Biodiversity and Vegetation Dynamics of *Tetraclinis* Articulata Stands in the Tlemcen Region (western Algeria)

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Abstract

Berber red cedar is endemic to western North Africa (Morocco, Algeria and Tunisia). Most of the Tetraclinaie range is located in the warm temperate semi-arid bioclimatic zone. It offers great ecological diversity in our study area, and therefore a great adaptive strategy to drought.

Our study focuses on the assessment of vegetation dynamics through phytoecological analysis of Tetraclinis articulata matorral groups in the Honaine littoral in the Tlemcen region (northwestern Algeria). It is based on physiological, biometric, climatic, edaphic and syntaxonomic aspects. A comparison of the various biological, morphological and biogeographical spectra reveals the importance of therophytes, which undoubtedly confirms the degradation caused by the therophytization of all the formations predicted by several authors. Despite the presence of a shrub layer, which may give the illusion of a forest, this is no longer a forest ecosystem but a pre-forest ecosystem transformed into sparse matorral. This degradation confirms the impoverishment of the plant's flora, especially sylvatic species, which have given way to ephemeral therophytes and chamaephytes adapted to common, repetitive fires. The results of the various spectra provide an initial basis for assessing the adaptive potential of cedar against degradation factors.

Finally, this study has enabled us to identify the ecological and biological behavior of Tetraclinis articulata and certain accompanying plant species that have difficulty resisting ecological stress in this area, and it is to be expected that if the latter becomes more pronounced, their rarity, or even their disappearance, will be inevitable.

Keywords: Tlemcen (Oranie- Algeria), Tetraclinis articulata (Vahl.) Masters, Semi- arid, Matorral, degradation, anthropozoogenic, Phytodiversity, preservation.

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1. Introduction

The vegetation of the Tlemcen region has been the subject of several publications, including QUEZEL (2000); BENABADJI and BOUAZZA (1991-1995); MEZIANE (1997); BOUAZZA et al. (2001); MESLI-BESTAOUI (2001-2009); BARKA (2009); BARKA (2001), all of which show that the vegetation is part of a very rich and diverse Mediterranean forest. However, the study of anthropozoogenic action and the impact of climate change on the biodiversity and distribution of this vegetation (extension or disappearance of certain species) needs to be pursued in the future.

In this study, we will show that the Tlemcen region has a highly diversified flora, closely linked to the various disturbance factors. From a systematic point of view, the vegetation of the study area brings together elements of very different origins and diverse biological types. It is characterized by a diversity of structure, physiognomy and composition in the tree, shrub and herbaceous strata, thanks to the geographical, geological and climatic variety offered by the two Monts (Traras and Tlemcen).

This zone is mainly composed of Tetraclinis articulata and Pistacia lentiscus. These species are considered to be the main species at our study sites. The variety of landscapes, their distribution, but also their remarkable differences, are conditioned by a large number of ecological factors.

In this study, we present the method used in this floristic inventory and the sampling techniques. Sampling is the operation by which a certain number of elements are collected for observation or processing. It is the only method that can be used to study wide-ranging phenomena such as vegetation, soil and possibly their interrelationships.

Surveying is one of the basic experimental tools for studying these phenomena.

In order to select the right stations, a rigorous sampling approach is required.

This is the study of plant groups in the field, essentially using the survey method, which consists of choosing locations that are as typical as possible, while noting the environmental conditions. It is never done in a continuous manner, but allows us to learn about the floristic composition and structure of each station, as well as the ecology of the dominant species.

The station depends on the homogeneity of the discovery and the plant diversity in order to avoid transition zones. To meet the objective of our work, we carried out a floristic inventory, the aim of which is to gain a good understanding of the causes of the ecological station factors concerning the spatio-temporal distribution of this vegetation, but also to gain a good grasp of the dynamics of these natural plant formations.

2. Materials and methods

- **Study area**

Our study region is located in the western part of Algeria. It occupies a privileged position in relation to the rest of the national territory, thanks to its diversity and its plant genetic heritage.

The territory of the Tlemcen wilaya is a "unifying space" in areas with different dynamics and characteristics. In particular, it is open to the rest of the world over an arc of land and sea almost 250 km long. Located in the extreme west of the country and bordering Morocco, the wilaya of Tlemcen runs along this border, from Marsa Ben M'hidi to El Bouihi, for 170 km. It is bordered to the north by the Mediterranean Sea, to the east by the wilaya of Sidi Bel Abbès, to the south by the wilaya of Naâma and to the north-west by the wilaya of Ain Témouchent.

Thanks to its geographical position, the wilaya can reconnect with several segments of its history as a link between coastal Oranie and the country's western steppe highlands on the one hand, and between western Algeria and the regions of eastern Morocco on the other.

For a more justified choice of stations, vegetation remains a more important criterion. This led us to select homogeneous stations to facilitate field sampling. We therefore chose six representative stations (Honaïne, Filaoucène, Nadroma, Ghazaouet, Beni Snous and Azail). This choice was randomly guided by the concern to reflect the diversity and complete inventory of species at the stations. It depends largely on the presence of pre-forest formations and matorrals.

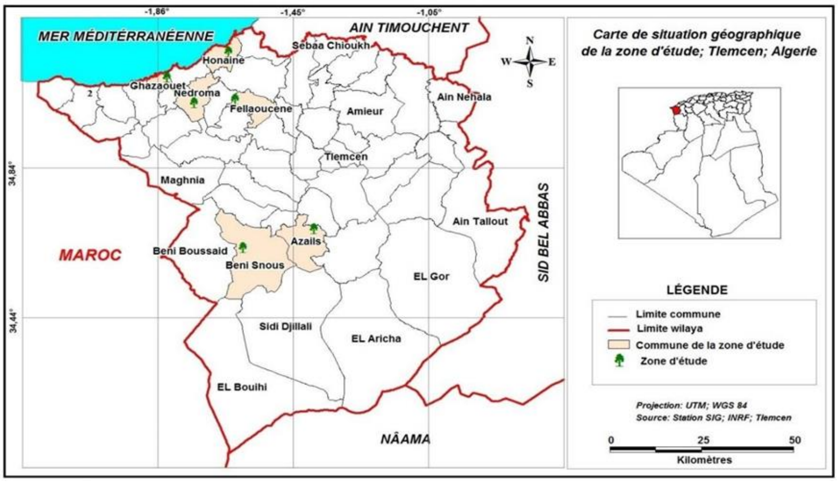


Figure 01: Situation map and location of Tetraclinis articulata in the study area

2.2. The physiography of the selected stations:

Station 01: Honaine (X: -1 38° 56', Y: 35° 09' 50)

The Honaine site has a north-westerly exposure and a fairly varied vegetation cover of 70-80%. It lies on a slope of 20-35%, with a limestone substrate. The dominance of Tetraclinis articulata confirms the xericity of the station and its location in the thermo- Mediterranean stage.

The presence of Quercus ilex explains the presence of an ancient forest subjected to strong anthropozoic pressure, particularly fires. It is dominated by the following species: Quercus ilex, Pistacia lentiscus, Tetraclinis articulata and Olea europea, Cistus monespeliensis, Cistus villosus, Calycotome villosa subsp inter média, Daphne gnidium, Ulex boivini, Asphodelus microcarpus, Lavandula dentata and Echium vulgare.

Station 02: Fillaoucène: (X: -1 37° 45', Y: 35° 02' 14)

This station is located in the commune of Fillaoucene in the northern part of the wilaya of Tlemcen. The slope of the station is greater than 30%, varying between 35% and 45%, and the coverage rate is 40 to 60%, with a northern exposure. Water potential is based on underground and surface springs. The most important element is the Oued Tafna.

The vegetation at the Fillaoucene station is largely composed of the following species: Tetraclinis articulata, old trees of Ceratonia siliqua, Olea europea subsp oleaster and Pinus halepensis, Pistacia lentiscus, Pinus halepensis, Quercus coccifera, Lavandula stoechas, Ampelodesma mauritanicum, Phillyrea angustifolia, Cistus salvifolius, Daphne gnidium, Asparagus acutifolius, Arbutus unedo, Asphodelus microcarpus and Inula viscvosa.

Station 03: Nedroma (X: -1 45° 02', Y: 35° 01' 42)

This station is part of the central Traras, a rural area whose main activity is based on agriculture and livestock farming. It is located between 361 and 474m altitude on a 30 to 35% slope with a north-easterly exposure.

This station has a 20-30% cover with northeast exposure. The relief of this station is essentially formed by the northern and eastern slopes of the Djebel Fillaoucène, with very steep slopes, usually in excess of 25%. It becomes gentler in the northern part with the appearance of several fertile depressions.

Among the species that can be found on this station, a stand of Aleppo pine dominates an undergrowth composed of : Tetraclinis articulata, Juniperus oxycedrus, Calycotome villosa subsp inter média and Quercus ilex. The presence of species indicative of vegetation degradation and overgrazing, such as Ampelodesma mauritanium, Asphodelus microcarpus, Urginea maritima and Chamaerops humilis.

Station 04: Ghazaouet (X: -1 49 55', Y: 35° 05'47)

The Ghazaouet station is located in the northern part of the Monts des Traras with a north-easterly exposure and an altitude of 116 to 122 m. The soil is relatively poor in organic matter, with a siliceous substrate.

The slope is 20 to 25% and the coverage rate is 20 to 25%, with northeast exposure. It is deeply affected by water erosion. The relief is characterized by small topographical features, the most widespread of which are slope systems.

Characteristic species include Quercus ilex, Quercus coccifera, Quercus faginea subsp tlemceniensis, Tetraclinis articulata, Pistacia lentiscus, Phillyrea angustifolia, Lonicera implexa, Juniperus oxycedrus subsp rufescens, Ruscus aculeatus, Ampelodesma mauritanium. Myrtus comminus, Olea europea, Ceratonia siliqua , Juniperus phoennicea, Rosmarinus officinali, Lavandula dentata, Cistus salvifolius, Calycotome spinosa, Erica multiflora, Chamaerops humilis, Lagorus ovatus, Fagonia critica and Rumex bucepholophorus.

Station 05: Beni Snous (X: -1 36 26', Y: 34° 38' 28)

The Beni Snous station is located on the northern slopes of the Monts de Tlemcen and northeast of the town of Tlemcen at an altitude of 700 m; it is characterized by a slope of between 30 and 35% on a limestone substrate.

Coverage is around 35 to 40% with a northern exposure. The characteristic species of the Beni Snous station are as follows: Tetraclinis articulata, Quercus ilex, Quercus coccifera, Juniperus oxycedrus, Lobularia maritima, Pistacia lentiscus, Arbutus unedo, Calycotome villosa subsp intermedia, Ampelodesma mauritanicun and Olea europea subsp argentea.

Mediterranean chamaephytes such as Daphne gnictium, Helianthemum helianthemoides, Anthylis tetraphylla, Cistus salvifolicus and forest species indicative of a sub-humid climate such as Smilax aspera and Lonicera implexa can also be found here. This station is in a phase of floristic loss, with a remarkable generation of Quercus ilex in some cases after the fires.

Station 06: Azaïl (X: -1 23 52', Y: 34° 41' 30)

The station is situated at an altitude of 680m and represents a cover rate of 20 to 35% with a north-easterly exposure. The state of regeneration and successive stages of degradation are marked by the presence of stunted Quercus ilex and Juniperus oxycectrus subsp rufescens. The presence of a few relics of Tetraclinis articulata and Pinus halepensis shows the evolution of this station. This station also features a number of species considered anthropogenic and non-palatable thorny species such as Lagurus ovtus, Catamanche coerulea, Juncus maritinus and Salvia verbenaca.

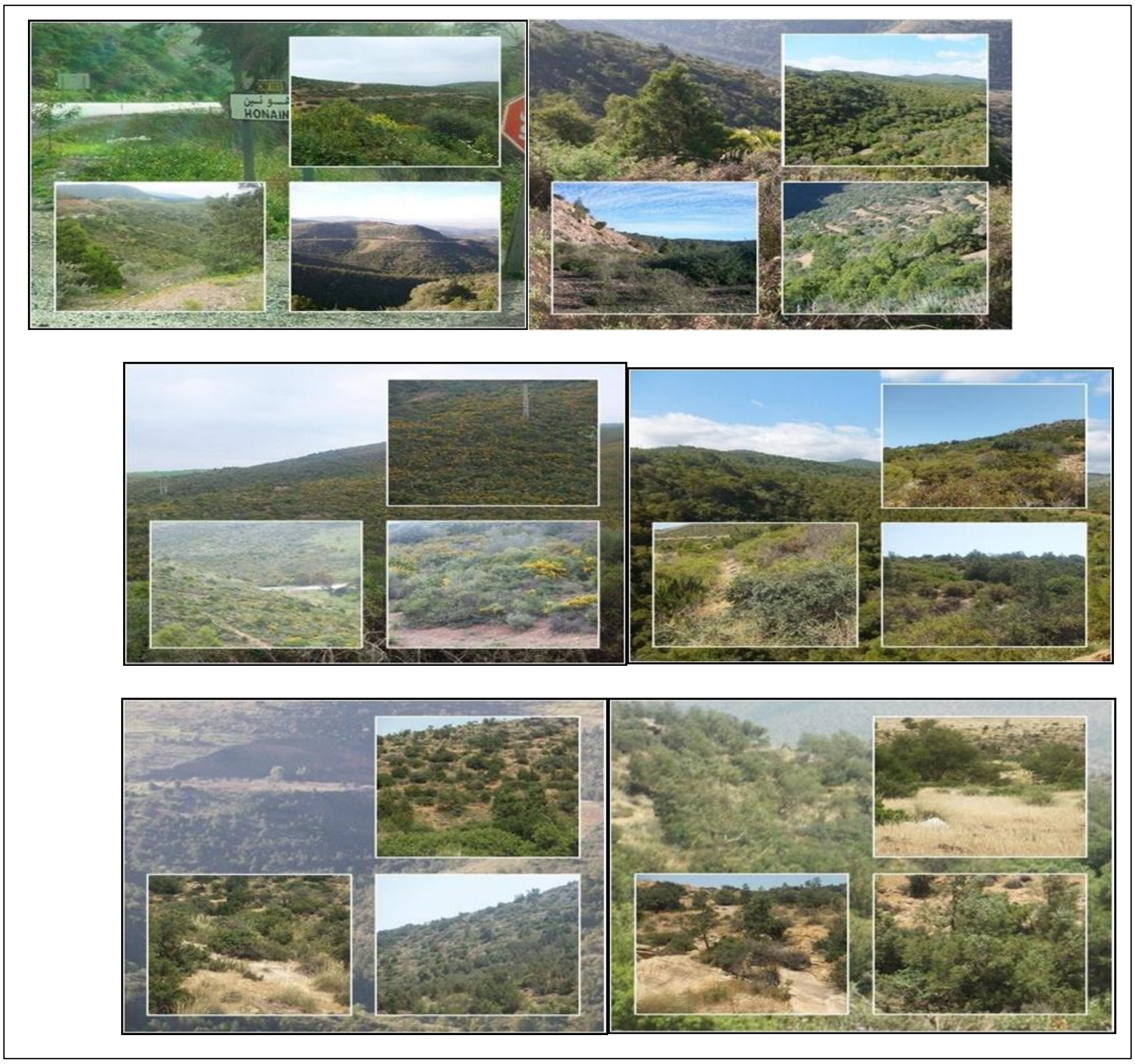


Figure 2 : Study stations (general view).

Plant stratification is considered to be an initial analysis of the plant formations that can be observed at most sites. In our case, we were able to delimit the study stations in two different zones, according to local edaphic conditions, meticulous field observations concerning the evolution of degradation, topography, floristic composition and the antropozoogenic effect.

The forest and pre-forest groupings on the one hand, and the matorrals on the other, which have their optimum development in the study area, are represented physiognomically by three plant formations: arborescent, shrubby and herbaceous.

Tree formations: represented by taxa such as Quercus ilex, Quercus suber, Quercus coccifera, Phillyrea angustifolia, Olea europea subsp oleastetr, Pinus halepensis, Arbutus unedo, Myrus communis, Ceratonia siliqua, Pistacia lentiscus.

Shrubby formations: These include groups generally between 0.5 and 1.5 meters in height. The main species forming these groups are : Ulex boivini, Cistus ladiniferus, Cytisus triflorus, Calycotome intermedia, Crateagus oxyacantha, Asparagus acutifolius, Asparagus albus, Chamaerops humilis subsp argentea, Ampelodesma mauritanicum, Daphne gnidium, Lavandula stoechas.

Herbaceous formations: The stratum that groups plants whose aerial part is no longer woody. They are represented by herbaceous plants and tree seedlings that germinate after winter and set seed with a cycle of less than twelve months, such as : Anagallis arvensis, Aegilops triunciali, Echium vulgare, Ammoïdes verticillata, Malva sylvestris, Reseda alba, Calendula arvensis, Urginea maritima, Adonis dentata, Bellis annua, Bromus rubens, Convolvulus altheoides, Centaurea umbellatum, Laucus carota, Inula viscosa, Echinops spinosus, Sinapis arvensis, Sedum acre.

Sampling and station selection

Surveying is one of the basic experimental tools for studying these phenomena. DAGNELIE, (1970) ; GUINOCHET, (1973), who define sampling as all operations designed to draw individuals from a population to constitute the sample.

The sampling adopted in our case is of a subjective type, leading in theory to the elaboration of statistical tests, in practice, the information gathered is very incomplete, taking into account the floristic and ecological homogeneity of the station. This sampling method consists in choosing the most representative and sufficiently homogeneous stations, integrating all the structural situations and vegetation facies encountered in the area.

Given the size of the inaccessible areas and the lack of maps, this sampling was imposed on us more than the other samplings. In view of the size and inaccessibility of the study area, the lack of maps and the existing interaction with the vegetation in this region. This sampling was imposed on us by the same factors as the other samplings.

Survey method

In order to meet the objectives of this study, we followed the sigmatist phytosociological method (BRAUN BLANQUET 1952, GUINOCHET 1973), also known as the Zuricho-Montpellier method (floristic surveys), which consists of listing all the species present as well as the site conditions.

We noted the type of plant formation, cover and other complementary information essential for interpreting the clusters, based according to (BEGUIN et al., 1979) on the principle that the plant species, and better still the plant association, are considered the best

integrators of all the ecological factors (climatic, edaphic, biotic and anthropic) responsible for vegetation distribution.
In 1982, OZENDA emphasized in many of his writings that the study of plant groupings in the field is essentially carried out using the survey method, which consists of choosing locations that are as typical as possible. He also noted the environmental conditions, the list of species and, for each species, a set of notations designed to define as precisely as possible its place and role in the group. These surveys were carried out using the minimum area method.
In order to gain a broad understanding of the diversity of plant formations, we carried out 50 floristic surveys at each station. The surveys were carried out in spring, the season considered to be optimal. Each of these surveys includes ecological characters of a stational nature: location and date, altitude (M), exposure (N.S.E.O), slope (%), nature of substrate, geomorphology, survey surface (minimum area), cover, physiognomic type of vegetation and survey number.

A good survey should be like a true portrait of the group (ELLENBERG, 1965), which can then be referred to for the synthesis work of comparing plant groups. Surveys or floristic data boil down to an exhaustive list of all the species present in the survey area, followed by a number of so-called analytical characters such as:
The average cover rate, theoretically defined as the percentage of the soil surface that would be covered (GOUNOT, 1969).This list varies from station to station and from year to year within the same station.
DAHMANI, MEGREROUCHE (1997) point out that analysis of the floristic richness of the different groups, their biological and chronological characteristics, highlights their floristic originality, their state of conservation and their heritage value.
The minimum area varies according to the number of annual species at the time of the survey and, consequently, the vagaries of rainfall and operating conditions. (DJEBAILI, 1984).

To give a more accurate picture of the actual vegetation, each species is then assigned an "abundance-dominance" coefficient based on a BRAUN BLANQUET (1947) scale. All authors - GOUNOT (1969), GODRON (1971), DJEBAILI (1978), FRONTIER (1983) and AIME et al. (1986) agree that the minimum area of 60 to 100m² is sufficiently representative in Mediterranean formations such as ours, and thus define a floristically homogeneous surface, containing most of the species in the stand, and the survey in question is deemed significant" (AINAD TABET,1996).

On this subject, GOUDRON (1971) adds that: to control the representation of survey sampling, the most common procedure is that of the area-species curve. Using this approach, we can draw up floristic tables for each station in the study area.
To check the representativeness of the sample, the most common procedure is the area-species curve (GODRON, 1971). In this method, a complete species inventory is taken on a 1 m² plot. By successively doubling the areas (2, 4, 8, 16 ...) and adding any new species that

appear, we have assumed to obtain an area (n) where there are no new species. To this end, our surveys were carried out in the spring period (March, April, May) of the years 2017-2018.

In our case, we noted the abundance, dominance and sociability of the species in the survey, as the distribution of each species is not necessarily homogeneous.

The devices to be undertaken are as follows:

In our case, the minimum area of matorrals in the Monts des Traras is around 64 m² (Fig.117) at the Honaine, Fillaoucene, Nedroma and Ghazaouet stations, while in the Monts de Tlemcen it is 128 m² (Fig.118) at the Beni Snous and Azail stations.

The minimum area is very large in vegetation-poor sites. It can change over time, depending on climate, exposure and human activity, and especially on the appearance of therophytes, as in the case of the Beni Snous and Azail staion. So the size and shape of the survey "derive from these homogeneity requirements". It is now accepted that, in the Mediterranean region, the survey area varies from 100 to 300 m² in forests, 50 to 100 m² in matorrals, and a few square metres in grasslands (GEHU, 1987). This confirms the advanced degree of degradation suffered by these Mediterranean forest formations as a result of environmental constraints.

1. Results and discussion

Algerian flora is characterized by a remarkable level of endemism (12.6%), i.e. 653 species out of a total of 3139. There are 07 endemic tree species (QUEZEL et SANTA, 1962). More than three quarters (77.9%) of Algeria's strict endemics or sub-endemics are plants that are more or less rare in Algeria, while more or less common endemics account for less than a quarter of the total (VELA and BENHOUHOU, 2007).

The latter offers a highly interesting study model, thanks to the diversity of its landscapes and the remarkable distribution of its plant cover, conditioned by a large number of ecological factors. It's a territory with multiple ecological facets, confirmed by the presence of vegetation zones ranging from deciduous forest in the west, through mixed oak forest in the north, to coniferous forest (reforestation) and holm oak scrub in the northeast.

Systematic composition

Plant formation is an important concept, since it enables us to identify the physiognomy, which is of prime importance in understanding the behavior and dynamics of the various plant groups. To understand vegetation, it is essential to study the changes and architecture of the plant cover.

Measuring biodiversity, as originally defined by WILSSON et al, (1990), means counting all the species present in a given location. According to BEGUIN et al. (1979) and RAMEAU, (1988), vegetation is therefore used as a faithful reflection of stationary conditions, a synthetic expression of them.

DAHMANI (1997) points out that "analysis of the floristic richness of the various groups and their biological and chronological characteristics would enable us to highlight their floristic originality, their state of conservation and their heritage value".

The nature and current composition of plant communities in the study area cannot be understood without taking into account the biotic, abiotic and anthropogenic factors that have marked the evolution of the various ecosystems specific to this biogeographical zone.

The floras used to identify the taxa collected are: La Nouvelle Flore d'Algérie et des régions désertiques méridionales (QUEZEL and SANTA, 1962-1963), la flore méditerranéenne (PACCALET, 1981), la flore du Sahara (OZENDA, 1963-1977), la grande flore de France en couleurs de (BONNIER, 1990), la flore d'Algérie (BENISTON, 1984). the herbarium of the botany laboratory managed by Professor Bouazza.

Species distribution by Subphylum

In this section, we will study the floristic composition of matorrals in the Tlemcen region, taking into account the species' membership of systematic groups: sub-branch, class, family, order, genus and species. It should be noted that it is impossible to make a precise study of the vegetation of a station without identifying the plants found there, which make up the flora of the territory under consideration.

The plants observed in this zone number 450 species in all stations: Honaine (217), Fillaoucene (208), Nedroma (157), Ghazaouet (123), Beni Snous (161) and Azaïl (197). They belong to the phylum Spermaphytes, which forms two sub-branches of Gymnosperms and Angiosperms, with an average of (1.91%) and (98.08%), as shown in Table 64 of the appended results.

Gymnosperms constitute a minimum number of (02) species in the Ghazaouet station, in contrast to angiosperms which largely dominate with (213 species) in the Honaine station. The latter constitute an average of 177.16% throughout the study area, including the matorrals of the Monts des Traras (176.25%) and the Monts de Tlemcen (179%). According to these results, the two Monts are characterized by a very high floristic richness.

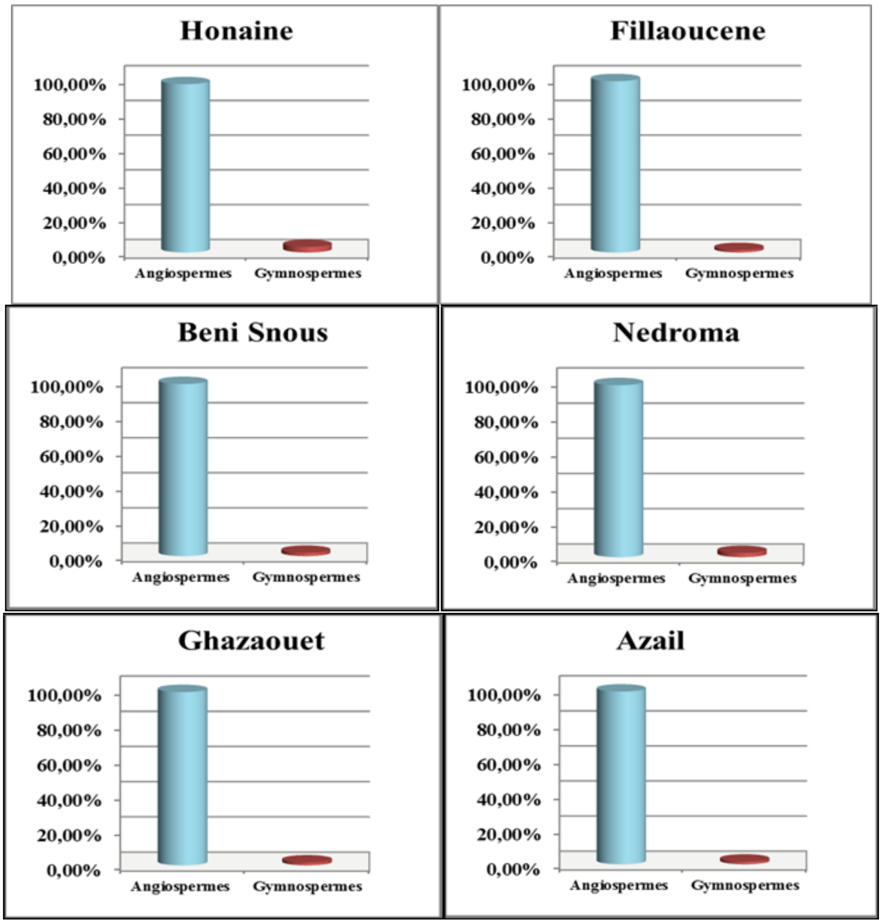


Figure 3: Flora composition by sub-branch

Species distribution by class

Of all the species inventoried, angiosperms predominate, particularly eudicots with a rate of 84.79% (184 species), which contain three sub-classes, gamopetales, dialypetales and apetales, of which the first and second have an equitable percentage, while the last sub-class has a significant percentage. These three sub-classes group together several families including numerous species that characterize the matorrals studied and can only be explained by the strong pressure exerted by anthropozoogenic action. The Monocots are the least anolous, with a percentage of 14.75% (32 species), while the Pinopsida class is represented by a single species and a rate of 0.46% at the Honaine station.

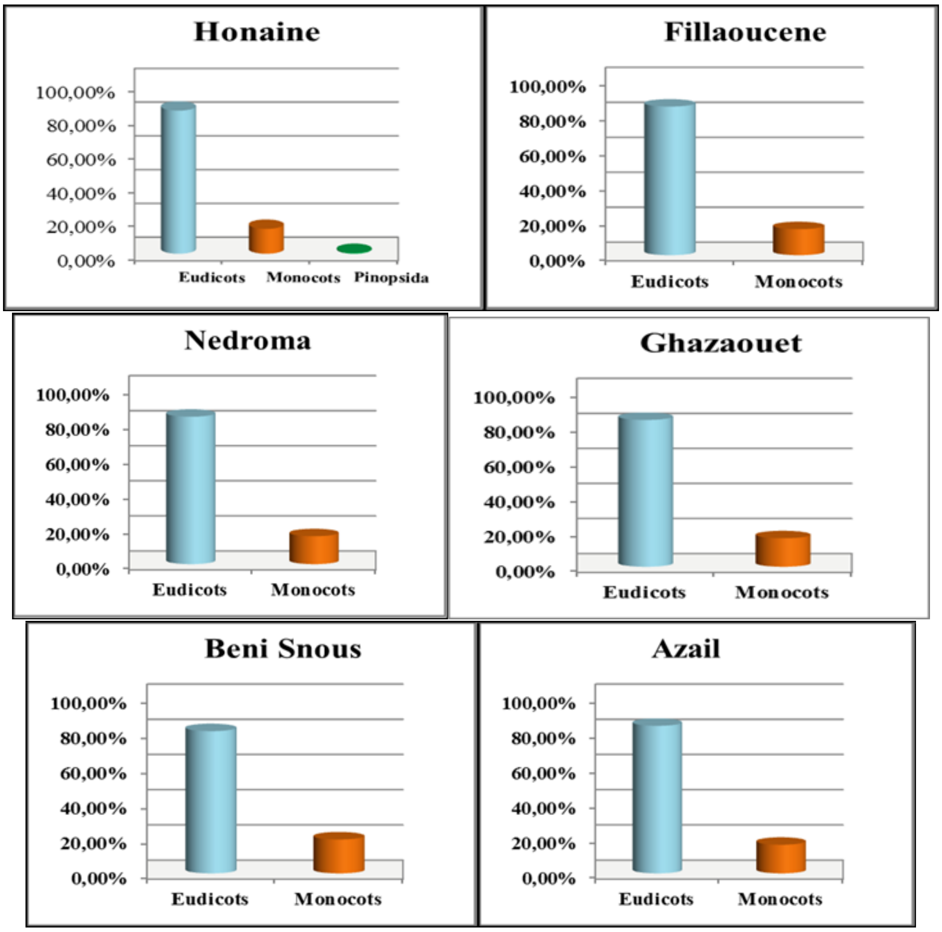


Figure 4 : Flora composition by class

Distribution of families, genera, orders and species :

The division of a territory into phytogeographical groups is most often based on essentially floristic criteria (distribution of families, genera and species, etc.).

In our case, the generic and specific distribution between families is not homogeneous. Tables 65 and 66 show that the best represented families are Asteraceae (33), Fabaceae (33), Lamiaceae (21), Poaceae (19), Liliaceae (13), Cistaceae (11), Apiaceae (10), Euphorbiaceae (6), Caryophyllaceae (8) and Brassicaceae (7).

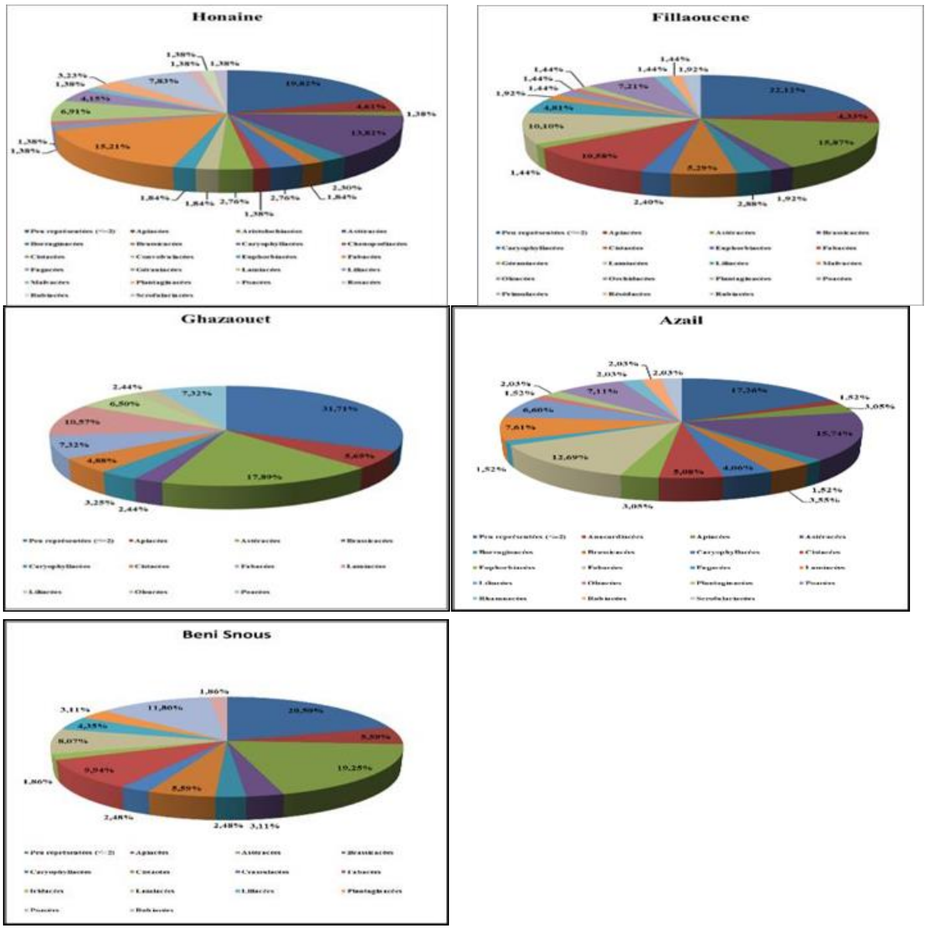
The dominance and distribution of these families are conditioned by climate change, relief and the geographical position of the sites. The Asteraceae are found mainly in pastureland and cultivated fields, while the Poaceae also inhabit forests, scrubland and pastures.

The species that make up the Cistaceae family are pyrophytes, and help to spread fire in forests. Despite their importance in terms of diversity, the other families encountered are poorly represented throughout the area. The percentages given in Table 66 of the floristic composition of the study area by family confirm that the density of groupings during the spring vegetation period depends on the exposure of the study sites.

The results obtained show that in the interactions between vegetation, the climatic factor and relief play a dominant role in the dynamics.

In most of the stations, the floristic procession includes the maximum number of genera, represented by 3 to 7 species. In the Nedroma station, we have a percentage of 3.82% for the Plantago genus. For the Honaine station, we have 1.38% (Lavandula, Trifolium, Quercus, Euphorbia, Lotus, Eryngium, Convolvulus, Asparagus), while for the sparsely represented genera, less than 2 with a single species, we have Honaine (136), Fillaoucene (167), Nedroma (136), Ghazaouet (110), Beni Snous (116) and Azaïl (152).

The orders most represented in the study stations are Asterales, with an average number of (30), a maximum rate of 16.87% in the Honaine station (33), Lamiales (22) with a rate of 12.89%, Rosales (25) with a rate of 13.88% and Personeles (15) with a rate of 8.62%. The remainder have low percentages and are included in the group of poorly



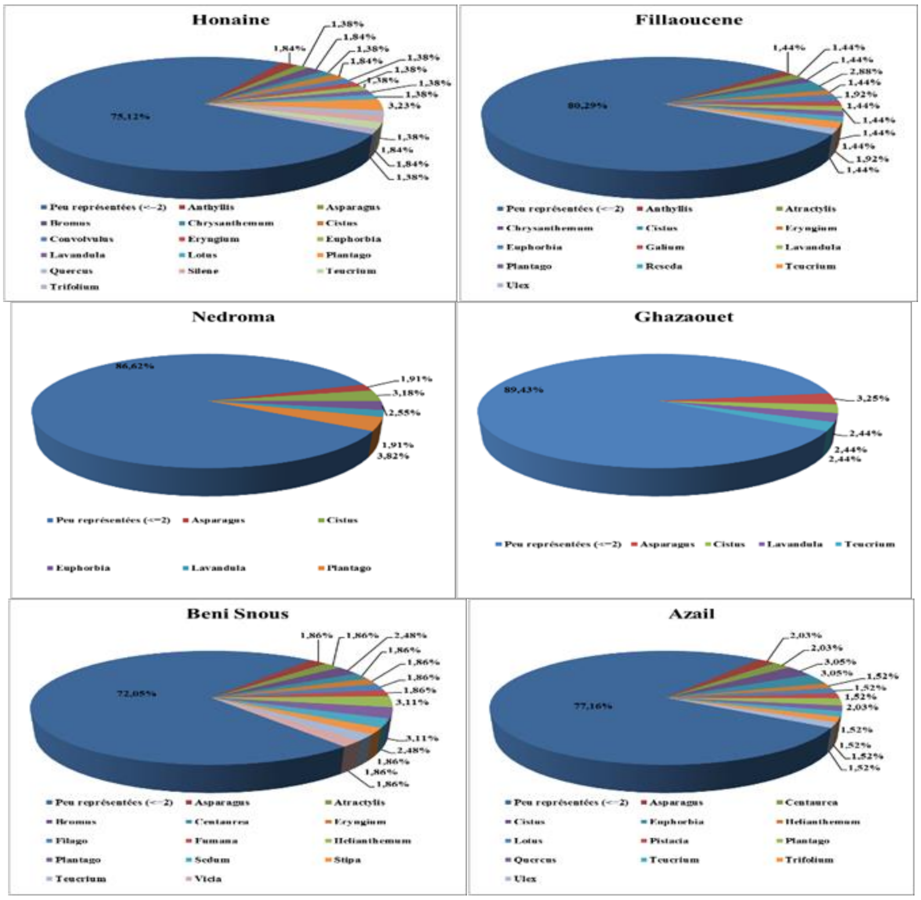


Figure 5: Flora composition by genus

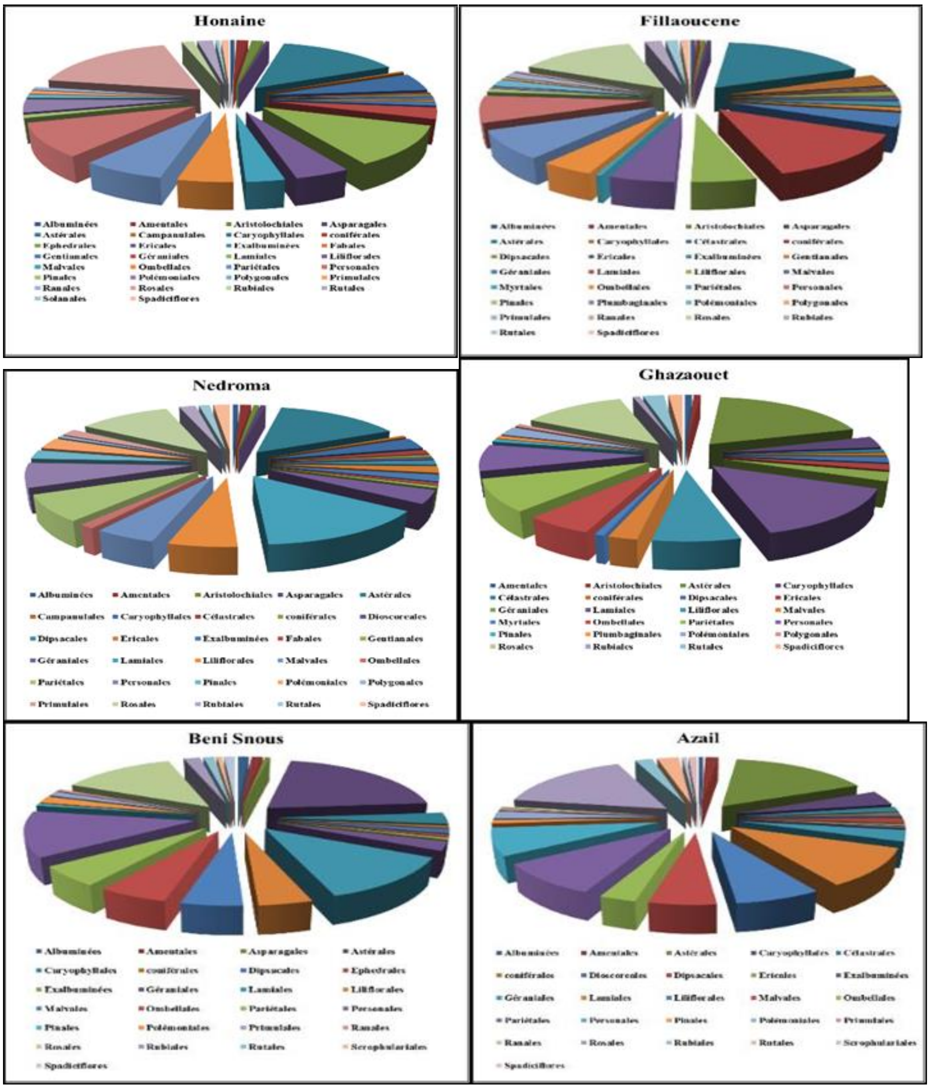


Figure.6: Composition of flora by order

Biological spectra

The biological type of a plant is the result of all biological processes on the aerial vegetative part, including those that are modified by the environment during the plant's life and are no longer hereditary (POLUNIN, 1967).

Many systems have been proposed to classify these different biological types, the most widely used being the ecological classification of RAUNKIAER (1934) in QUEZEL (1999). Like all classifications, it establishes the group's biological spectrum, thus providing a complementary element to its definition.

The biological spectrum (GAUSSEN et al., 1982) is the percentage of various biological types. It is essentially the same in regions that are geographically very far apart, but with similar living conditions. ROMANE (1987) recommends the use of biological spectra as indicators of the distribution of morphological and probably physiological traits.

Indeed, the shape of the plant depends on how it copes with the unfavorable season, the snowy winter in some regions and the drought in others.

The study carried out at the six stations provides information on biological, morphological and biogeographical diversity, based on a count of the species that make up the floristic procession in the matorrals studied. For all species, these spectra have been taken into account in the overall analysis.

Numerous studies have been carried out to highlight the relationships between the distribution of biological types and environmental factors, in particular climate (rainfall and

temperature) (RAUNKIAER, 1934); DAGET et al. (1977); DAGET (1980); DANIN and

ORSHAN (1990) and the relationships between the distribution of biological types and "altitude, nature of substrate" (FLORET et al., 1990).

Analysis of the biological type provides information on the influence of the local environment on vegetation. These biological types are considered to be an experiment in the adaptation strategy of flora and vegetation to environmental conditions. The five main biological types are: Phanerophytes, Chamaephytes, Hemicryptophytes, Geophytes and Therophytes.

Therophytization is thought to originate in the phenomenon of aridization

(BARBERO et al., 1990); (SAUVAGE, 1961); (GAUSSEN, 1963); (NEGRE, 1966);

(DAGET, 1980); (BARBERO et al., 1990); (AIDOUD (1983); (BOUAZZA et al., 2004)

and (BENABADJI et al., 2004). The latter present therophyly as a form of resistance to drought, as well as to the high temperatures of arid environments.

For all the stations studied, therophytes present the highest rate (53.19%), which testifies to the strong anthropic pressure and the invasion of tree and shrub strata, favoring the installation of these therophytes.

Tables 69, 70 and 71 with representative figures from the stations studied confirm this therophytization and clearly show that the distribution of biological types in plant formations within a station and even between stations remains heterogeneous just in terms of the position of Phanerophytes and Hemicryptophytes.

In contrast, therophytes, chamaephytes and geophytes are everywhere and hold a particularly important place, represented by Liliaceae, Orchidaceae and Iridaceae, with a percentage that remains high in the matorrals of the Tlemcen region.

-The Honaine station follows the pattern: Th > Ch > Ge > Ph > He

-The Fillaoucene station follows the pattern: Th > Ch> Ge > He > Ph

-The Nedroma station follows the pattern: Th > Ch > Ge > Ph > He

-The Ghazaouet station follows the pattern: Th > Ch > Ge >Ph > He

-The Beni Snous station follows the pattern: Th > Ch > Ge > He > Ph

-The Azaïl station follows the pattern: Th > Ch > Ge > He> Ph

-The study area follows the pattern: Th > Ch > Ge > Ph > He

We also note that the absence of nanophanerophytes is certainly linked to the intense erosion of the region, but above all to the power of the winds (GANISANS and GUBER, 1980).

Despite the low participation of phanerophytic species (6.98%) in the study area, where the number varies between 6 and 16 species, they are dominant in terms of biomass, making up forests, pre-forests, matorrals and scrub.

They are abundant in plant formations on all sites, which is further evidence of the existence of a forest and/or pre-forest formation. These are generally Quercetea ilicis species.

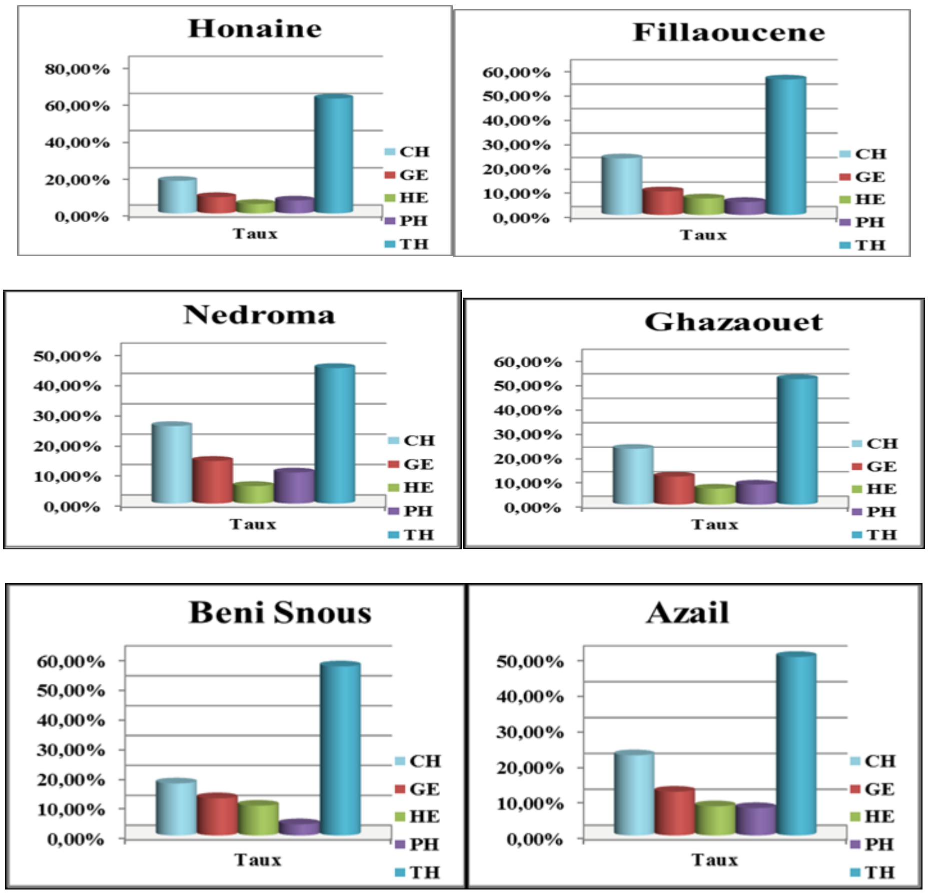


Figure 7: Composition of flora by biological type

Morphological spectra

The intense anthropization that the region's forests continue to undergo is reflected in the invasion of therophytes, which are generally annual herbaceous species. Thus, climatic rigors favor the development of short-cycle herbaceous species at the expense of perennial woody plants, which are generally more demanding in terms of water and trophic requirements.

The non-regeneration of perennial plants thus leads to changes that result in non- resilient rangelands, and also to a change in potential production and botanical composition (WILSON, 1986). The plant cover is dominated by three types of vegetation: perennial woody plants, perennial herbaceous plants and annual herbaceous plants.

From a morphological point of view, plant formations are marked by heterogeneity between ligneous and herbaceous species, and between perennials and annuals, given the severe degradation affecting species regeneration. The herbaceous stratum dominates, followed by the shrub stratum and finally the arborescent stratum.

Annual herbaceous species are the most dominant with a percentage of 48.85%, perennial woody species come second with 20.28% and in third place we find perennial herbaceous species with a percentage of 17.36%.

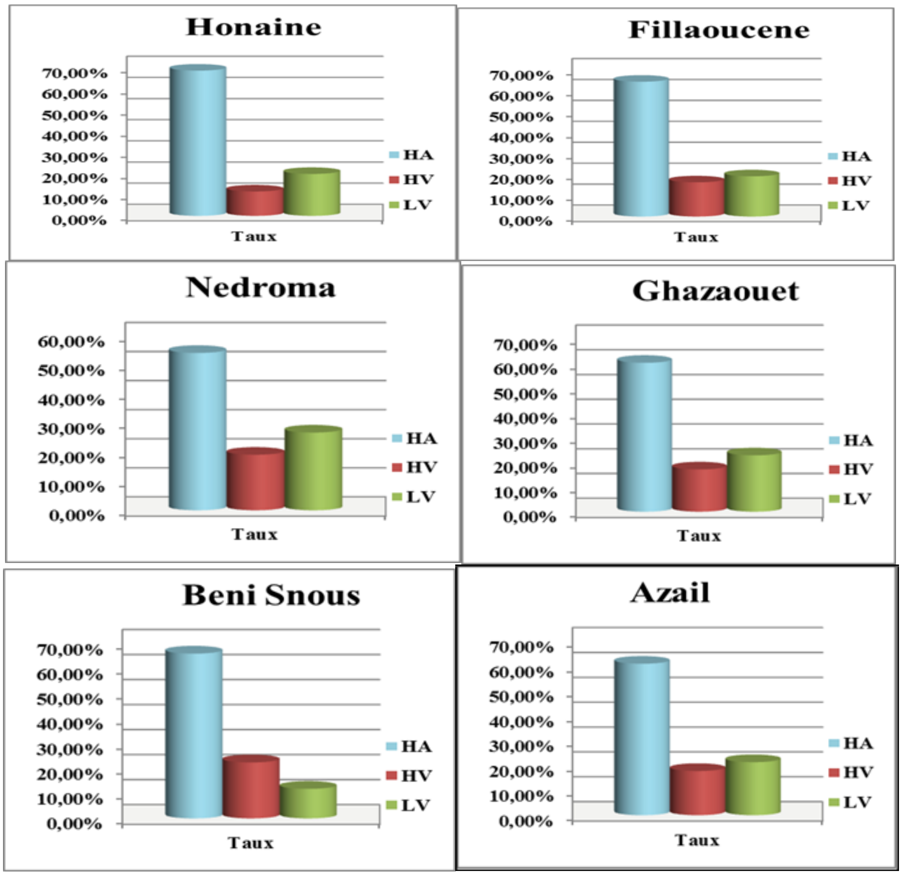


Figure 8: Flora composition by morphological type

Biogeographical spectra

Biogeographical analysis of the current flora is likely to provide valuable information on how they were established in the study region, particularly in the light of paleohistorical data.

ZOHARY (1971) was the first to draw the attention of phytogeographers to the heterogeneous origins of Mediterranean flora.

QUEZEL (1983) explains this high biogeographical diversity in Mediterranean Africa by the climatic changes that have taken place in this region since the Miocene, resulting in the migration of tropical flora.

For QUEZEL (1991), a phytogeographical study is an essential basis for any attempt to conserve biodiversity. It also constitutes "a veritable model for interpreting regression phenomena (OLIVIER et al, 1995). There are still some species in our region whose ranges are currently expanding (Poaceae, Cistaceae, Asteraceae, etc.).

The distribution of the various species sampled in the study area by phytogeographical element is very heterogeneous. The Mediterranean element is the most important, represented with an average of 35.53%. Table (71) shows the percentages of phytogeographical elements for each station.

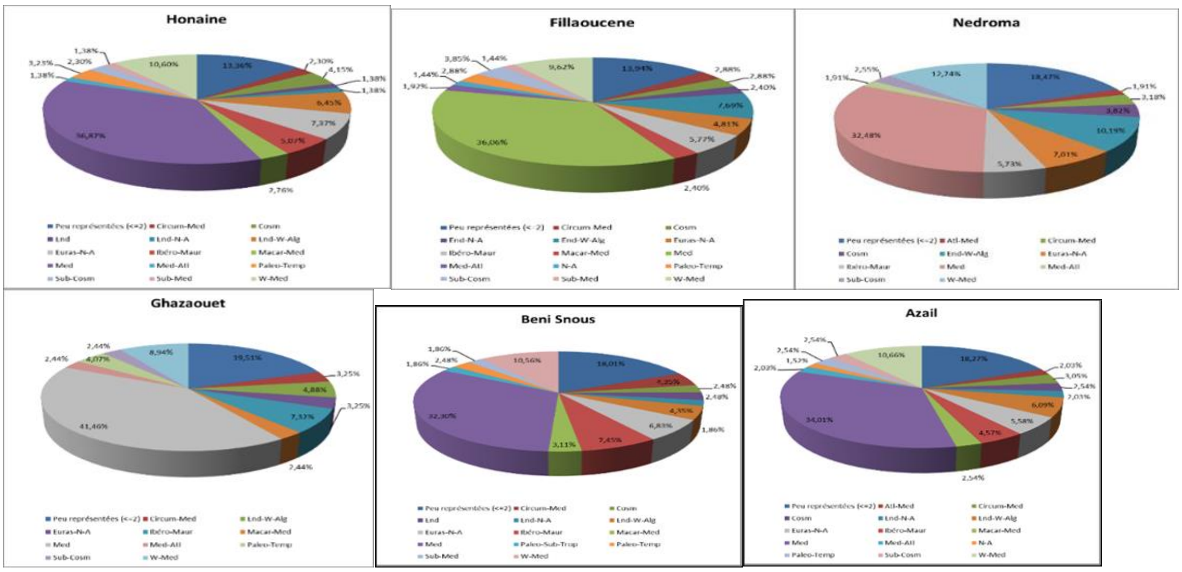


Figure 9: Flora composition by biogeographical type

Rare or endangered species

The study of the flora of the Mediterranean basin is of great interest to the region, given its great richness, its high rate of endemism, its diversity linked to the heterogeneity of the historical, paleogeographical, ecological and geobotanical factors that determine it, as well as to the secular impact of anthropic pressure (QUEZEL et al., (1980) ; QUEZEL (1983-1985) and HEYWOOD (1995)).

Abundance or rarity in the QUEZEL and SANTA flora is indicated by a single index. This index has eight levels, ranging from "extremely rare" (RRR) to "extremely common" (CCC).

They are based on a subjective assessment of the knowledge accumulated at the time by the authors, on the one hand, and their predecessors on the other, all of whose observations are collected in the work of RENE MAIRE. Only four levels will be retained in this work, corresponding to a greater or lesser degree of rarity: RRR, RR: very rare; R: rare; AR: fairly rare, and the other three related to the degree of abundance: AC: fairly common; C: common, CC, CCC: very common.

It should be pointed out that, in rare cases, the rarity index is not mentioned, and that it had to be completed using data from the FENNANE (1988) catalog and indications (distribution, but also ecology) and the plant's own knowledge, where applicable.

The results presented in the form of graphs of all the stations studied focus on the rarity of plant species. We obtained results corresponding to the four levels of greater or lesser rarity: RRR (very very rare) with 0.31%, RR (very rare) with 3.78%, R (rare) with 7.49% and AR (fairly rare) with a percentage of 5.81%.

In order to acquire as much data as possible on the structure and dynamics of plant communities, we carried out surveys taking into account floristic parameters (species frequency and abundance-dominance) divided into six classes (very rare, rare, frequent, abundant and very abundant species) at six different stations (Honaine, Fillaoucene, Nedroma, Ghazaouet, Beni Snous and Azaïl).

Synthesis of the frequency intervals of these classes shows that the averages for very rare species (67.37%), rare species (20.58%), frequent species (8.15%), abundant species (2.52%) and very abundant species (1.28%). Characteristic species include: Scorpiurus muricatus L. (RR), Sedum acre L.(AR), Senecio gallicus L. (RR), Teucrium polium L. (R), Ulex boivini Webb. (R), Agropyron repens L. (RR), Agrostis elegans Thor. (R), Ajuga chamaepitys (L.) Schreber. (AR), Brassica nigra (L.) Webb.Da.Ja.Koch . (R), Calystegia soldanella (L.).Br . (RR), Campanula rapunculus L. (R), Centaurea pungens Pomel. (RR), Helianthemum helianthemoïdes (Desf.) Gross. (RRR), Hordeum murinum L. (AR), Urginea maritima (L.) Baker.(AC), Verbascum sinuatum L. (CC), Valerianella coronata L.(C), Sonchus oleraceus L. (CCC)...etc...

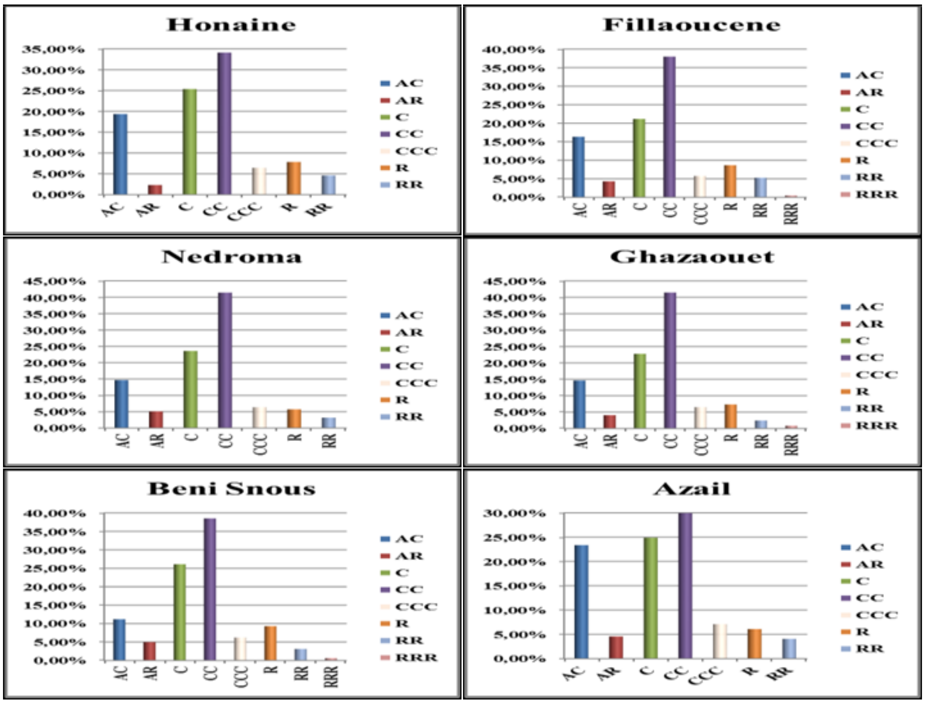


Figure 10: Flora composition by rarity

Figure 11 : Some plant species in the study area

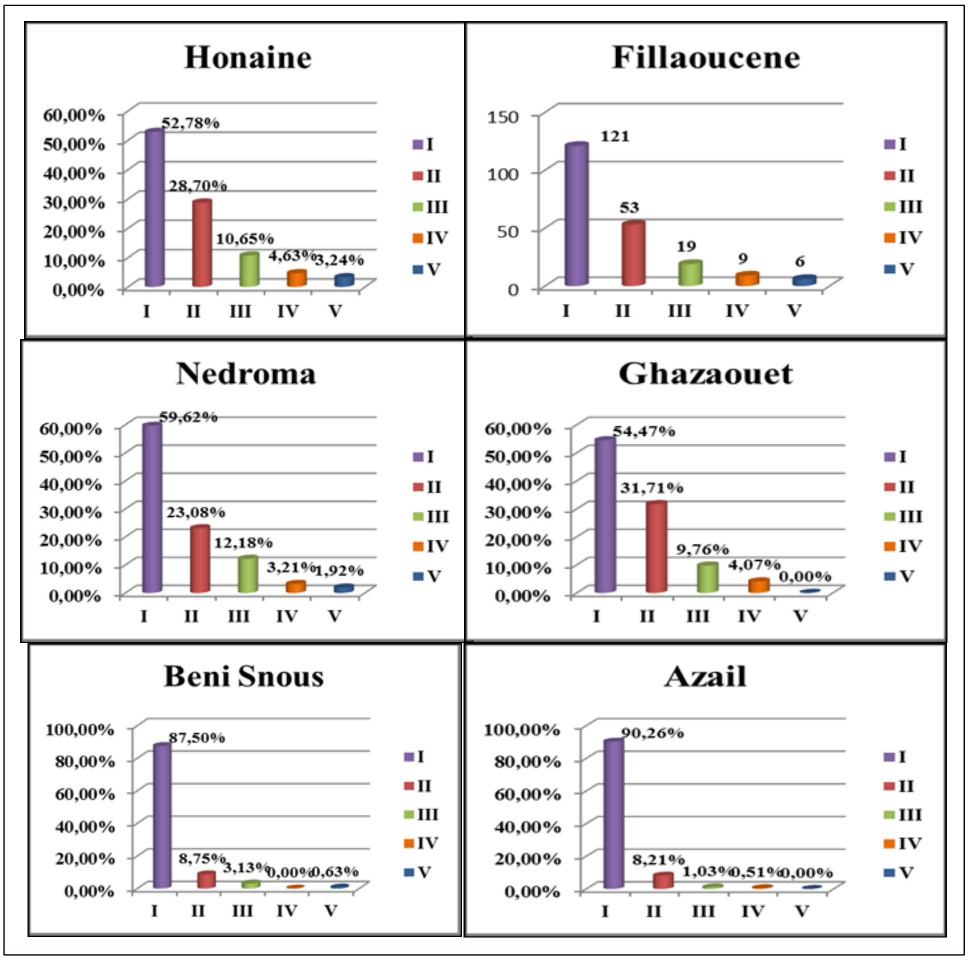


Figure 12: Vegetation frequencies in the study area

Disturbance index

The importance of the disturbance index is proportional to the dominance of therophytes, which find here a favorable environment for their development, which also reflects a more open environment. This index shows the therophytization of the area following steppization, which is considered the ultimate stage in the degradation of the various ecosystems, with the dominance of sub-nitrophilous species linked to overgrazing (BARBERO et al, 1990). LOISEL et al in 1993 confirmed that the calculation of the disturbance index can quantify this therophylization of an environment.

It is expressed by the following formula:

Ip =Number of chamaephytes + Number of therophytes/ Total number of species encountered

For all stations, this index remains high compared with the results of EL- HAMROUNI (1992) in Tunisia, where it obtained 70% as a high value.

In this context, BARBERO et al (1990) point out that these disturbances caused by man and his herds are numerous and correspond to two increasingly severe situations ranging from matorralization through steppization to desertization. The origin of the extension of these biological types is mainly due to adaptation to winter cold (RAUNKIAER, 1934 and OZENDA, 1963), summer drought (DAGET, 1980) or environmental disturbance by grazing and cultivation (NEGRE, 1966).

Chamaephytes and therophytes are the dominant biological types in the region. This shows the strong anthropozoic pressure on plant formations. In our case, the disturbance index is around 45% for the entire study area; this clearly shows the strong degradation caused by man's action, which is clearly visible (clearing, urbanization, grazing and fire) that plant formations are undergoing, particularly in our forests.

4. Conclusion

The floristic study of the Tlemcen region shows a fairly high phytodiversity, influenced by numerous ecological constraints. According to HELLAL (1988), drought and the removal of palatable species lead to regressive phytodynamics.

The study of the species Tetraclinis articulata has enabled us to appreciate the different responses to climatic conditions, following a phytoecological evolutionary study of Tetralina matorrals in the Tlemcen region, in particular the Monts des Traras, which presents the range of this species on a phytosociological and phytoecological basis.

The Honaïne station, which belongs to the thermo-Mediterranean zone, has given way to pre-forest and matorral formations based on shrub and herbaceous species, as a result of numerous degradation factors.

The plant cover is mainly formed by species belonging to the Asteraceae, Liliaceae, Apiaceae, Poaceae and Cistaceae families, as well as by forest relics and lawns renowned for their resistance to harsh climatic conditions, as indicated by KILLIAN (1954), LEMEE (1953) and QUEZEL (1999).

This regressive evolution has resulted in a reduction in the density of cedar, giving rise to matorrals with Pistacia lentiscus, Cistus salviifolius, Halimium halimifolium, etc.

There is considerable uncertainty as to how phytodiversity will be extinguished, but all economic models point to phytogenetic erosion. Phytoecological dynamics are also discussed, enabling us to identify three facies with their floristic and edaphic characteristics.

The results obtained confirm the risk of regression of this plant formation in the matorrals of the Traras and Tlemcen mountains.

The aim of the study is therefore to weigh up these different factors in order to better understand how they play a part in the structuring and evolution of this vegetation.

In other words, to try to identify the major current vegetation structures at our study sites (Honïne, Ghazaouet, Nedroma, Fillaoucen, Beni Snous and Azail), given their importance in terms of the problems posed by the conservation and use of these environments.

By summarizing the main results, we wanted to highlight the importance of the relationships between the climatic and edaphic environment, vegetation structures and their spatio-temporal heterogeneity for understanding ecological systems and developing strategies for conserving their potential and biodiversity.

The conservation of the natural heritage of the region studied remains an essential action to preserve plant biodiversity against a regression that could become irreversible in the near future. Many of the studies carried out in these ecosystems have highlighted the rich floristic diversity of these environments, highlighting a panoply of endemic and/or rare species that must be prioritized for conservation. They have also highlighted the advanced state of degradation of these natural ecosystems, which is essentially attributed to the combined action of man and his animals (overgrazing).

The intense anthropization of these plant formations in the study area has resulted in the invasion of mainly therophytes. From the results obtained, we can conclude that all the formations studied are characterized by a dominance of therophytes.

In fact, plant formations with dominant phanerophytic cover have the lowest cover of therophytes, while those with negligible phanerophytic cover have a much higher cover of therophytes.

From a morphological point of view, plant formations in the study area are marked by heterogeneity between woody and herbaceous species, and between perennials and annuals. Annual herbaceous species dominate. From a phytogeographical point of view, the Mediterranean element is the most dominant.

It can also be seen that the proportion of tree strata is decreasing, while annual herbaceous strata are increasing. The calculation of the disturbance index is proportional to the dominance of therophytic species in all the stations studied, linked to the invasion of these annual species, spread by herds throughout the study area. This situation is set to worsen, and the remaining species are likely to disappear in the near future.

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