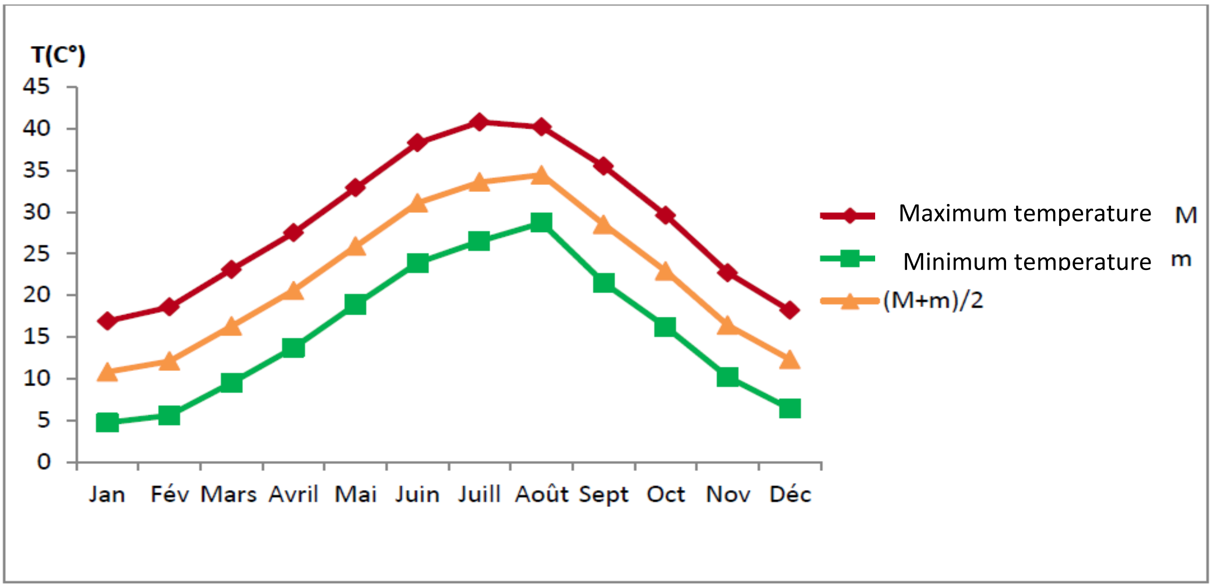
(Source O.N.M. of El Arfiane)

(M + m) / 2: Average monthly temperature.

Table I shows that the average of the warmest month maxima (M = 40.8 ° C) is recorded during the month of July and the average of the minimum of the coldest month (m = 4.7 ° C) is recorded in the month of January. The average annual temperature of 22.1 ° C is characterized by a relatively warm climate.

We see, on reading this information, that the thermal regime is regular (Pic 4). Minimum and maximum temperatures increase gradually to reach the maximum in July and similarly to reach a minimum in January, the gap between the two curves remains relatively constant (Pic 4).

Chapter I Framework for study: El-Oued region



Pic 4: Monthly change in minimum, maximum and average temperatures (1980 -2016).

6.2 Precipitation

The Oued region is characterized by rare and irregular precipitation (Nadjah, 1971). Table II shows the rainfall data in mm recorded between 1980 and 2013 (O.N.M., El Arfiane).

Table II: Average monthly precipitation for the period (1980-2013) (O.N.M - El Arfiane)

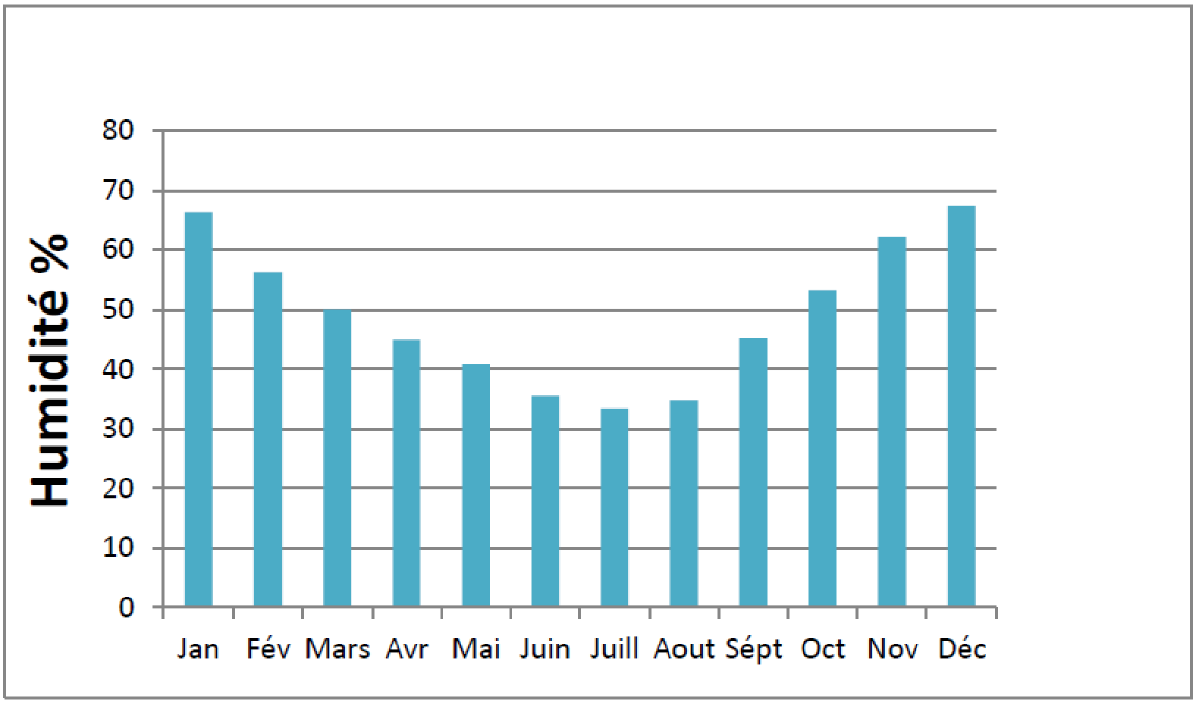
Month	jan	feb	Mar	Apri	May	June	July	Augus	Sept	Oct	Nove	Dec	Year
P (mm)	**18,76**	5,13	9,51	6,93	5,42	1,37	**0,64**	2,21	5,33	6,54	10,52	6,72	**79,08**

Table II shows that the maximum rainfall value is recorded in January with 18.76 mm and the minimum value in July with around 0.64 mm. Average annual precipitation is about 79.08 mm, less than the limit of 100 mm / year characteristic of Saharan climates.

The rainfall pattern of the study area is of the type (HAPE).

6.3 Relative Humidity of Air

The average monthly humidity varies between 31.31% (July) and 67.41% (January) during the period 1980 to 2013 (Pic 5).



Pic 5: Histograms showing the percentages of average annual humidity from 1980 to 2013 in the El Arfiane region

The annual average relative humidity is 49.19%. This average value divides the year into two periods: a wet period that generally extends from October to the end of February and a dry period for the rest of the year.

6.4 Dominant Winds and Sirocco

The wind acts either directly by mechanical action on the soil and plants or indirectly by modifying moisture and temperature (Ozenda, 1982). On the other hand, it constitutes for some biotopes a limiting ecological factor (Ramade, 1984).

In our study area northwest winds are most prevalent and occur mostly in spring, while east-north winds generally occur from late August to mid-October (Nadjah, 1971). Sirocco (Chihili), an extremely dry south wind, dominates throughout the summer (Dubief, 1959). Table III shows the average monthly velocities during the period 1980-2013.

Table III: Average monthly wind speeds between 1980-2013

Month	jan	feb	Mar	Apri	May	June	July	Augus	Sept	Oct	Nove	Dec
Speed (mm)	**2,52**	2,63	3,4	3,95	4,08	3,81	**3,5**	3,2	3,1	3,72	2,8	2,88

(Source O.N.M. of El Arfiane)

The highest average wind speed is recorded in May. It is 4.08 m / s.

6.5 Evaporation

According to Dubief (1959), evaporation is defined by the thickness, expressed in millimeters, of the layer of water evaporated in the unit of time considered: days, months, years. Table IV represents the average monthly evaporations during the period 1980-2013.

Table IV: Average monthly evaporation of the period (1980 - 2016)

Month	jan	feb	Mar	Apri	May	June	July	Augus	Sept	Oct	Nove	Dec
Et (mm)	64,15	95,09	146,59	177,34	237,04	302,64	300,05	263,49	192,11	150,24	101,94	76,03

(Source O.N.M. of El Arfiane)

The maximum of evaporation is recorded in June and July with respectively 302.64 and 300.05 mm and the minimum in December and January with respectively 76.03 and 64.15 mm.

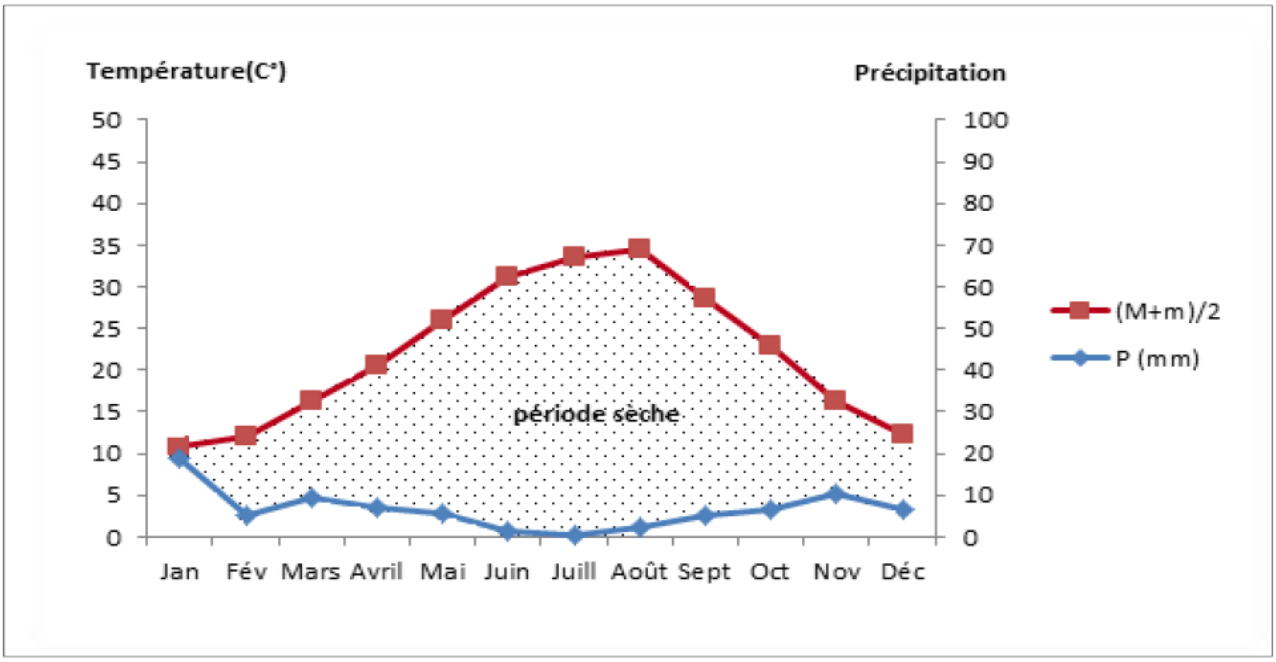
6.6 Climate Synthesis

Climatic synthesis is carried out in two complementary ways, through the Gaussen ombrothermal diagram (1953) and the Emberger climagram (1955). These two syntheses, generally chosen to characterize the Mediterranean climate, are also quite appropriate for a climatic synthesis of a Saharan region where the same thermal regime is recorded.

6.6.1 The Ombro-Thermal Diagram of Bagnouls and Gaussen

Bagnouls and Gaussen (1953) consider that a month is dry when the monthly precipitation total expressed in millimeters is less than or equal to twice the mean temperature of that month expressed in degrees Celsius ($P \leq 2T$). The climate is dry when the temperature curve rises above that of precipitation. It is wet if not (Dreux, 1980).

This diagram is obtained by plotting on the abscissa axis, the months of the year, and on the ordinate the precipitation on the right and the average temperatures on the left. Examination of the ombrothermal diagram of the study region for the period 1980-2013 reveals the existence of a single dry period spanning the whole year (Pic 6).



Pic 6: Bagnouls and Gaussen ombrothermal diagram of the El Arfiane region from 1980 to 2013.

6.6.2 Emberger Climagram

The Emberger system allows the classification of the different Mediterranean climates (Tassin, 2012). This classification involves two main factors, on the one hand the drought represented by the rainfall quotient (Q2) on the y-axis and on the other hand the mean

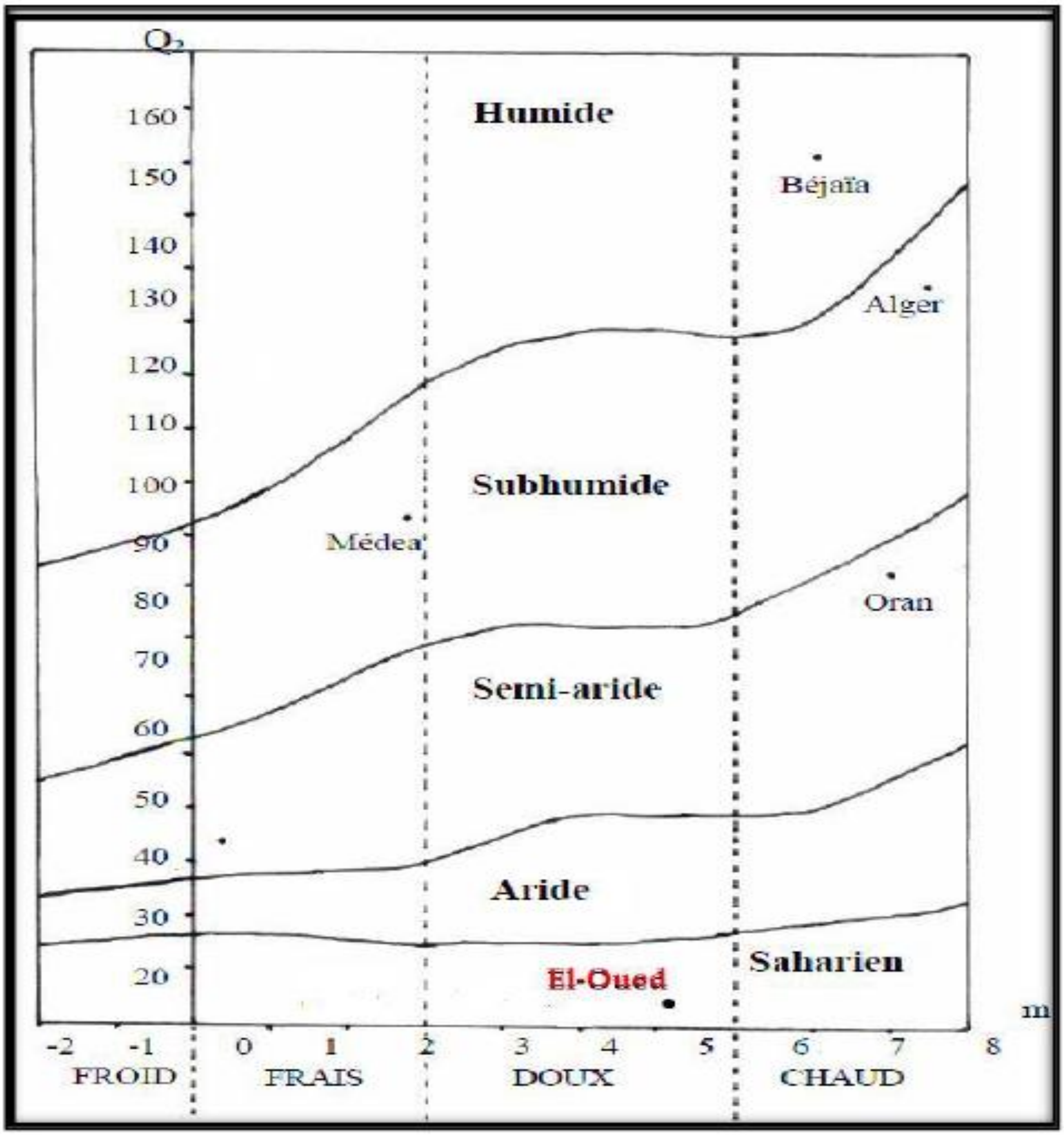
Chapter I Framework for study: El-Oued region

températures minimales du mois le plus froid en abscisses. Il est défini par la formule simplifiée suivante (Stewart, 1969) :

Q_2=3,43 P/ (M-m) avec pour nos données Q_2= 7,51

- P : Pluviométrie moyenne en (mm)
- M : Moyenne des maxima du mois le plus chaud en (°C)
- m : Moyenne des minima du mois le plus froid en (°C)
- 3,43 : Coefficient de Stewart établi pour l'Algérie.

Les valeurs du quotient pluviométrique **Q_2 (7,51)** et de **m (4,7)** permettent de situer la région d'El Oued dans l'étage bioclimatique saharien à hiver doux (Pic 7).



Pic 7: Climagramme d'Emberger de la région d'El-Oued.

Thus, the two syntheses confirm the El Oued region's belonging to a Saharan climate characterized by a rainfall of less than 100 mm / year and an average temperature of 22 ° C.

7 Saharan vegetation

In the Sahara, as elsewhere, vegetation is the most faithful witness to the climate (Gardi, 1973). The vegetation cover is discontinuous represented by perennial, woody, xerophyte plants and annual plants with very brief vegetative periods.

The Sahara's vegetation is mainly confined to habitats where topographical conditions are favorable to the maintenance of a plant life, mainly depressions, wadis beds and, to a lesser degree, mountainsides or Hills (djebels) and dune regions (ergs). This type of vegetation distribution was defined by Monod (1954) as a "contracted mode", as opposed to the "diffuse mode" of wetter climates. Each habitat hosts one or more groups of its own.

Several studies have been carried out on vegetation in the Sahara. The first works on Saharan vegetation are published by Maire (1933-1940), Leredde (1957) and Quézel, 1954, 1965. More recently, among the authors who contributed to the description of the vegetation cover of the Algerian Sahara, Barry And Celles (1972-73), Barry et al. (1981), Barry et al. (1985), Gehu et al. (1994), Kaabèche and Gharzouli (1993), Kaabèche and Gharzouli (1997a), Kaabèche and Gharzouli (1997b), Benhouhou et al. (2001), Benhouhou et al. (2003) and Boucheneb and Benhouhou (2012).

8 Saharan flora

The Saharan flora which developed over thousands of years presents adaptations that perfectly harmonize with the extreme conditions of these environments. It has long attracted botanists, phytogeographers and phytosociologists. The Saharan flora appears very poor if one compares the small number of species that inhabit this desert with the enormity of the surface that it covers (Ozenda, 2004). Indeed, on a surface of approximately nine million km², it counts only 1200 species. On the other hand, the number of genera is relatively high, as it is common for a genus to be represented by a single species (Ozenda, 2004).

This floristic poverty is the result of the combination of several unfavorable factors, including low and random rainfall, long periods of absolute drought, strong evaporation due to very high heat in the superficial layers of the soil and an ungrateful soil substratum Barry et al., 1976, Mainguet, 1995, Ozenda, 2004). This results in a particularly well-adapted flora. The subterranean parts are extremely developed and the foliage is reduced with accumulation in certain species of important reserves of tissue water and finally by an extreme reduction of the losses by perspiration. These adaptations are related to the climatic conditions that characterize desert biotopes.

Despite these climatic and pedological constraints, the systematic composition of the Saharan flora is characterized by its diversity. Indeed, there would be almost as many families in the Sahara as in the European flora (Ozenda, 2004). Moreover, it brings together geographical elements of very different origin, thus posing first-rate biogeographic problems (Ozenda, 2004).

This Saharan flora is divided into 104 families of Angiosperms comprising 400 genera and only 10 families of Cryptogams, the main ones being the Asteraceae, the Fabaceae and the Poaceae, which alone represent 35% to 40% of the Saharan flora Bounaga, 1974, Quézel, 1978).

The very particular biological characteristics of the Sahara, the existence of vast areas which constitute obstacles to the spread of species, endemism is particularly developed and reaches a remarkable 25% (Ozenda 2004). Note that endemism manifests itself at the level of the genus and especially of the species (Table V).

Table V: Floristic wealth and endemism of the main Saharan families

Family	Genre	Species	Number of sp ende
Asteraceae	80	164	13
Poaceae	74	203	19
Brassicaceae	44	73	12
Fabaceae	30	154	21
Chenopodiaceae	23	64	3
Caryophyllaceae	22	73	13

The flora of the northern Sahara is relatively homogeneous and the Mediterranean penetrations make this zone one of the most diverse regions on the biogeographical level of the Sahara. Endemism is high because of the vast barrier areas with 162 endemic species (Quézel, 1978).

As for the works on the flora, in addition to the published floras (Quézel and Santa 1962-1963 and Ozenda 2004), mention should be made of the following floral guides: Benchelah et al. (2000, 2006), Sahki and Boutamine-Sahki (2004) and Chehma (2006).

9 Flora and vegetation of El Oued

The flora of the El-Oued, linked to the northern Sahara, faithfully reflects the character of the latter, namely floristic poverty, a high rate of endemism and adaptation to drought.

Studies on floristics and by extension on vegetation are few in the El Oued region. We can cite the work of Chehma et al. (2005), Chehma (2006), Halis et al. 2012, Belhimer (2012) and Sedira and Bouguettaya (2013).

Conclusion

This study is a follow-up to the work carried out by Zeghedi and Malki (2017) and will focus on knowledge of the flora of the El Oued region and its surroundings, in order to evaluate the phytodiversity and its heritage value. These species belonging to the plant associations observed at the various study

Chapter II
General information on biodiversity

Chapter IIGeneral information on biodiversity

Introduction

Biodiversity is a complex notion, a neologism based on the words biology and diversity, which determine the expression "biological diversity". It is the diversity of the living world, within nature.

The concept of biodiversity emerged in the early 1970s within the World Conservation Union (IUCN). It was not until the Rio Conference on Environment and Development, organized by the United Nations in 1992, that the term was widely popularized.

The study of biological diversity concerns a wide range of disciplines within the biological sciences, each of which has developed its statistical indices and methods. These diversity measures play a central role in ecology and conservation biology, although biodiversity can not be captured entirely by a single value (Purvis and Hector, 2000).

1. Definitions of Biodiversity

The term biological diversity has several definitions, including the following:

According to Bornard et al., 1996 and Article 02 of the United Nations Convention on Biological Diversity (1992), biodiversity is defined as "the variability among living organisms of any origin including aquatic, marine and terrestrial ecosystems and Ecological complexes in which they take part "; This includes diversity within species, between species and ecosystems (Moignan-Moreau, 2008).

In other words, biodiversity is defined as the variability of living organisms in all its forms of organization: genetic, taxonomic, ecosystems and functional; It is measured at a given scale, ranging from micro-habitat to the biosphere (Barbault, 1995, Delong, 1996, Gaston and Spicer, 2004).

Another way of defining biodiversity by considering both the species and the plant groups was proposed by Géhu (2006). The author defined biodiversity as follows: it is the wealth of living organisms from there or a given portion of the biosphere. Specific biodiversity can be expressed by the number of plant species and

Different animal units per unit area of land. At a higher level of organization, the author defines the contours biodiversity that corresponds to the number of plant groups, in principle, to the same syntaxonomic level, present per unit of the terrestrial surface.

2. The different levels of biodiversity

There are three levels of organization of biodiversity, genes, species and ecosystems (Lévêque and Mounolon, 2008).

A) Genetic diversity

It corresponds to the genetic variation between individuals of the same species. There are three main approaches to quantifying genetic variability; The phenotypic approach, the analysis of enzymatic variability and the direct analysis of genetic variance (DNA sequencing) (Parizeau, 2001).

(B) Specific diversity

It corresponds to the diversity of species in an environment. This diversity can be measured in a variety of ways. The number of species in one region (its specific richness) is one of the most frequently used criteria.

(C) Ecosystem diversity

It corresponds to the diversity of a higher level of organization of the living being, the ecosystem. It is the structural and functional diversity of the ecosystems that are present in a region (Dajoz, 2006). It is the variety that exists in physical environments, and biotic communities in a landscape. This diversity is more difficult to assess than the first two because the boundaries between ecosystems are not clear.

These three levels of biodiversity are interrelated, with variations in one level directly affecting others (Pic 8).

3. The values of biodiversity

First, biodiversity has its own value. Thus, the services rendered to the human being are invaluable and the many species that compose it deserves to be protected (Lévêque and Mounolou 2008, Lêger, 2008, Marty et al., 2005, Aubertin and Vivien, 1998). The values of biodiversity are expressed through three fundamental points.

- Biodiversity plays a role in the great equilibria of the biosphere. In general, it participates in the cycle of water and in major geochemical cycles, including carbon and oxygen. It thus contributes to the regulation of the physicochemical composition of the atmosphere and influences the major climatic equilibria and therefore the conditions of life on earth.

- Biodiversity is a wealth to be exploited and valued. It constitutes a present and future vital resource for man. It supplies raw materials for the food industry, the pharmaceutical industry and perfumes, etc. The benefits of green tourism (ecotourism) should be considered.

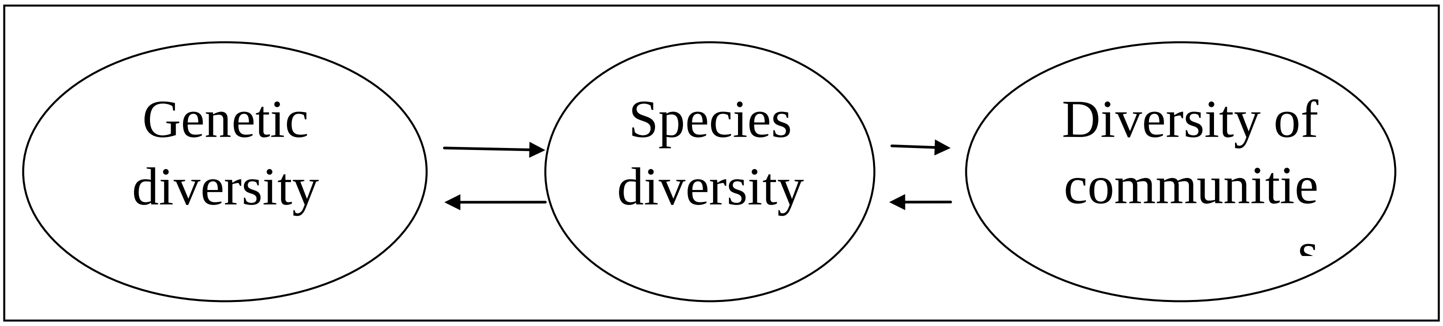
- The Rio conference and the debates surrounding the conservation of biodiversity have clearly demonstrated that the ethnic value of biodiversity has a moral dimension. The disappearance of species poses to humans the fundamental moral problem of its relationship with other forms of life and its responsibility in maintaining the diversity of living forms.

According to Mediouni (2000), biological diversity is a part of our lived, living, socio-cultural, economic and material heritage. Its development enhances our collective wealth and the inheritable resources of future generations.

Genetic diversity

Diversity of communities

Species diversity



Pic 8: The various levels of organization of biodiversity and their interrelationship (According to Ramade, 2008

Biodiversity, an autonomous and inalienable natural gift, derived from the evolution and organization of life on earth, are a foundation of the spatio-temporal equilibrium of our territory.

4. Floristic diversity in Algeria

The floristic diversity in Algeria reflects ecosystem diversity, in particular coastal zones, lowland areas, mountain areas, steppe zones and Saharan zones. These resources are important for the Algerian economy and for maintaining the ecological balance of these areas. The flora of Algeria is currently estimated at almost 4000 species (Dobignard and Chatelain, 2010-2013). According to these authors, the total flora of the national territory is currently estimated at 3744 species. This flora extends over an area of more than 2 million km², opening on the Mediterranean by a coastline more than 1200 km long and stretching from North to South by a length of nearly 2000 km. The Sahara, which occupies nearly 87% of its

surface area, has only a small proportion of this flora, with about 1200 species for the whole of the Sahara (Ozenda, 2004) and 668 for the Algerian Sahara (Benhouhou pers. Com.).
A detailed analysis of the Algerian flora for all the phytogeographical sectors of Algeria, including the Sahara, shows that of the 1919 taxa having a heritage value, 308 taxa are Saharan (Véla and Benhouhou, 2007). From this study we present the percentage of rare and common species in northern Algeria (all phytogeographic sectors combined) and the Sahara (Table VI).
Table VVI: Distribution of taxa by level of rarity / abundance for Northern Algeria and Sahara.6 Causes d'altération de la diversité biologique en Algérie
Overall, the decline in biodiversity affects all the natural ecosystems of Algeria (MATE, 2003). Of all the natural ecosystems, forests and wetlands are characterized by a marked decrease in their areas and biodiversity. The less productive terrestrial ecosystems, that is to say the steppe zones and Saharan zones, are also characterized by a decrease in their biodiversity
The major causes of the alteration of biological diversity in Algeria are essentially anthropogenic, usually aggravated by climatic factors. Thus, for the Saharan ecosystem, anthropogenic factors (overgrazing, destruction of woody vegetation, hunting and poaching) combine physical factors such as drought, wind and water erosion and the phenomenon of salinisation (MATE, 2009).

5. Conservation of biodiversity

For a long time scientists have accumulated knowledge about nature without worrying about the conservation of natural systems and their biological diversity (Lévêque and Mounolon, 2008). With the degradation of ecosystems accelerating, the conservation of biodiversity has become a necessity.
Generally, concern for the conservation of biological biodiversity is based on the principle that it is a world heritage, natural resources that must be preserved (Barbault, 1995). An important step in the conservation of biodiversity was taken in Rio de Janeiro in 1992 at the United Nations Conference on Environment and Development (UNCED). The Convention on Biological Diversity (CBD) is one of the main agreements resulting from the "Planet Earth" Summit. The objectives of the Convention are set out in Article 1 of the CBD as:
"... conservation of biological diversity, sustainable use of its components and fair and equitable sharing of benefits arising from the utilization of genetic resources, including through satisfactory access to genetic resources and appropriate transfer of relevant

technology , Taking into account all rights to such resources and technology, and with adequate funding ".

Chapter II Biodiversity Overview

Algeria ratified the Convention on Biological Diversity in 1995. It has incorporated the global objectives and indicators adopted under the Convention into its national biodiversity strategy and action plan. Similarly, it has devoted considerable effort to the conservation of biological diversity.

Moving from an institutional level to an effective and operational level of biodiversity conservation, research is undeniably a prerequisite. The collection and knowledge of biological diversity, in particular flora, is carried out through research programs.

Better knowledge of biodiversity will make it possible to better protect and use it for sustainable socio-economic development. Protecting and valorising a species or an ecosystem suggests a knowledge of these ecological requirements and therefore of its autoecology, its synecology and its functioning.

A major effort must be made to build capacity to conduct research in the field of biodiversity and to implement biodiversity protection, especially in developing countries.

Saharan ecosystems have an interesting biodiversity. However, it is strongly weakened by the increase in anthropogenic activity. Knowledge of the floristic diversity of the Saharan environments for its conservation is a major research objective and for which this work constitutes a modest contribution.

6. Biodiversity assessment

Since the Rio Conference in 1992, the natural resources of the world and those of the region Mediterranean, among others, has been distinguished under the same title, namely the Biodiversity. Many international programs are currently Threats to biodiversity (OUELMOUHOUB, 2002).

To assess the biodiversity of our study sites, we have taken into account the Floristic diversity. The most commonly used parameters are described below.

Total wealth (S)

Total wealth S is the total number of stand species observed. She is
Considered as a fundamental element of a community of species (BLONDEL,1979).

Average wealth (s)

According to RAMADE (1984), the average wealth s corresponds to the average number of species

Present in N readings.

Shannon Index

The quantitative study of biodiversity can be carried out by different approaches that are Based on the use of indices of floristic diversity. Among these indices, we have That of Shannon which is expressed by the following formula (BLONDEL et al 1973).

$$H' = - \Sigma Pi \, Ln \, Pi$$

Or :

Pi is the abundance of species i.

H 'measures the amount of information given by the indication of the species of an individual of the

Collection, from the proportions of species observed there. It varies according to The richness and distribution of species abundance of biotopes considered. The Wealth is high and the distribution of abundance balanced, the greater the diversity.

In order to better evaluate the biodiversity we also considered the index Of equitability which makes it possible to measure the degree of equilibrium and which is expressed by the formula:

$$E = H' / H'max$$

With: H '= Ln S

Where: S is the number of species

The value of the equitability (E) varies between 0 and 1. If the value of E tends to 0, it is said that the Stand is in imbalance. When E tends to 1, it means that the stand is in

(RAMADE, 1984).Being noted from 1 to 6 in the matrix analyzed.

Conclusion

The importance of the conservation of all three fundamental levels of biodiversity (ecosystems, species and genes) has been widely acknowledged, In order to facilitate the assessment of biodiversity, considerable efforts have been made towards identifying surrogates because the efficient evaluation of regional biodiversity would help in designating important areas for nature conservation at larger spatial scales

Chapter III
Methodology

Introduction

The methodological approach adopted for the study of vegetation is based on the Sigmatist method, elaborated by Braun-Blanquet (1952). This approach includes two steps:

·An analytical step that corresponds to the realization of the floristic surveys;

·A synthetic step corresponding to their analysis and comparison

Enabling the identification of similar sites in relation to factors of middle. For the synthesis step we have based ourselves on numerical analyzes, which Are currently widely used for the processing of plant data (ABDELKRIM 2004). Note that we did not make a diagnosis Phytosociological, the objective of the work being oriented towards the evaluation of the biodiversity of the some sites of the wilaya of El Oued Sampling and harvesting of floristic data The type of sampling chosen is subjective sampling, it is the most Simple and most intuitive sampling (GOUNOT 1969). The choice of surfaces for Must be carried out at two levels of perception (MEDDOUR 2004). The first Level relates to the scale of plant formations where observations are general and Fast. They are based on the homogeneity and representative of the overall structure of the

Vegetation without going into details. The second level concerns observation within the training and Area, and must be more detailed and more precise. It is based on the repetition Of the same species combination on a certain surface "called surface Floristically homogeneous ". This criterion plays the main role in the choice of site (GOUNOT, 1969, LACOSTE & SALANON, 2001).

Other criteria of homogeneity are chosen in the choice of the location of the As topographical, edaphic, geological. It should be pointed out that these Criteria are often difficult to determine accurately. In the case of our sampling sites, in addition to the criteria mentioned above, we Are directed to the following sites: Douar El Ma, Ben Guecha, Taleb Larbi (Pic 9)

1.Size of statements

In order to obtain a complete and sufficient idea of the vegetation which it is proposed to study, It is necessary to determine the minimum area. It is defined by GOUNOT (1969) As the smallest area on which almost all species of the community Are represented; It varies according to plant formation and the diminution of the association individual. According to GOUNOT (1969) and GUINOCHET (1973), the minimum area is delimited using Of the area-species curve after obtaining a plateau, indicating that the maximum Of species has been taken into account. The minimum area usually used in the study of forest formations varies Between 100 and 400 m², from 20 to 50 square meters for grassland and Lawns and a few square meters when these formations are very dense and homogeneous (OZENDA, 1982).

In the case of our surveys, the minimum area chosen varies between 25 and 100 Square meters depending on the biotope considered. For forestry training we have opted for an area of 100 m² and for shrub and open formations we have retained 25 m² (De BELAIR 1990).

2.Realization of floristic surveys

The completion of the statement must comply with the principles mentioned above and also with the That the synthesis step requires for the comparison of the readings between them (LACOSTE & SALANON, 2001).

The phytosociological survey must be supplemented by precise indications allowing its Identification and its location in space and time. The main indications Are: date, geographical location, altitude, slope, exposure, soil type, Survey area, recovery rate and dominant species. Each species is accompanied by a coefficient of abundance-dominance. This last Takes into account the relative space occupied by all the individuals of the same species (GUINOCHET, 1973). The two characteristics of abundance-dominance are evaluated In accordance with the BRAUN BLANQUET scale (1952) detailed below:

5: overlap greater than 75%, any abundance.

4: overlap of 50 to 75%, any abundance.

3: covering of 25 to 50%, any abundance.

2: very abundant species, covering over 5%.

1: scanty species.

+: Very scanty species, low coverage.

Within the framework of this thesis, we have produced 50 floristic From each commune. The period Sampling period coincided with the spring flowering period and The month of March / April and May 2017. A period during which the majority Of floristic species are in bloom.

3.Identification of species

The identification of the species was done in two phases: the common species were Recognized on the ground. Unidentified species were harvested, dried and then Determined using the flora of QUEZEL and SANTA (1962-1963), the different guides Of botanical forums on the Internet and the herbarium of the Department of botanical. Nevertheless, some species could not be determined due to the absence of Flowers and / or fruits for correct identification. We were forced to Remove from the list.

4.Treatment of plant data

The objective of a multivariate analysis is to simplify the raw data from Objective reduction of these raw data into a simpler and easier form Understandable to the user. In general, the numerical processing of the raw matrices Of data is achieved through the application of classification and ordination.

5.Classification

Classification is a technique of analysis whose principle is to collect the objects Which have a degree of similarity sufficient to be combined in the same class. The calculation Of an index of similarity makes it possible to combine the most similar elements in the same class. The classification leads to a hierarchy of dichotomous type and allows Effective delimitation of homogeneous classes (BRIANE, 1994).

6.Ordination

It is a multivariate analysis that involves several variables. It summarizes The information contained in the data on a reduced number of dimensions reflecting Better the proximities between object (relays) and / or between variables (species) (LINCY, 2003).

Among multivariate analysis techniques, factor analysis Correspondence (AFC) is widely used in ecology (MEDDOUR, 2004). This method is very appropriate for the description of the vegetation whose effectiveness Appears in the individualization of plant groups according to gradients Ecological factors. However, the AFC has a major disadvantage in The graphic expression of the results and which is characterized by the distortion of the original cloud Of points known as the Guttman effect (McCUNE & GRACE, 2002). The resolution Mathematician of this problem has allowed the development of a new technique, the Of relaxed correspondence (DCA) (HILL & GAUCH, 1980 in OUELMOUHOUB, 2002). The latter was selected to analyze our data. The software used for the analysis of our data is the

PC-ORD (Mc CUNE ET MEFFORD, 1999). We have classified through a cluster Analysis and an ordination through a "Detrended correspondence analysis" (ACD) on Our matrix of 60 collected and 100 species. For the purposes of the analysis we have An increase in the scale of one unit, the coefficient of abundance-dominance Thus

7 Phytogeographic types

In order to evaluate the phytogeographic diversity of taxa, it is customary to define the chorological types. Species are attached to various categories according to the similarity of their range or phytogeographical origin. Species characterized by the same chronological type constitute what is called a chronological element (Senterre, 2005). The set of chronological types is expressed as a percentage.

Information on the biogeographical origins of species was also taken from the flora of Algeria (Quézel and Santa, 1962-1963.(

8.Biological Types

The biological types or life forms defined by Raunkiaer (1934) allowed to classify the plants according to their size and the position of the buds of renewal in relation to the surface of the soil. This criterion is used to account for the ability of the plant to endure the unfavorable season. The Raunkiaer classification recognizes the following main life forms:

Phanerophytes: large woody plants exceeding 0.25 m, with aerial replacement bud. The trees, shrubs, shrubs and creepers can be distinguished;

The chaméphytes: woody or herbaceous plants with alternate buds, more or less high above ground, but not exceeding 0.25 m in height, are represented by shrubs and perennial grasses;

Hemicryptophytes: Herbaceous plants with continuous or discontinuous assimilation, with replacement bud at ground level. They are characterized by basal rosette leaves;

Geophytes or "soil plant": renovating buds are hidden in the soil. We distinguish bulbous, tuberous, or rhizome geophytes;

The therophytes: monocarpic plants completing their development during the favorable season, with total existence not reaching a full year: winter or spring.

Determination of the biological spectrum of vegetation makes it possible to know the relationships which show the dependencies between the distribution of biological types and the factors of the environment (Ellenberg and Mueller-Dombois 1966, Floret et al., 1990)

The percentage of the various biological types characterizing a plant formation is illustrated by the biological spectrum. This spectrum informs about the environment in which the formation studied is located. In arid zones, the development of the biological spectrum is often difficult, as species often behave differently depending on the specific conditions of the environment.

Chapter IV
Results and discussion

Introduction:

In this chapter, we have the results of the analysis of the phytodiversity of the species collected in our zone of study. This phytodiversity is expressed through the specific wealth, specific diversity, the equitability, the systematic composition, the endemism, the scarcity, the biological and phytogeographical standards. During the period of sampling carried out during the months of April and May 2017, we took 50 phytosociological statements in Fifteen stations through the courses of the wilaya of El-Oued (Table VI)

Table VI: location of statements

Name of location	*Number of statements*	*N° of statement*
Sahn bou Guamza	4	R1-R2-R3-R4
Echeaanba	4	-R5-R6-R7-R8
Sbayes	4	R9-R10 R11-R12
El mkhalia	4	R13-R14-R15-R16
Akibe	4	R17-R18-R19-R20-
El mkhalia ouest	4	R21-R22-R23-R24
Bouras	3	R25-R26-R27
Douilat	2	R28-R29
Erguaat	3	R30-R31-R32
Byar jdod	3	R33-R34-R35
Chott tella	3	R36-R37-R38
Kour Jwali	3	R39-R40-R41
Garet tir	3	R42-R43-R44
Boukhayal	3	R45-R46-R47
El Irg	3	R48-R49- R50

1. Analysis of floristic diversity:

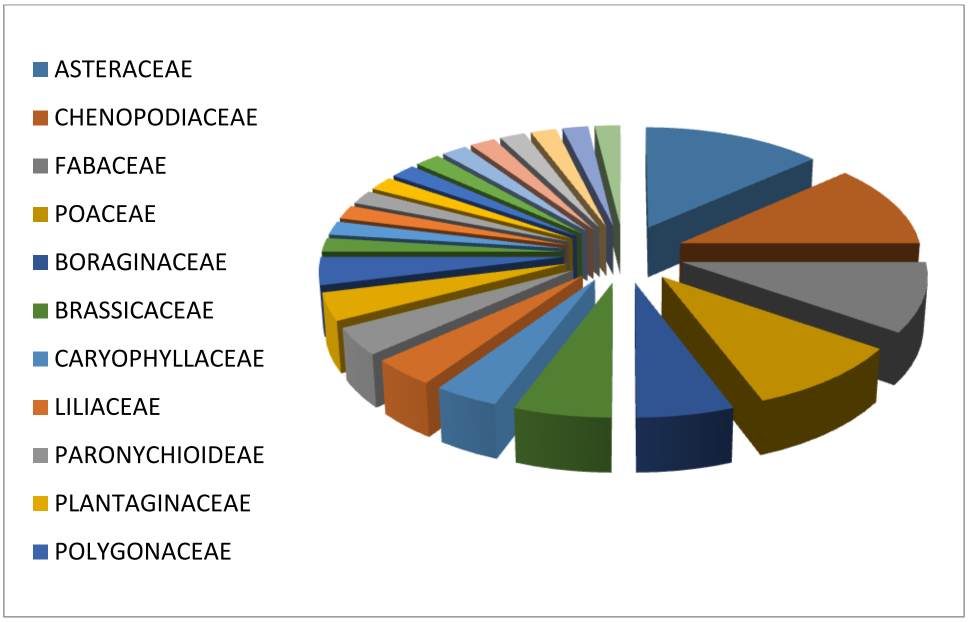
1.1. Taxonomic characterization

The principal indexed families are represented on the level of the tableauVII.

Table VII: Specific importance of the principal listed families:

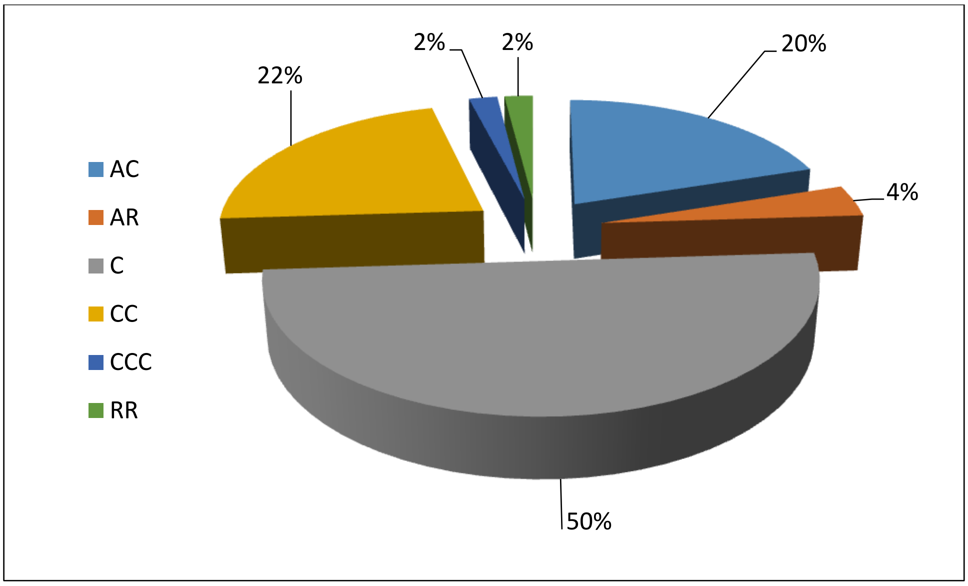
Families	Nbre of species	Families	Nbre of species
Asteraceae	7	Cyperaceae	1
Chenopodiaceae	6	Ephedraceae	1
Fabaceae	5	Euphorbiaceae	1
Poaceae	5	Geraniaceae	1
Boraginaceae	3	Polygonaceae	2
Brassicaceae	3	Rosacee	1
Caryophyllaceae	2	Tamaricaceae	2
Liliaceae	2	Thymelaeaceae	1
Paronychioideae	2	Zygophyllaceae	1
Plantaginaceae	2	*Malvaceae*	1
Apiaceae	1	*Scrophularaceae*	1
Cistaceae	1	*Plumbaginaceae*	1

The Asteraceae occupy the first place and have the largest number of species (07 species), followed by Chenopodiaceae (06 species) and Fabacea (05 species). The Poaceae follow with 05 species, Brassicacea and Boraginaceae three species, Liliaceae, Paronychioideae, Caryophyllaceae and Plantaginaceae two species. The remaining 14 families are slightly represented, the number of species is 1 species (Picture 10).



Picture 10: Botanical families of sampled sites.

Concerning the scarcity of species, we have chosen the scarcity scale proposed by QUEZEL & SANTA (1963). The percentage of all categories are shown in Picture 11.



Picture 11: Spectrum of scarcity of sampled sites

The common category (C) represents 50% of all species listed, 22% are very common (CC), 20% common enough (CA) and 2% very common (CCC). The relatively rare and rare categories are represented respectively by 4%, 2%. These include Calobota saharae (Coss. & Dur.) Boatwr. & B.E.van Wyk (AR); *Astragalus gyzensis Del (RR), Lotus halophilus Boiss. & Spruner (AR).*

Overall systematic composition

The taxa composing the different plant groups identified were grouped into families, this was done from the flora of Quézel and Santa (1962-1963).

The taxa recorded in our study area (52 species) are divided into 24 botanical families, each with a variable number of species and genera (Table VIII).

Table VIII: Number of genera and species per family in the study area

Families	**Species**	**Genera**
Asteraceae	7	7
Chenopodiaceae	6	6
Fabaceae	5	4
Poaceae	5	4
Boraginaceae	3	3
Brassicaceae	3	3
Caryophyllaceae	2	2
Liliaceae	2	2
Paronychioideae	2	2
Plantaginaceae	2	1
Polygonaceae	2	1
Apiaceae	1	1
Cistaceae	1	1
Cyperaceae	1	1
Ephedraceae	1	1
Euphorbiaceae	1	1
Geraniaceae	1	1
Rosacee	1	1
Tamaricaceae	1	1
Thymelaeaceae	1	1
Zygophyllaceae	1	1
Malvaceae	1	1
Scrophularaceae	1	1
Plumbaginaceae	1	1

It should be noted that of the 24 families surveyed 15 are represented by only one species (mono-specific). However, 9 families, namely Asteraceae, Chenopodiaceae, Fabaceae, Poaceae, Boraginaceae, Brassicaceae, Liliaceae, Paronychioidea and Caryophyllaceae account for more than half of the species inventoried. The Chenopodiaceae is the most numerous because of their well-known adaptation to salt soils.

1.2. Biodiversity analysis

The analysis of biodiversity is assessed through two essential parameters: specific richness (total specific richness and average richness) and specific diversity.

Specific wealth

A- The total specific richness

The total number of species observed in our study area is 52 taxa, ie 1.56% of the Algerian flora estimated at 3139 (Quézel and Santa, 1962-1963). This percentage has probably lowered if the Pictures proposed by Dobignard and Chatelain (2010-2013) are included. These taxa are divided into 24 families (Appendix I).

B- Average wealth

In the sampled sites, the average wealth calculation was based on the 50 floristic surveys selected for the analysis of the data.

The average wealth is 14 species per survey, 30 species being the maximum number harvested in a survey and only one species is the minimum number observed for a survey.

C-Specific diversity

The analysis of the specific diversity is based on the Shannon-Weaver indices and fairness. The calculation is carried out on a data matrix composed of 52 species belonging to 50 records. The results of the two indices are shown in Table IX.

Table IX: The Shannon Index and Equity for the Study Area

Parameters	Valeus
Indice o Shannon (H')	5,62
Equitability (E)	0,91

According to Table XIII, the value of the Shannon index is high (H '= 5.62 bits). This value means that our species are distributed more or less evenly with a balanced distribution of abundance for all floristic surveys.

The value of fairness tends to 1, which means that the species are distributed in a balanced way, ie most species have equivalent levels of abundance.

2. Multivariate analysis of data

The analysis of the floristic surveys was carried out on an initial matrix consisting of 50 surveys and 52 species. In this analysis, two statements (R23 and R30) were eliminated due to their eccentric position within the cloud of projected points on the first factor plane. These are heterogeneous surveys carried out in the regions; Of Douar El Ma, Ben Guecha, Taleb Larbi Tabi) -Table VVI- where mainly the psammophile species in mixtures with species typical of reg. The final matrix, on which we have carried out the digital processing, is therefore made up of 50 surveys and 52 species. This matrix was subjected to a relaxed correspondence analysis (DAC) and an ascending hierarchical classification (CHA) corresponding to the cluster analysis of the software used. At the level of our matrix, the lines are represented by

the statements and the species by the columns. At the intersection surveyed-species (row-column) is noted the abundance-dominance of the species.
The software used for these analyzes is the PC-ORD. Version 04 "(Mc Cune and Mefford, 1999).

2.1 Analysis of relaxed correspondence

The results obtained from the CDA applied to the data matrix are of two types. They are expressed mathematically by the eigenvalues and the inertia rates of the factorial axes extracted from the analysis on the one hand and on the other hand graphically through the orthogonal planes of the factorial axes obtained. For our analysis we present only the eigenvalues of the three axes produced by the DCO and which are the following:

- Axe1: 0.86;
- Axe 2: 0.36;
- Annex 3: 0.27.

Due to the particularly high eigenvalue for axis 1 and to a lesser extent that of axis 2, we have retained only the first two axes for the representation of the statements and the species on the graphs. Note that in most multivariate ecological data applications, the first two axes provide the maximum amount of information contained in the data matrix (Dervin, 1988; Bonin and Tatoni, 1990).

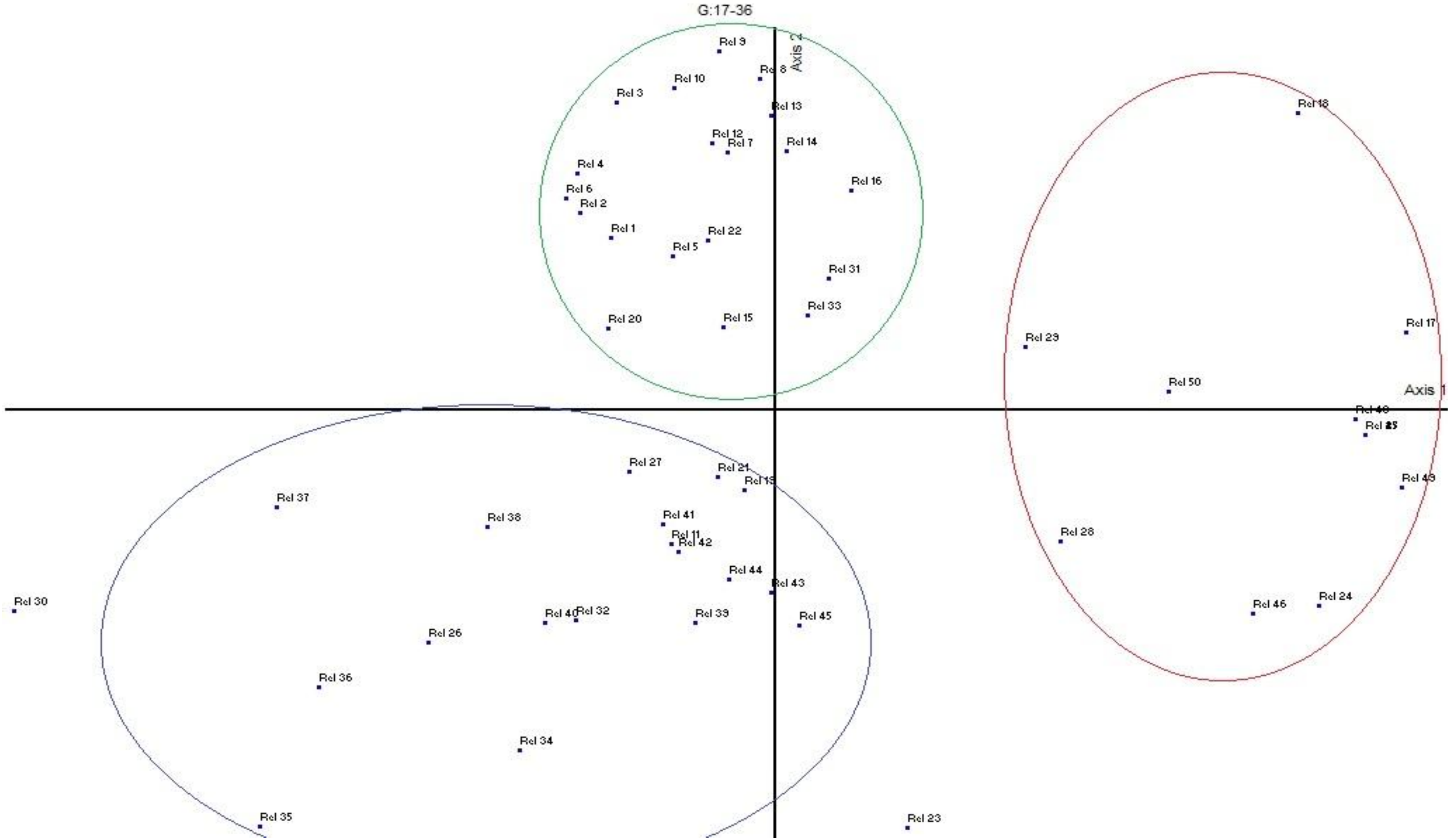
2.1.1 Individualization of survey groups

The analysis of the factorial map of the statements of the plan 1-2 (Picture 12) reveals a distribution of the statements into three distinct sets.
The set I: individualized at the end of the negative part of axis 2. It is composed of 18 statements: R11, R13, R21, R26, R27, R32, R34, R35, R36, R37, , R40, R41, R42, R43, R44 and R45.
- Set II: located in the positive part of the factorial plane. It occupies largely the positive quadrant (+1, -2) and an average portion of the quadrant (+1, +2). It is. It comprises 19 statements: R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R12, R13, R14, R15, R16, R20, R22, R31 and R33.
- Set III: located in the positive part of the factorial plane. It occupies a part of the positive quadrant (+1, +2) and part of the quadrant (+1, -2). It is composed of 11 statements: R17, R18, R19, R21, R24, R25, R28, R40, R43, R46 and R50.
The projection of the species on the factorial plane 1/2 illustrates the characteristic species of each of the three main sets highlighted (Picture 13).

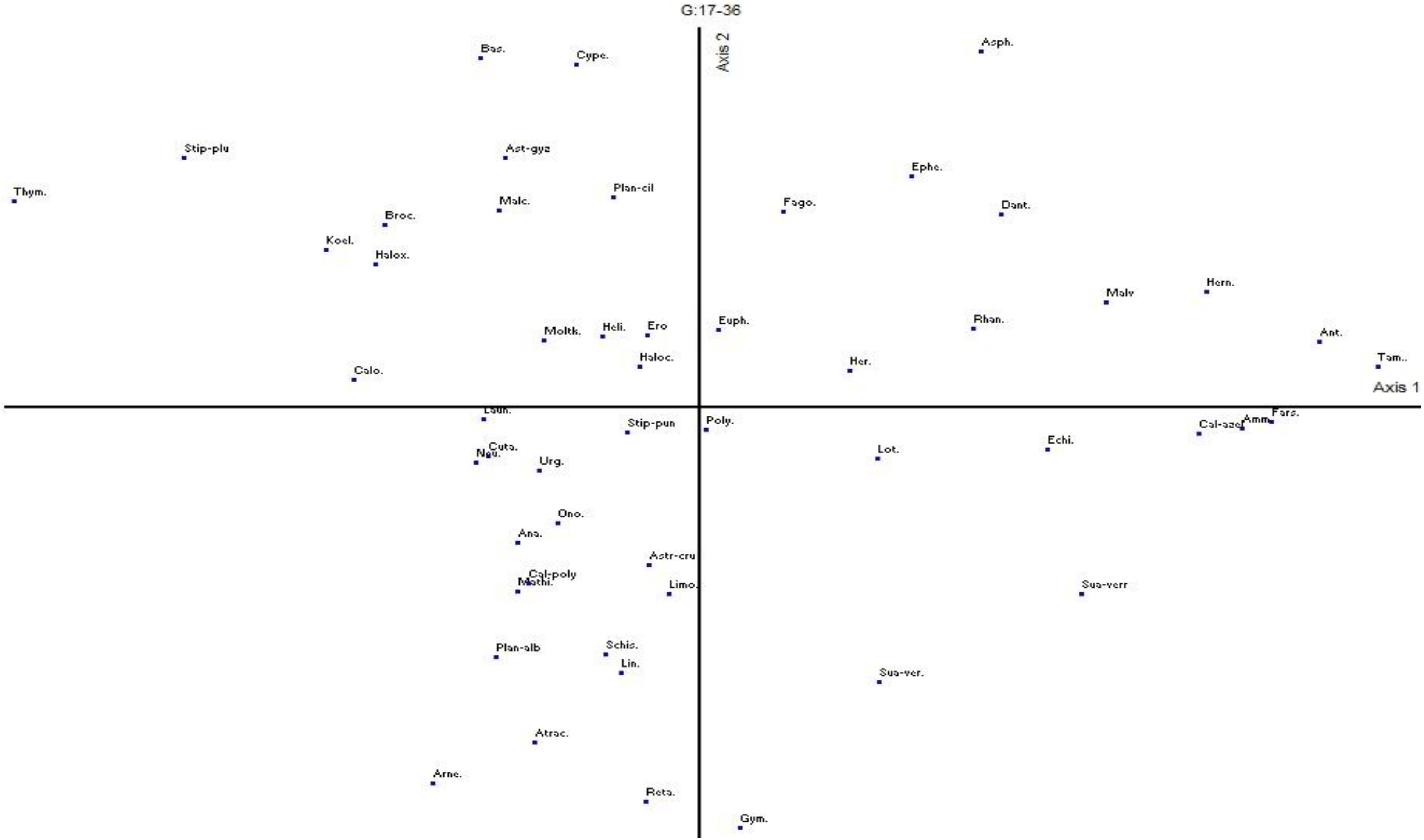
2.2 Hierarchical ascending classification

The ascending hierarchical classification (HAC) or "cluster analysis" confirms and clarifies the floristic groups identified by the analysis of relaxed correspondences. This analysis makes it possible to compare the position of the statements on the factorial map and to objectively delineate the individualized sets.

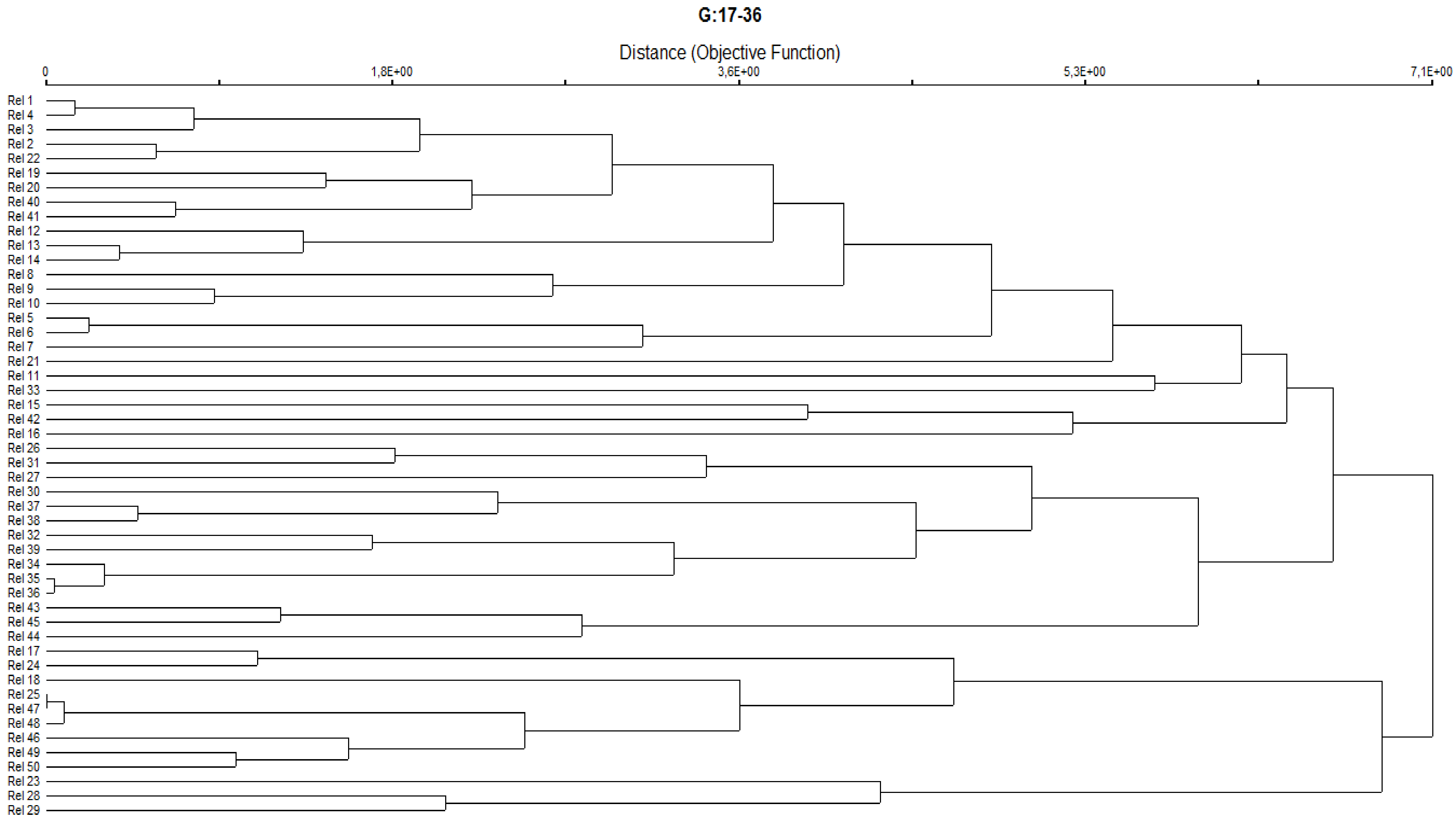
The results obtained made it possible to distinguish three sets (Picture 14).



Picture 12: Factorial map of the 50 records on the factorial plane ½ of the DCA.



Picture 13: Factor map of the species on the factorial plane 1/2 of the DCA.



Picture 14: Hierarchical bottom-up classification of 50 surveys

2.3 Ecological and floristic characterization of the identified sets

The superimposition of the species factor map to that of the surveys makes it possible to visualize, for each set retained, species associated with it. Moreover, the observations made on the ground allow us to realize a floristic and ecological characterization of the different sets.

<u>The set I</u>

This set consists of 18 statements and 45 species made at El mkhali, Bouras, Erguaat, Byar jdod, Chott tella, Kour Jwali, and Garet tir. The surveys were conducted at an average altitude of 86 m on a sandy substrate. Recovery is low, it is about 25%.

Physiognomically this group is characterized by a dominance of psammophilous species such as *Calobota saharae, Stipagrostis pungens, Euphorbia guyoniana, Cyperus conglomeratus, Calligonum azel, Calligonum polygonoides subsp. Comosum, Ephedra alata, Koelpenia liniaris Pallas, Stipagrostis plumosa, Moltkiopsis The ciliata, Plantago ciliata, Polycarpaea repens* and *Danthonia forskahlii*.

<u>Set II</u>

It consists of 19 records and 43 species recorded at Sahn bou Kamza, Echeaanba, Sbayes, El mkhali, Bouras, Erguaat, Byar jdod,. The latter were carried out at an average altitude of 40 m, on a soil with a coarse sandy texture, sometimes with the presence of gypsum crust in some surveys. The average overall recovery is of the order of 27%.

Physiognomically this is a training in Anabasis oropediorum. This formation is characterized by the presence of psammophilous species such as: *Retama retam, Astragalus cruciatus, Euphorbia guyoniana, Neurada procumbens, Stipagrostis plumosa, Calligonum polygonoides subsp. Comosum, Plantago albicans*. In addition, this group presents some gypso-halophilic species: *Limoniastrum guyonianum, Tetraena geslinii* and *Suaeda vermiculata*.

<u>Set III</u>

This set consists of 11 records from Akibe, El mkhalia oust, Bouras, Bukhayal and El Irg. The latter were carried out at an average altitude of 97 m, on a substrate where the sandy element dominates. The average overall recovery is of the order of 27%. The sandy texture is illustrated by the presence of psammophilous species at high frequency such as: *Stipagrostis pungens, Euphorbia guyoniana, Turra, Calligonum azel, Calligonum polygonoides, Ephedra alata, Polycarpaea repens,* and *Moltkiopsis ciliate*

2.4 Interpretation of Factor Axes

The organization of the surveys along the axes considered (axis 1 and axis 2), the ecology of the species belonging to these surveys and the eigenvalues of the two axes makes it possible to propose the most important ecological gradients in the distribution of the vegetation. It is also necessary to specify that the determination of these ecological gradients is often difficult because of the complexity of the Saharan habitats and the plasticity of many Saharan species.

2.4.1 Ecological significance of axis 1

The particularly high eigenvalue for axis 1 suggests the existence of a complex gradient. Referring to the factorial maps of the surveys (Fig. 9) and the species (Fig. 10), after analyzing the floristic contents of the surveys and

surveys and the field notes for the general characteristics of the stations in question, axis 1 is Characterized by the following ecological elements:

In its negative part, the surveys were carried out at altitudes ranging from 70 m to 135 m and up to 165 m. Moreover, the species evolve on soils with coarse and sandy textures. This explains the installation of species with an ecological preference for soils that have coarse textures such as: *Anabasis articulata, Thymelea microphylla, Koelpenia liniaris* and *Plantago albicans*, or other species of psammophilous species, such as *Stipagrostis pungens, Calligonum polygonoides, Brocchia cinerea* and *Retama raetam*.

- In its positive part, the surveys were carried out at low altitudes varying between - 20 m and 50 m. Moreover, the species evolve on soils with a clay-loamy texture, with a higher or lower salinity. This is illustrated by the presence of well known halophilic species such as *Herniaria fontanesii*, *Lotus halophilus, Suaeda vermiculata*, *Limoniastrum guyonianum* and *Rhanterium suaveolens*

Thus, axis 1 translates from the negative side to the positive side, a sandy textural gradient towards silty soils and a finer texture, with an increasing gradient of soil moisture and salinity superimposed on it. This complex gradient contrasts the species of habitats with sandy and dry soils to those of humid and saline soils.

2.4.2 Ecological significance of axis 2

The bursting of the statements along axis two is not very important. The same is true for the eigenvalue (0.36). This suggests a slightly marked gradient.

In its negative part, the surveys were carried out on sandy-loamy soils with very frequent limestone outcrops. The most frequent species that reflect this ecology are saxicoles, strict calcicoles and tolerant gypso-saxicoles (Quézel, 1965). These include: Atractylis serratuloides Gymnocarpos decander, Polycarpaea repens, Arnebia decumbens, Farsetia aegyptiaca and Urginea noctiflora.

In its positive part, the species are derived from surveys carried out on sandy loam soils with a clay crust of varying size on the surface. Sands are present but in the form of thin veneer winds. The most frequent species are: Asphodelus refractus, Malcolmia aegyptiaca and Haloxylon articulatum,

The elongation obtained along the axis 2 again brings out the influence of the substrate through its texture. It is thus a complex edaphic gradient which governs the distribution of species along the axis 2 where opposed on the one hand saxicole species, strict calcicoles and gypso-saxicoles and on the other hand halophiles Preferring sandy loamy textures.

Conclusion

The results of the ACD, confirmed by the hierarchical classification, made it possible to distinguish four distinct floristic groups. Each of these groups has been characterized in floristic and ecological terms. In addition, interpretation of the results determined the main factors governing the distribution of vegetation in our study area.

General conclusion

General conclusion

The purpose of this work is to describe the vegetation observed at the level of some habitats encountered around the El Oued region. This description focuses on the floristic and ecological characterization of the main plant groups identified in the study area. This vegetation is characterized by an appreciable biological diversity, as well as by the originality of its flora perfectly adapted to extreme pedo-climatic conditions.

The climatic study and the bioclimatic synthesis made it possible to know the fundamental feature of the climate of the region of El Oued. It is located on the Saharan bioclimatic stage in mild winter with an annual precipitation not exceeding 80 mm.

In order to meet the objective of this study, 50 plant surveys were carried out according to a subjective sampling at the level of fifteen stations around the El Oued region during the month of April and May 2017. This sampling allowed To identify 52 species.

The specific diversity of our study area is important (H '= 5.62 and E = 0.91), these values appear when most species have equivalent levels of abundance.

This analysis also underlines the heritage value of the flora of our study area, especially through its rare and endemic elements. Thus, out of 52 taxa identified, 13 are endemic, representing an endemism rate of 25.00%.

Rare taxa contain 6 taxa depending on the flora of Quézel and Santa (1962-1963), whereas most of the species inventoried in this study are considered common or fairly common.

According to the results obtained, we can say that our study area offers an interesting floristic diversity and an appreciable richness of the patrimonial. This flora deserves to be conserved through the adoption of adequate conservation measures.

The data collected in the field underwent a double numerical treatment, namely a relaxed correspondence analysis (DCA) and a hierarchical classification followed by a syntaxonomic analysis.

The numerical analysis made it possible to identify the ecological factors governing the distribution of these different groups. These are the salinity and texture of the soil, which are the determining factors and to which are added to a lesser extent the soil moisture and the altitude.

The results obtained made it possible to individualize three floristic groups corresponding to three plant associations.

This work therefore constitutes a contribution in the knowledge of the vegetation of the region of El-Oued. This study is original because the sites were examined in detail for the first time and the results obtained reinforced the phytosociological edifice proposed by Quézel (1965) and Géhu et al. (1994).

The prospects for research on the vegetation of this region can be oriented on the one hand towards a precise mapping of the main associations identified and on the other hand a floristic and ecological characterization of the latter allowing a better management of the routes of the region.

Finally, at the end of our study on the flora of the El Oued region and for which we have made a modest contribution, it is necessary to continue the field investigations in order to clarify and update the data on the " Ecology, chorology and the current status of species. These field studies should therefore be pursued by further research in order to have a more thorough assessment of the phytodiversity of this particular study area and of the whole of the Saharan zone in general.

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Annex

Annex I : global floristic List

Familles	Espèces	Type biologique	T.phytogéographique	Degré de rareté	Nom commun
APIACEAE	*Ammodaucus leucotrichus Coss. & Durieu*	Cham	SA	AC	Oum draiga / Kamoune l'Ibel
ASTERACEAE	*Launaea capitata (Spreng.) Dandy*	Ther	SA	AC	Adide
	Brocchia cinerea Vis.	Ther	SA	CC	Chehia
	Koelpenia liniaris Pallas	Ther	SA	AC	Grayn Ghzal
	Atractylis serratuloides Sieber ex Cass.	Ther	SA	AC	Ser
	Rhanterium suaveolens Desf.	Ther	SA	C	Arffadj
	Anthemis stiparum Pomel	Ther	SA	C	Arbyane
	Onoprdon macracanthum schousb	Ther	SA	C	khorchof
BORAGINACEAE	*Moltkiopsis ciliata (Forssk.) I.M.Johnst.*	Cham	SA	C	Halma
	Arnebia decumbens (Vent.) Coss et Kral.	Ther	SA	C	Hommayr
	Echiochilon fruticosum Desf			AC	Hamret ras
BRASSICACEAE	*Malcolmia aegyptiaca*	Ther	SA	C	el harra
	Mathiola livida DC.	Ther	SA	C	Echchakra
	Farsetia aegyptiaca Turra	Hémicr	SA	C	Felfel sahraa
CARYOPHYLLACEAE	*Herniaria fontanesii J. Gay.*	Ther	SA	C	Chhayba
	Polycarpaea repens (Forssk.) Asch. & Schweinf.	Ther	SA	C	Khnaynit Alouche
CHENOPODIACEAE	*Suaeda fruticosa auct. Afr. N. non L*	Cham	SA	C	Souide
	Bassia muricata (L.) Asch	Cham	SA	C	Ghobaytha
	Haloxylon articulatum Boiss	Cham	SA	C	El bakel
	Suaeda mollis (Desf.) Del.	Cham	SA	C	Souide
	Halocnemum strobilaceum (Pall.) M.Bieb.	Cham	M	C	Guerna
	Anabasis articulata (Forssk.) Moq.	Cham	SA	C	Bguel
CISTACEAE	*Helianthemum lippii (L.) Dum.Cours.*	Cham	SA	CCC	Rguig / Samhari
CYPERACEAE	*Cyperus conglomeratus Rottb.*	Cham	Tro	C	Saad
EPHEDRACEAE	*Ephedra alata Decne.*	Cham	SA	CC	Alanda
EUPHORBIACEAE	*Euphorbia guyoniana Boiss. & Reut.*	Hémicr	End	CC	T'mye/ Lobbayn
FABACEAE	*Calobota saharae (Coss. & Dur.) Boatwr. &B.E.van Wyk*	Phan	End	AR	Merkh
	Retama raetam (Forssk.) Webb	Phan	SA	C	R'tem
	Astragalus cruciatus Link	Ther	SA	C	Aaghifa
	Astragalus gyzensis Del	Phan	SA	RR	Dliliaa
	Lotus halophilus Boiss. & Spruner	Ther	MIT	AR	Dhaifa
GERANIACEAE	*Erodium glaucophyllum (L.) L'Hér.*	Ther	MSA	C	T'myer
LILIACEAE	*Urginea noctiflora*	Géo	SA	AC	Basi cifar
	Asphodelus refractus Boiss.	Ther	SahM	AC	Tazia
PARONYCHIOIDEAE	*Gymnocarpos decandrus Forssk.*	Cham	SA	AC	Djefna
	Herniaria fontanesii J.Gay	Cham	M	AC	Echchahba
PLANTAGINACEAE	*Plantago albicans L.*	Hémicr	M	CC	Inem
	Plantago ciliata Desf.	Ther	SA	CC	Lalma
POACEAE	*Stipagrostis pungens (Desf.) De Winter subsp. pungens*	Hémicr	SA	CC	Drinn
	Schismus barbatus (Loefl. ex L.)	Ther	M	C	Khafoura

	Thell.				
	Cutandia dichotoma (Forssk.) Trab.	Ther	M	C	Lmasse
	Danthonia forskahlii (Vahl.) R. Br.k				
	Stipagrostis plumosa (L.) Munro ex T.Anderson	Ther	SA	CC	N'sie
POLYGONACEAE	*Calligonum azel Maire*			C	Azel
	Calligonum polygonoides subsp. comosum (L'Hér.)Soskov	Cham	SA	C	L'arta
ROSACEE	*Neurada procumbens L.*	Cham	SA	C	Saadane
TAMARICACEAE	*Tamarix gallica L.*	Phan	SA	CC	Tamgal
THYMELAEACEAE	*Thymelaea microphylla Coss. & Durieu ex Meisn.*	Cham	MSA	CC	Methnane
ZYGOPHYLLACEAE	*Fagonia glutinosa Delile*	Ther	SA	CC	Cherrik
MALVACEAE	*Malva parviflora L*	Cham	MSA	CC	Khobaize
SCROPHULARACEAE	*Linaria peltieri Batt.*	Ther	SA	AC	Gussia
PLUMBAGINACEAE	*Limoniastrum guyonianum Dur*	Cham	MSA	CC	Zyta

Type biologique : Ther (Thérophyte) / Hémicr (Hémicryptophyte) / Cham (Chamaéphyte) / Phan (Phanérophyte) / Géo (Géophyte).

Type phytogéographique : M (Méditerranéen) / P(Pluri-régional) /SA (Saharo-arabique) / nd (Endémique) / MSA (Méditerranéo-Saharo-arabique) / Tro (Tropical) / SahM (Saharo-Méditerranéen

Résumé

La présente étude est une contribution à la connaissance et à la description des groupements végétaux au niveau de quelques habitats rencontrés aux alentours de la région d'El Oued. Les données sont représentées par 50 relevés floristiques réalisés selon un échantillonnage subjectif dans 15 sites de la région d'étude. Ces données sont traitées par l'analyse de la biodiversité et des méthodes numériques (DCA et CAH). Les résultats obtenus ont permis d'individualiser trois ensembles floristiques, correspondant à trois associations végétales, qui ont été définis et décrits lors de l'étude phytosociologique. L'analyse numérique a également permis d'identifier les facteurs écologiques régissant la distribution de ces différentes associations. Il s'agit par ordre décroissant de la salinité, la texture du sol, l'humidité et l'altitude. Les associations obtenus ont été comparées et rattachées aux unités supérieures décrites et hiérarchisées par Quézel (1965) et Géhu, Kaabbhèche et Gharzouli (1994).

Mots clés : Sahara septentrional oriental, El Oued, analyse numérique, facteurs écologiques, associations végétales.

Abstract

The present study is a contribution to the knowledge and the description of plant communities in a few habitats present in the neighbourhoods of El Oued. The data are represented by 50 floristic relevés realized according to a subjective sampling strategy in 15 sites of the study area. These data are processed by analyses of biodiversity and numerical methods (DCA and CAH). The results obtained allowed to individualize five floristic sets, corresponding to five plant associations, which were defined and described by a phytosociological study. The numerical analysis also allowed to identify the ecological factors governing the distribution of these different associations. These are, starting from the most important ones: salinity, texture of soil, moisture and altitude. The associations obtained were compared and attached to the higher units described and based on the hierarchy proposed by by Quézel (1965), Géhu, Kaabbhèche and Gharzouli (1994).

Keywords: The northern eastern Sahara, El Oued, numerical analyses, ecological factors, plant associations.

ملخص

هذه الدراسة عبارة عن مساهمة لمعرفة ووصف المجتمعا النباتية في بعض ضواحي منطقة الوادي. المعلومات المتحصل عليها تمثل 50 كشف نباتي طبقا للنمط الذاتي المأخوذة من 15 موقع بمنطقة الدراسة. هذه البيانات تم معالجتها بتحليل التنوع و من خلال الطرق العددية باستخدام التحليل التوافقي و تحليل الكتلة الهرمية.,النتائج التي حصل عليها سمحت لنا بتشخيص ثلاث مجموعات نباتية تمثل ثلاثة تجمعات نباتية التي حددت ووصفت بالطريقة الفيتوسوسيولوجية, التحليل العددي مكن ايضا من تحديد العوامل البيئية المتحكمة في توزيع هذه المجموعات المختلفة بمنطقة الدراسة والتي تتمثل في الملوحة , نوعيةالرتبة , الرطوبة و الارتفاع. وفي الأخير تم مقارنة و إسناد المجمعات النباتية الناتجة للوحدات العليا الموصوفة من قبل Quézel (1965)و.Géhu, Kaabbhèche et Gharzouli (1994)

الكلمات المفتاح الصحراء الشمالية الشرقية , - الوادي , التحليل العددي , العوامل البيئية