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Survey of the damp areas’ plant coverage diversity of Zahrez Chergui and Gharbi (Djelfa) and of the “Chott” el Hodna (M’sila) in Algeria

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The plant diversity of wetlands was analysed by two principal descriptors which are the bioclimate and the anthropic action. The impact of these factors was widely expressed by degradation and rapid substitution of the rug vegetal species. Dominated by the mediteranean elements (42%), that relatively poor flora (A total of 131species) was biologically characterized by a neat abundance of Therophytes (39%), the Chamaephytes (29%), the Hemicryptophytes (15%) and Geophytes (11%) to the detriment of the Phanerophytes (5%). The interpretation of the vegetation by the relevance factors has permitted to define the affinities between the different groups. This multidimensional treatment demonstrated the major importance of the anthropic and the bioclimatic factors that govern this dynamic. At the end of this study, the degradation of the soil privileged has been demonstrated by the anthropozoic action and the smaller amount of rain that caused the therophytisation; consequently, the quality of the soil could be described.

Key words: Plant diversity, flora, relevance factor, bioclimate, anthropic action.

INTRODUCTION

Actually, the desertification affects a quarter of the earth’s surface. In Africa, more than a billion hectares are moderately or severely affected by desertification. In Algeria, desertification affects 20 million hectares (arid steppe and semi arid where 3 million inhabitants live), every year, the desert invades 7000 000 ha from the arid area (Quitanilla, 2001). The concept of biodiversity has been popularized since the conference of Rio de Janeiro and the convention on biodiversity signed by many states (1992).

Consequently to this desertification issue, Algeria is confronted to a significant destruction of its vegetal rug, a decrease in both its soil fertility and ecological ecosystems productivity. 251 sampling and 131 species have been studied according to the relevance factors, but only 229 samplings were considered, based on the abundance dominance of the species that had as a result the following vegetation groups: The first was characterized by sand soils sampling with 98 samplings a vegetation covering of 30%, characterized by: *Aristida pungens, Saccocalyx saturoides, Malcolmia aegyptiaca, Silene arenareoides, Cutandia dichotoma,* the second group with 68 samplings represented the salty soils sampling with a vegetation covering of 20% , marked by the dominance of: *Limoniastrum guyonianum, Reaumuria vermiculata, Eroduim murinum, Halocnemum strobilaceum,*

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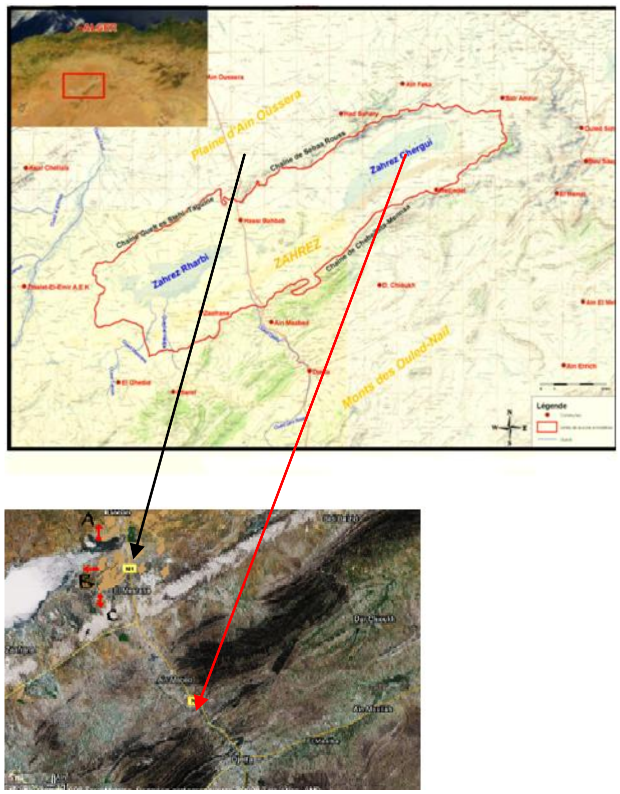

Figure 1. Location of points statements of halophytic vegetation in the dune environment and Zahrez.

Thymelea microphylla, salsola vermiculata, Spergularia salina. The third group at a southern side with 63 samplings and a covering of 32% was characterized by: *Juncus maritimus, Peganum harmala*, *Bellis annua*, *Arthrophytum scoparium, Atriplex halimus.*

The region of the chotts and the dune cordon of the basin of the zahrez indeniably constitute, by extension sand mass and also its hydric and eolien erosion an interesting material of study, in addition to the man's destruction of the vital species (Pouget, 1980; Senni, 2011). This dynamic is specifically accentuated around the Zahrez et al. (2004), concerning the salty soils, when the saltiness reaches a certain level, this can lead to degradation of the physical salinity and chemical criterion of the soil as well as the bioclimatic conditions. Parallel to the edaphic changes, important changes are observable on the vegetation; consequently, every modification of the area leads to a sensitivity and fragility of the vegetation and this causes the substitution of some species by others.

This work aims to analyse the steppe vegetation located on weatlands, the saharian Atlas, the Hodna Mountains and the dunes area. Most species can be identified by the Mediterranean chorological element (42%), the Saharo-arabian element (22%), and these element are the most representation for the region.

The Shannon evenness varies between 2 and 05 for The Groups 1 and 2 indicating that the medium is slightly rich in species and individuals, 3 and 35 for Group 3. This shows that individuals are distributed on heterogenous manner; it means that there is not an equal distribution of individuals among species. In addition, we will take a multidimensional analysis in order to jointly handle the floristic and ecological variables. This study will be addressed through the identification of plant grouping, their phytoecological and phytogeographic characterisation, the evaluation of the floristic diversity by the indexes of diversity, and on the other hand , the determination of aridity and biodiversity which constitutes an element of orientation for a strategy for the conservation of these formations.

MATERIALS AND METHODS

Study area

The study was conducted upon data extracted from phytecological surveys undertaken on the level of the weatlands, chott el hodna(M'sila) 35°18'-35°32'N/4°15'-5°06'E, 390 m a.s.l) is an area with 85 000 ha , This chott occupies the lowest, almost central, part of a basin at the eastern end of the High Plateau. The area flooded each year varies but is usually in excess of 80 000 ha and is some 77 km long and up to 19 km wide. The chott holds water only in the winter and is saline, with salts encrusting the muddy periphery in summer. Zahrez chergui (35°08'-35°19'N/3°24'-3°43'E751 m a.s.l) with19 500 ha, this chott occupies the eastern and lowest end of the trough holding the Zahrez Rharbi. The depression is fed by 11 oueds and the area subject to inundation, 34 km long and up to 9 km wide, is bounded by humid sands along the southern shore. An area of permanent swamp occurs at the western end, and the land rises from the eastern end to a high ridge separating this endorheic system from the Chott el Hodna farther east.

Zahrez gharbi (34°51'-34°58'N/2°36'-2°58' E, 826 m a.s.l) with 22 000 ha (Djelfa) located at 200 km in the north of Algiers (Algeria, Figure 1). The inundated zone of the Zahrez Rharbi is 25 km long and up to 10 km wide, with a cool winter and precipitations ranging from 275 to 326 mm, (mean values from the years 2002 and 2008), the system is endorheic and saline. The dominant seasonal distribution of rainfall in the region is of type HPEA (winter, spring, summer, autumn) respectively the region is categorized as semi – arid, the most common to this area is the endemic species (*Herniaria mauritanica)* classified as an Algerian endemic plant in the Quezel and Santa (1963) flora, and Bonnier (1990) flora. Nevertheless, it exists in the neighboring countries situated in the western frontiers and other species are noticeable, such as *Reaumuria vermiculata, Salicornia arabica*, which are classified very rare, then they are to be particularly protected.

Geology and morphology

The following structural units can be distinguished:

(i) The glaze: Calcareo gypsum crusts are formed by alluvial deposits from the quaternary,
(ii) The central portion corresponds to a bowl where the loaded waters in chlorides and sulphates are concentrated (Figure 2),
(iii) Zahrez lower createaceous is constituted of thick sequences in large mainland, formed by limestone –marl clay. The Triassic consists of clay and gypsum, salt plays a fundamental role due to its extension and its high content.

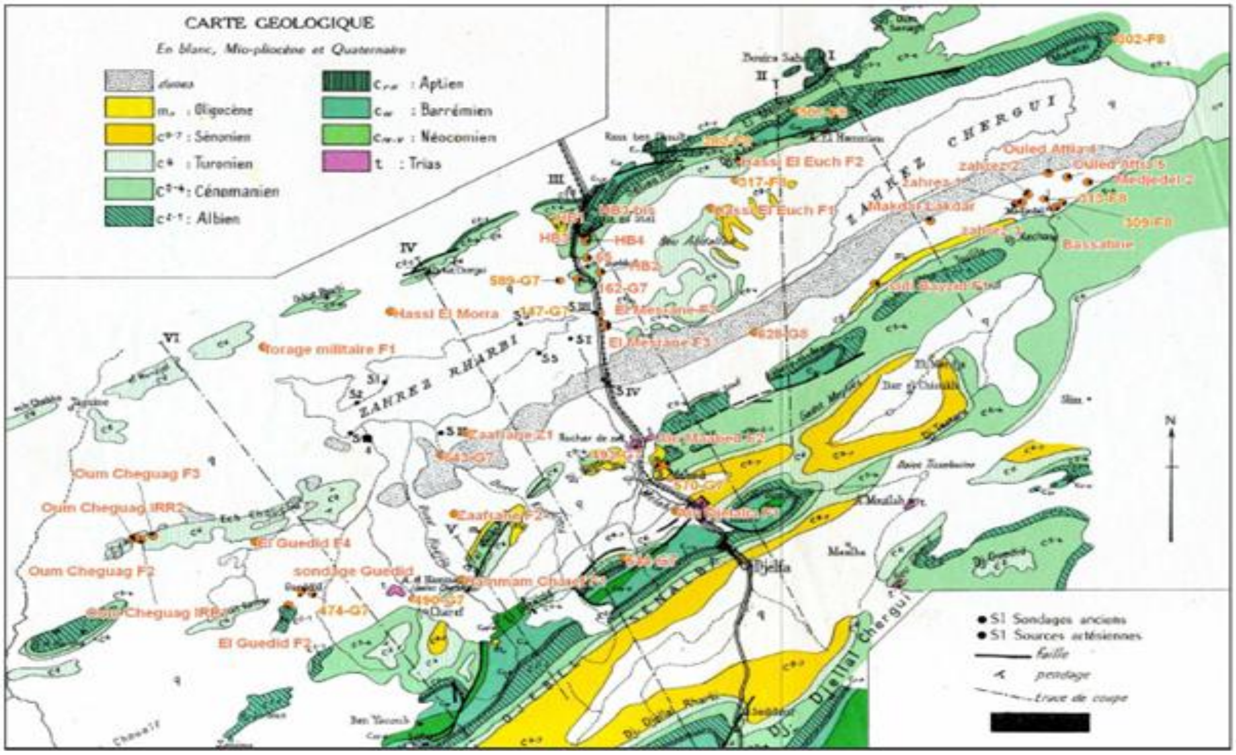

Figure 2. Geological map of the Zahrez region and the dune area.

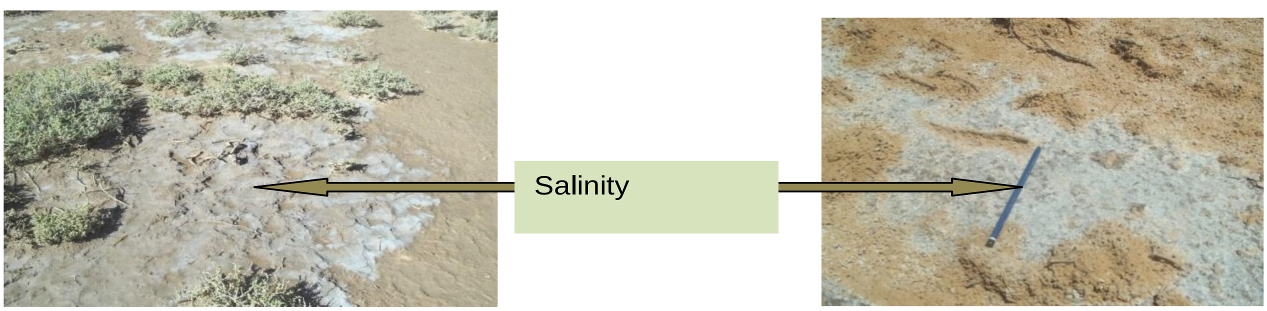

Figure 3. Description of salinity (Chott). Photo taken by Senni, March 2012.

Edaphic character

The following main types of soils may be encountered according to:

(i) Textured soils silty sand, poorly developed on calcareo gypsum (Figure 3),
(ii) Raw –mineral soils at the dunes,
(iii) Salt –affected soils occupant inside the chott (Figure 4).

Bioclimate

The study of temperatures and precipitation provided a good overview on the regional climate. The region is subject to a Mediterranean climate. However, the southern part of the region of chott el hodna undergoes Saharian influence (Kaabeche, 1997) .The hodna average annual precipitation varies between 400 mm to the North and 137mm to the South. The data indicated that the temperature of the chott is characterized by a cool winter (-0, 6<m<6.2°C) while July and August are the hottest months (33°C<m<37.9°C). The Zahrez's average precipitation is 250 mm/year. The minimum temperature is +7°C and the maximum is 38°C. The wettest month is May during which we register a monthly average of 33.7 mm, while July is the driest with 8.34 mm (Boumezbeur, 2002). The dry season lasts between 6 and 9 months, this season plays a crucial role in the distribution of vegetation.

Methods of sampling

In order to meet the objective of this study, 251 phyto-ecological samples were performed on the whole distribution area of the vegetation. The choice of samples was based on a sampling that

Figure 4. Period of the resurfacing groundwater in Sebkha halophilic Vegetation Zaafrane -Djelfa, Algeria (Photo taken by Senni, March 2012).

takes into account the vegetation's structure where the criterion of ecological floristico homogeneity was privileged. The survey method of surface, which is extremely variable in size depending on the type of community (minimum area), was used.

The choice of techniques vegetation description is based on the objectives that were set. In our case, it is a dynamic order with the intention to establish or revisit vegetation plots to describe changes in vegetation. In our study, it is the systematic sample rate (Bouxin, 2008). The method of the minimum area was used. For Djebaili (1984), this minimal area varies according to each type of plant association. As for Walter (2006), the minimum area can be identified by the surface of the dominant taxon or plant after careful field survey. According to the method of Braun-blanquet (1957) and from the shape of the species area curves, the chosen area was 100 m² Khabtane and Rahmoune (2012) and Stambouli and Bouazza (2013) state that it is a minimal surface from which a sample area can be considered statistically representative. For the qualitative survey (phytoecological survey) sampling of plant communities must meet the criteria of homogeneity and representativity.

The vegetation of the three areas (Zahrez Gharbi, Zahrez Chergui and Chott el hodna) was sampled using the floristic sampling. Each species was assigned a coefficient of abundance dominance, Gillet (2000), Dufrêne (2003), Delpech (2006), Amghar and Kadi hanifi (2008) and Ghezlaoui et al (2011); many authors work with different coefficient of abundance dominance, but in our work the Gounot (1969) coefficient has been chosen, and each area was characterized by its topography, lithology and altitude. On a reading line of every 10 cm long.

Data processing

Considering the important number of data 251 sampling, 131 species, it was found useful to compare them based on statistics methods of multivariate analysis, Relevance factors (AFC). Meddour (2011), Chessel and Gautier (1983), equability (E) Shannon evenness (H'), diagram rank frequency (DRF). The correspondence analysis presented on this name and developed by (Aidoud-Lounis, 1997). The number of axes taken into consideration plays an important role in the differentiation and the structure of the whole data. According to Frontier and Pichod (1998), the diversity of the elements of a community is a quality that is required for analysis. In fact, the notion covers two aspects:

(i) Species diversity (number of species),
(ii) Equability, this is how fall individuals in a given space.

The index of species diversity can be summarized into two main categories:

(a) Index of species richness,
(b) Shannon evenness,

To compare species diversity of two populations who do not have the same richness specifically, the evenness E=H/Hmax was calculated, where: Hmax=Log2S, S=number of species. Rank frequency diagram (DRF) has a significant descriptive quality that allows to visualize the distribution of species.

Calculation of spectra

The listed species were identified according to their biological type (Phanart lindacher, 1995). In this work, the covering as parameter of ponderation has been selected to establish the raw and real biological spectra. All the selected samplings were characterized by an abundance –dominance coefficient to calculate the real spectra according to Tomaseli (1954) method, related to the calculation of the covering of a species.

Calculation of the diversity index

The specific diversity index of Shannon evenness [H'] was calculated for the three sampled areas, this index values was between 0 bits and 5 bits per individuals (Frontier, 1983). As heterogeneity the Shannon index takes into account the evenness degree in abundance species (Magurran, 2004) and equability [E] which represents the link between the theoretical maximum specific diversity and the log species richness of the samples.

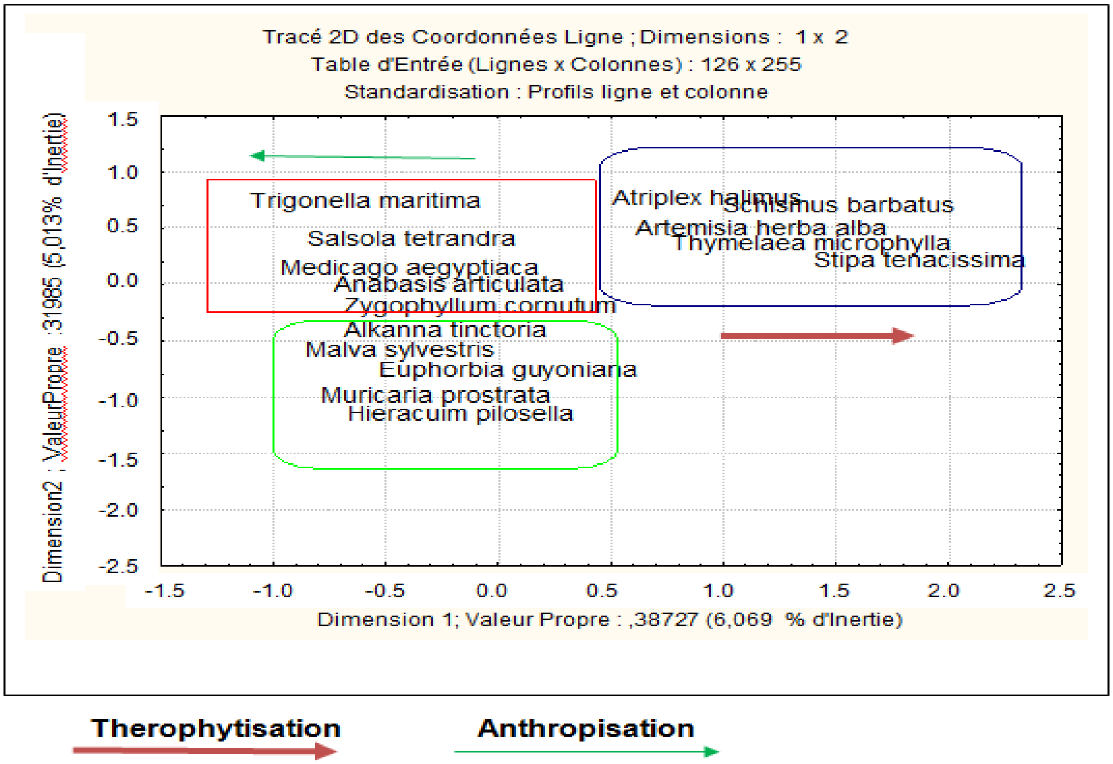

Figure 5. Factorial species of the distribution along the axes 1 and 2.

RESULTS

Floristic composition

The results of the floristic data have proven to be divided into two groups: A Steppic vegetation on glaze near the chotts and halophyte vegetation specific to chotts. The steppic vegetation is often on calcimagnesic soils with gypsum accumulation, on less evolved soils of the nearby rivers or on marly substratum more or less saliferous. The plant vegetation noticed was: *Salsola tetrandra var villosa* and *Salsola vermiculata alluvium* on medium to thin textured steppes. *Traganum nudatum* and *Thymelea microphylla* on calcareous glacis crusts silted steppes.

Eroduim glaucophyllum on gypsum crust glacis steppes. The therophytes were generally dominant due to frequent grazing. This category of species has also shown a high degree of resistance in dry periods (at high temperatures). The chamaephytes also kept an important place in this plant vegetation.

Factorial map of plant species

The factorial plan (1-2) shows 3 groups of ecological affinities neighboring. Group 1: Is the Chénopodiacées, Group 2: Is the species which are less exacting frequent in sandy areas and sometimes in other zones. Group 3: Is the psammophiles species (Figure 5).

Factorial map of plant species

For the study area, the dominant biological type was in the following order: Thérophytes (38.95%), chamaephytes (29.77%), hémicryptophytes (15.26%), phanéropytes (5.34%) and géophytes (10.68%) (Figure 6).

The phytogeographical division

The Mediterranean element comes first with (42%), the Saharo-arabic element and multiregional element come in second place with (20%) and (12%). Les endemiques with (9%). Thirdly, come the Mediterranean-saharian element with (8%), finally come euro-Mediterranean and European element (2%) and (2%), the rest cannot be significant (Figure 7).

Diversity indexes

The Shannon evenness [H'] and regularity [R] were respectively of 2.05 and 0.33. The Shannon evenness varies between 0.5 (low diversity) and 4.5 (high diversity), the Shannon evenness of Group 1 was (2.05) as while the regularity was of (0.32) for Group 1, medium value may indicate an average diversity, given the scale of variation of this index is 0.5 to 4. The Shannon evenness

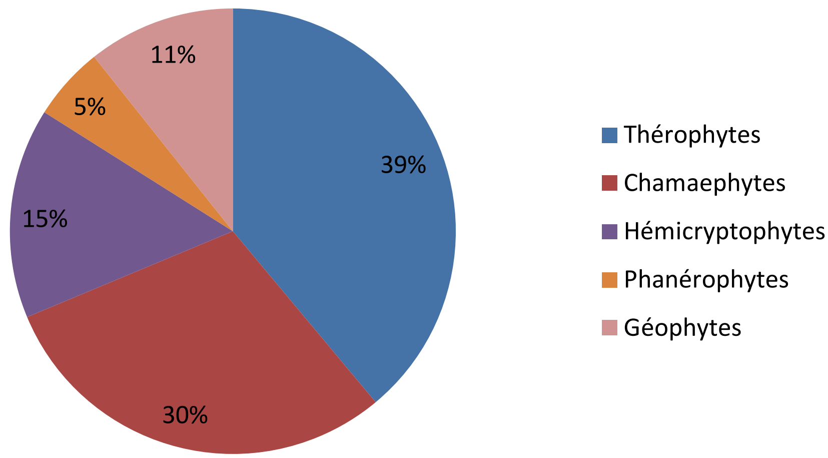

Figure 6. Distribution of plant species based on biological types.

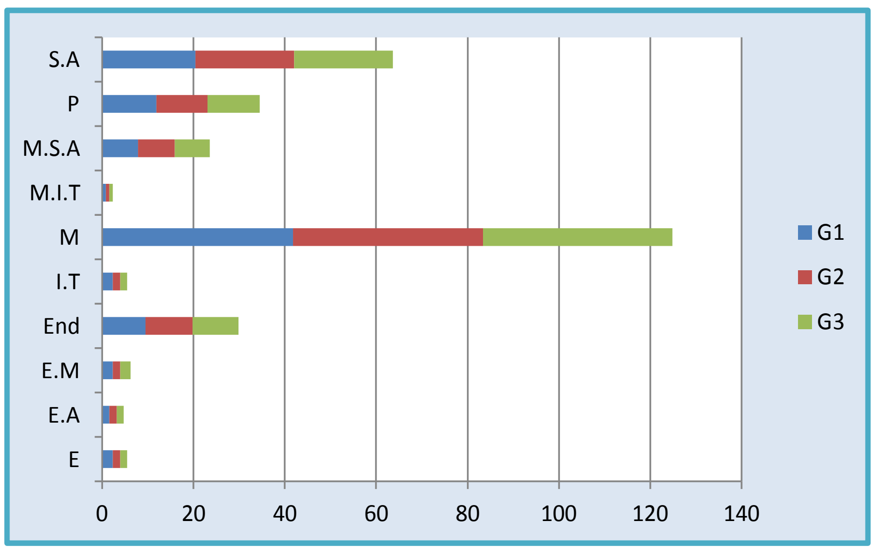

Figure 7. Phytochoriques types of three grouping, E: European, EA: Eur-Asian; EM: Euro-Mediterranean; End: Endemic, M: Méditerranén-IranoTouranienne; MSA: Méditerranén-Saharo-Arabian, MED: Mediterranean, P: multiregional, SA: Saharo-Arabian; IT: Irano-Turanian.

of group 2 was of 2.05, Group 3 was of 3.35 while the regularity was 0.32 and 0.33 respectively for Group 1 and 2 and 0.56 for group 3. The eigenvalues and the inertia of the main factorial axes of the relevance factors (AFC) varies between 4.27 and 12.70 and inertia ratio of 3.165 to 6.068%. The diagram rank frequency (Figure 8) obtained for the three groups show curves that are the same in all gaits. they then take a convex shape.

DISCUSSION

Biological characterization

Several authors such as Raunkier (1934), Floret et al. (1990), already mentioned in precious work Benabadji et al. (2007); have studied the relationships that highlight the dependencies between the distribution of the biological types and environmental factors, including climate (temperature and precipitation) and other factors such as altitude and the nature of the substrate. In our study area, the distribution of the biological types in the plant vegetation in damp regions and silted areas of Djelfa and M'sila followed the following order: Therophytes >Chamephytes > Hemicrypyophytes >Geophytes >Phanerophytes.

Biological types of the study area showed the predominance of Therophytes (38%) on the Hemicryptophytes (15%). The Therophytes occupy the first position. This

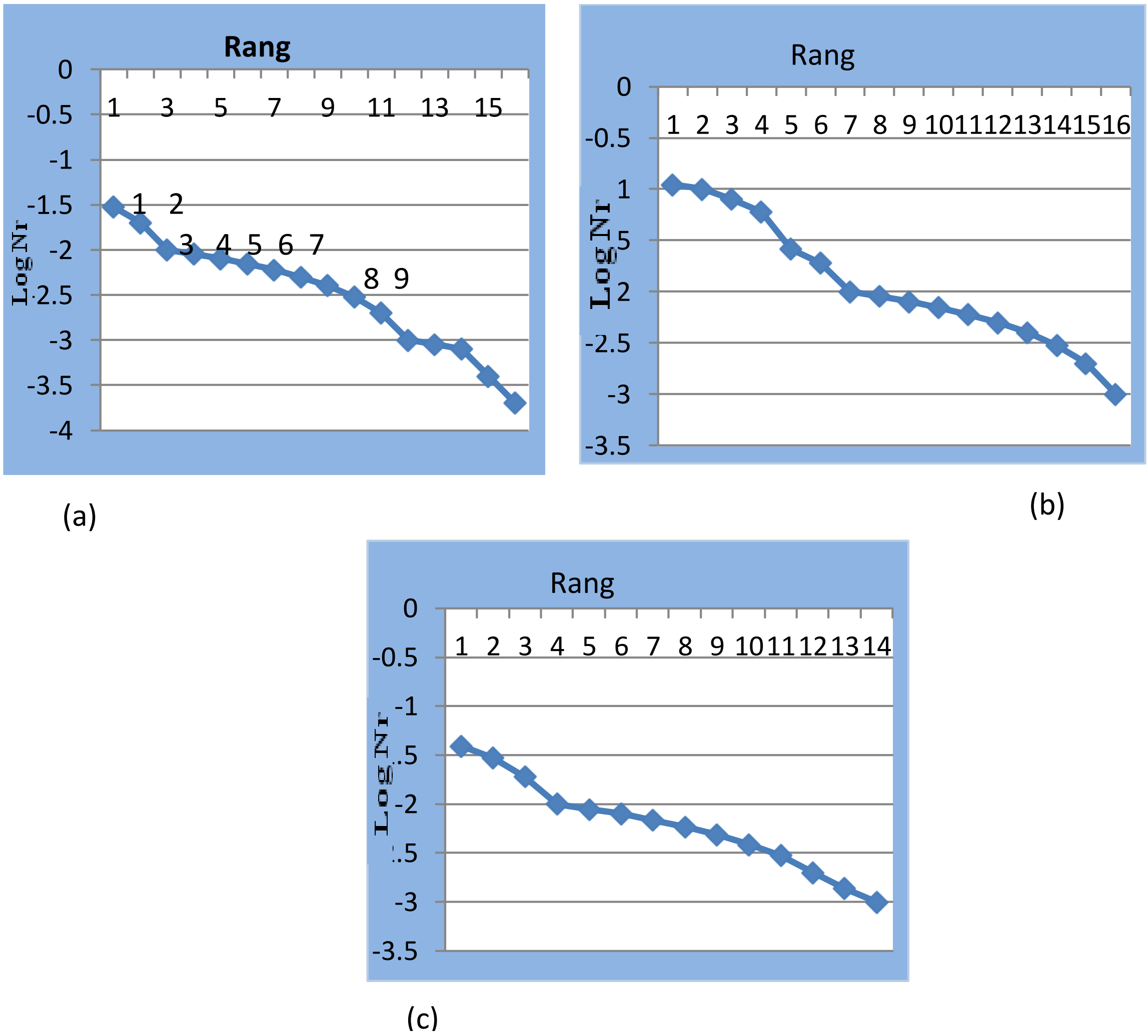

Figure 8. Diagram rank –frequency of the three groups, (a): Diagram rank-frequency -Group 1. (b): Diagram rank-frequency -Group 2. (c): Diagram rank-frequency -Group 3.

significant representation reflected the increasing proportion of therophytes caused by the aridity and heat of the climate, while that of hemicryptophytes decreases. The therophytisation was the result of aridity and human action, the less watered of groups are the richest with Therophytes, the most anthropic groups are the most therophytised. The abundance of therophytes can be explained by the strong presence of seasonal habitats immersion for the development of annual plants to germinate and grow fast (Hammada et al., 2004).

Prolonged aridity and anthropic action

It has been noticed that the extended aridity and human action acted in the same direction, draining the soil environment. This pedoclimatic drought allowed the development of the Therophytes that do not require much water and that of Chamaephytes that physiologically adapt much better to drought.

This human action is accompanied by the degradation of the vegetation cover; consequently, we remarked a deflation of the soil in a spot and a silting in another. This silting due to the self mulching permitted the development of the Therophytes. Due to aridity, the floristic richness (S) decreased the diversity specific index of Shannon evenness and equability increased, while within the anthropisme, the floristic richness (S), the diversity specific index of Shannon evenness and equability increased.

The increase regularity was confirmed by tracing of the diagrams –rows –frequency (DRF). The shape of the curves allows a better reading of the two components of diversity: species richness is seen in the extension of the curve to the right, while the equability is deducted by the concavity or the convexity of the curve. The results agreed with those of Connel (1978), Le houerou (1993), Huston (1994), Le houerou (2005), Bouchetata (2002)

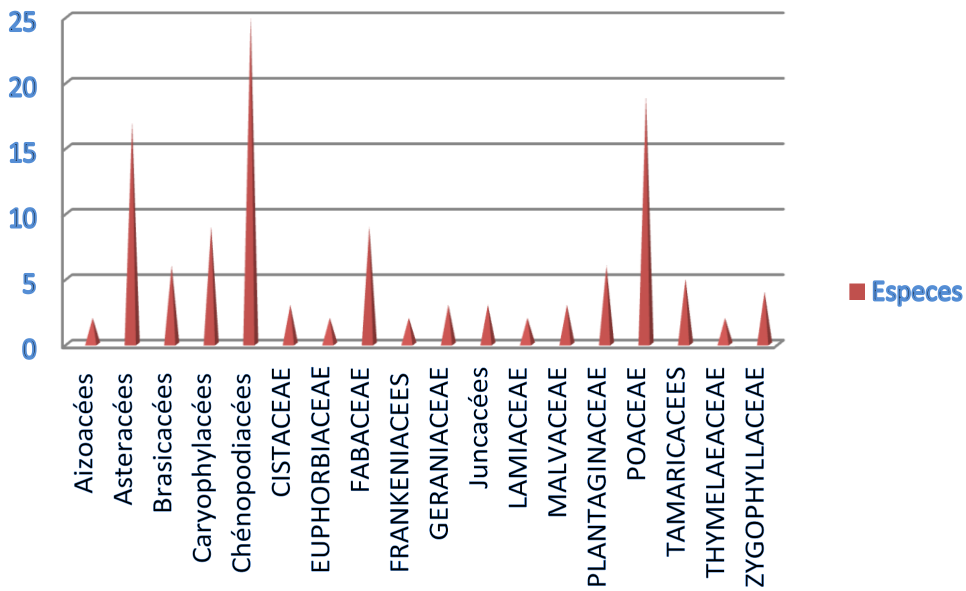

Figure 9. Specific richness of the groups.

and Haddadouche et al. (2007), known that diversity increased in general with human action and aridity, the combination of these two disturbances (especially grazing) tended to reduce competitiveness.

However, the combination of the biological type with different indexes [H' and E], pointed out that the therophytisation was the cause of the increase of the indexes in arid and disturbed habitats. It has been found that the more rigorous, the environmental conditions are the more of the Therophytes increased, whereas, the Phanerophytes decreased. It has been witnessed a therophytisation caused by several causes: In one hand aridisation Barbero (1990), Dahmani (1997) and Kadi hanifi (1998) in the other hand the anthropisation, Grime (1977), in fact grazing enriched the soil with nitrates and allowed the development of the ruderal species. This therophytisation was also due to the phenomenon of self mulching, mechanism occurring in areas with high evaporation and limestone a soils deep and covered with sand in surface. This phenomenon allowed the storage of water and thus promoted the development of annuals. The Therophytes were generally more dominant because of frequent grazing. This category of species showed a resistance in dry periods.

For the entire study area, the dominant biological type remained in the following order: Therophytes, Chamephytes, Hemicryptophytes, Phanerophytes and geophytes.

Specific richness

The best represented families were: Chenopodiacees, caryophylacees and poacees (Figure 9).

Global study chorological

The flora of the Mediterranean basin was a model to interpret the phenomena of regression, Quezel (1983) explained the importance of biogeographic diversity of Mediterranean Africa by climatic changes. The same author pointed out that phytogeographical study was an essential basis for any attempt to conserve biodiversity. The flora of the region included several phytochorologiques groups; the most representative was the whole Mediterranean with 58 species.

Conclusion

From taxonomic point of view, the most represented families were Chenopodiaceae (25 species), Poaceae (19 species) and Asteraceae (17 species), and caryophylaceae (9 species), Fabaceaea (9 species), Brasicaceae (6 species) Tamaricaceae (5 species) and Zygophylaceae (4 species). The analysis of this biological diversity highlighted the role of the annual species within these formations, in particular (Therophytes 39%). As the chorological level, the Mediteranean has detained the first place with (42%), followed by the saharo-arabian (20%), and the multi-regional (12%). These species deserve a special attention. They represent a heritage, they need protection and preservation of their habitat. If no conservation action is taken, the beginning of both substitution of some species by others can be seen, or to their definite disappearance and this will lead to the desertisation.

The acting factors are the bioclimate and the human action, indeed the bioclimate through the atmospheric drought is the main factor of the diversity of these chott's formations. This factor seems to support the majority of the relevance factors axes, then comes the human action (overgazing, deforstation). According to Kadi hanif (1997, 2003), the aridity phenomenon associated to the disappearance of the vegetation significantly reduce the infiltration in the soil, resulting in a decrease in the chemical weathering of primary minerals, so a lower clay content and thin elements. This reduction of the water in the soil still contributes to the decline of the biological diversity and to an emphasis on the reduction of the organic material and soil nitrogen. The low content of humus and clay mineralogy induced the reduction of the absorbing complex, consequently, the fertility decreases. The recommendation was the setup of long-term observation networks combines the use of the different tools and allows developing methodologies of collection and transfer of compatible data. The interest of these observatories is to follow, in the time, the evolution of process and to allow the definition of references situations or benchmarks. The elaboration of a strategy and a regional program of fight against desertification for sustainable management of the environment on one side and on the other hand the value of wetlands as a generating element of wealth that can be achieved by promoting ecotourism.

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