

Exploring the floristic diversity of The Honaine Region (Northwest Algeria)

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ABSTRACT

The identification of the different plant formations in the Honaine region was carried out according to conventional methods of vegetation description, mainly based on the vegetation survey, according to the method of abundance-dominance coefficients of Braun-Blanquet (1951), also known as the Zurich-Montpellier method. The main objective of this study is to deepen our understanding of the floristic diversity in this region of northwestern Algeria. The results of the floristic study reveal that the region is home to 32 families, 61 genera and 73 species, among which Lamiaceae (12.33%), followed by Asteraceae (10.96%) and Poaceae (9.59%), are the most predominant flora. The most notable biological forms identified are Chamaephytes (30.14%), Therophytes (30.14%) and Phanerophytes (20.55%). For morphological types, we have perennial woody (39.72%) and annual herbaceous (34.25%). Biogeographical analysis of current flora can reveal valuable information about their evolution and provenance, among which the most important are the Mediterranean type (43.83%), the West-Mediterranean type (10.96%) and the North African Endemic type (5.48%). All this rich flora of the study area requires more serious protection and safeguarding in the future to maintain the continuity of these Mediterranean ecosystems, which have become increasingly fragile.

Key words :Floristic study, Braun-Blanquet method, floristic diversity, Honaine; Northwest Algeria.

Mathematics Subject Classification Number : 62P12

1. INTRODUCTION

The preservation of biological biodiversity is a priority in Algeria, given the variety of existing ecosystems, their sensitivity and the rate of their degradation. Biodiversity, according to Lepart (1997), goes beyond mere specific diversity. It encompasses three fundamental elements: genes, species and ecosystems, and takes into account counts the interactions between these elements as

well as the spatial and temporal dimensions, as highlighted by Barbault (1995) and Di Castri and Younes (1996). Studies conducted on the vegetation of the Algerian forest testify to the richness and diversity of its plant heritage, which is part of the Mediterranean forest (Benabdelli, 1996; Bouazza *et al.*, 2001).

The analysis of the floristic richness of the different groups, their biological and chorological characteristics, would make it possible to highlight their floristic originality, their state of conservation and, consequently, their heritage value (Dahmani, 1997). To better understand the dynamics and distribution of plant formations, the study carried out is mainly based on the enumeration of species, with an identification of their biological, morphological and biogeographical types.

2. MATERIELS

2.1 Location

The area studied is part of the Eastern Traras and is located northeast of the wilaya of Tlemcen, about seventy kilometers from the capital of the wilaya. It is characterized by a fairly rugged terrain and occupies an area of 7,005 hectares (Figure 1).

Its geographical coordinates extend from approximately 35° 10' to 35° 20' of latitude North and longitude 1° 60' to 1° 72' West.

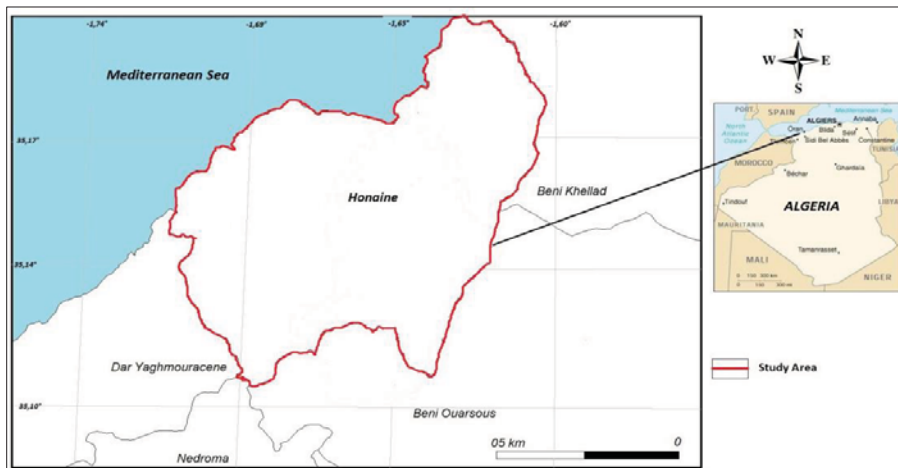


Figure 1. Honaine Region Situation Map

2.2 Relief and soil

This coastal portion of the Trara Mountains has a mountainous relief that is particularly accentuated in its southern part, where the summit of Tadjra culminates at 845 meters.

The torrential morphology is predominant in this region, creating very pronounced elevations. The main physical factors analyzed highlight the sensitivity of the study area, characterized by a very rugged terrain with steep slopes, as well as a dense and river-rich hydrographic network. The wadis that cross

the region are numerous: Oued es Safsaf, Oued El Beir and Oued El Guelta in the east; Oued Honaine and Oued El Manzel in the center; Oued Amellak and Oued Kiouma in the west.

Lithologically, there is an abundance of soft carbonate formations, which makes the area particularly prone to various erosion processes. In addition, soil plays a crucial role in the distribution of vegetation, being influenced by source rock, topography and climatic characteristics (Ozenda, 1954). According to the soil study carried out by Seladji in 2006, the soils in the study area consist mainly of fersiallitic red soils and calcimagnesian soils.

2.3 Bioclimate

The bioclimatic synthesis highlights the climatic characteristics that delimit the different levels of vegetation (Rivas-Martinez, 1981; Dahmani, 1997; Benabadji, 1991- 1995; Bouazza, 1991-1995). Based on the meteorological data provided by the stations of Ghazaouet (Tlemcen) and Beni Saf (Ain Temouchent), under the National Office of Meteorology (ONM) for the year 2020, the region of Honaine is characterized by a Mediterranean climate. This climate is distinguished by two distinct periods: a rainy season spread over nine months, from September to May, followed by a shorter dry period in June, July and August, often tempered by the sea breeze.

The variations in the values of the Emberger Pluviothermic quotient Q_2 and the average of the minima of the coldest month m , lead to changes in the vegetation, which evolves according to climatic changes (Alcaraz, 1969). The calculation of Q_2 allowed us to determine that the study area is located in the medium to moderate winter semi-arid bioclimate, indicating a slight aridity of the climate directly influencing the plant stands.

The semi-arid to arid bioclimate corresponds mainly to the thermo-Mediterranean domain, characterized by the presence of conifers such as *Tetraclinis*, *Pinus* and *Juniperus*, as well as residual hardwood formations such as *Pistacia atlantica* and *Acacia* (Quézel, 2000).

3. METHODOLOGY

The identification of the different plant formations was carried out according to conventional methods of vegetation description, mainly based on the vegetation survey. The survey plots were located on surfaces with a homogeneous vegetation cover in terms of structure and floristic composition. These areas were the subject of one or more surveys according to the method of abundance-dominance coefficients of Braun-Blanquet (1951), also known as the Zurich-MontPELLIÉNE method. This method consists in assigning to each species two values: the first corresponding to abundance-dominance, and the second to sociability.

The use of stratified sampling has led to relevant results (Godron, 1971; Frontier, 1983). Preliminary field surveys allowed us to have a global vision of the diversity of the situation. According to Ellenberg (1956), the selection of stations depends essentially on the homogeneity of the vegetation cover in order to avoid transition zones. Within the areas thus determined, the choice of locations for our surveys

was made subjectively, taking care to respect the criterion of structural, floristic and ecological homogeneity (Gounot, 1969; Gehu and Rivas-Martinez, 1981).

Each survey was carried out in a homogeneous floristic area according to the minimum area method (Braun-Blanquet, 1952; Gounot, 1969). The size of the survey area had to be equal to the minimum area, which could be determined in the field or arbitrarily assessed according to the number of species present in the ecosystem studied. This area is of particular importance in areas with low vegetation density. In our study area, a surface area of 100 m² seemed sufficient to represent the minimum area of plant formations. We carried out about a hundred floristic surveys throughout the region, using semi-permanent monitoring plots distributed in different vegetation units, in order to guarantee a representativeness of the variability of the environment. According to Gehu in 1987, the size and shape of the survey are determined by the requirements of homogeneity. It is now accepted that in the Mediterranean region, the survey area varies from 100 to 300 m² in forests and from 50 to 100 m² in matorrals. Hadjadj Aouel (1995) recommended a minimum area of 100 m² for Oranie thuya matorrals.

4. RESULTS AND DISCUSSION

4.1. Classification of plant formations

4.1.1. Family classification

Analysis of the floristic procession reveals a heterogeneity in the distribution of genders and species between families, with a total of 32 families, 61 genera and 73 species.

Table 1 and Figure 2 show that the best represented families are Lamiaceae (12.33%), followed by Asteraceae (10.96%), Poaceae (9.59%), Liliaceae and Cistaceae (8.22%), Ericaceae, Fabaceae and Fagaceae (4.11%). The Apiaceae, Cupressaceae, Euphorbiaceae and Oleaceae families are also well represented, with a frequency of 2.74%, while the other families have a representation of 1.37%.

Table 1: Floristic composition by family

Family	Number of species	Percentage %
Lamiaceae	9	12.33%
Asteraceae	8	10.96%
Poaceae	7	9.59%
Cistaceae	6	8.22%
Liliaceae	6	8.22%
Ericaceae	3	4.11%
Fabaceae	3	4.11%
Fagaceae	3	4.11%
Apiaceae	2	2.74%
Cupressaceae	2	2.74%
Euphorbiaceae	2	2.74%
Oleaceae	2	2.74%
Araceae	1	1.37%
Aristolochiaceae	1	1.37%

Caprifoliaceae	1	1.37%
Cesalpineeae	1	1.37%
Convolvulaceae	1	1.37%
Crassulaceae	1	1.37%
Fumariaceae	1	1.37%
Gentianaceae	1	1.37%
Geraniaceae	1	1.37%
Globulariaceae	1	1.37%
Myrtaceae	1	1.37%
Palmaceae	1	1.37%
Papaveraceae	1	1.37%
Pinaceae	1	1.37%
Plantaginaceae	1	1.37%
Primulaceae	1	1.37%
Rubiaceae	1	1.37%
Therebintaceae	1	1.37%
Thymel�aceae	1	1.37%
Zygophyllaceae	1	1.37%
Total	73	100%

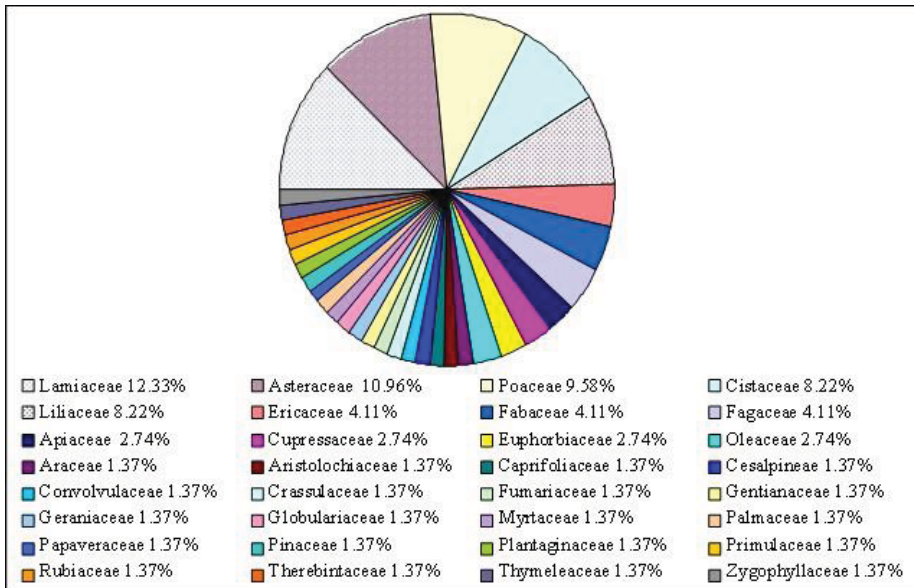


Figure 2. Floristic composition by family

4.1.2 Biological classification

4.1.2.1 Biological types

"Organic forms" are a key element in the definition of plant formations, according to Delpech *et al.* (1985). Since the first classification systems, which were purely descriptive and based on the observation of a plant's ability to flower and fruit for one or more successive years, most authors have sought to integrate ecological variables into the proposed classification systems (Grisebach, 1872; Warming, 1908; Ozenda, 1977).

Raunkiaer (1904 and 1907) points out that biological types reflect a strategy of adapting flora and vegetation to environmental conditions. Romane (1987) highlights a significant correlation between biological types and many phenological characteristics. He recommends the use of biological spectra as an indicator of the distribution of other morphological traits and probably physiological traits.

Floret and Pontanier (1982) pointed out that Raunkiaer designed its classification according to how species survive the cold period, in regions with a marked cold season.

In the Mediterranean regions, the critical period is no longer winter but the dry season. Adaptation to this period is achieved by creating biological types that are symmetrical to those defined by Raunkiaer in cold-season regions (Ozenda, 1982). The classification of species according to the biological types of Raunkiaer (1904-1934) is mainly based on the adaptation of the plant to the unfavourable season and focuses on the position of the hibernating buds in relation to the soil surface, seeking to classify the plants according to similar forms.

This classification has been extended to the entire plant kingdom since then (Braun Blanquet, 1928; Rothmaler, 1955). In addition, different categories have been defined within the same type (Godron *et al.*, 1968). However, it is not always easy to classify a plant into one type rather than another: in addition to the sliced character inherent in any classification system, field observation has shown that the biological type of the same plant can change depending on the climate, implying that "biological types are naturally to be noted as they are in the vegetation studied, not as they usually are" (Emberger, 1966). In our case, we adopted the classification elaborated by Raunkiaer (1918) and modified by Braun Blanquet (1932).

4.1.2.2 Biological Spectrum

The biological spectrum according to (Gaussen *et al.*, 1982) is the percentage of the various biological types.

Table 2: Biological types in the study area

Biological types	Number of species	Percentage %
Chamaephytes.	22	30.14
Therophytes	22	30.14
Phanerophytes	15	20.55
Geophyte	8	10.96
Hemicryptophytes	6	8.22
Total	73	100

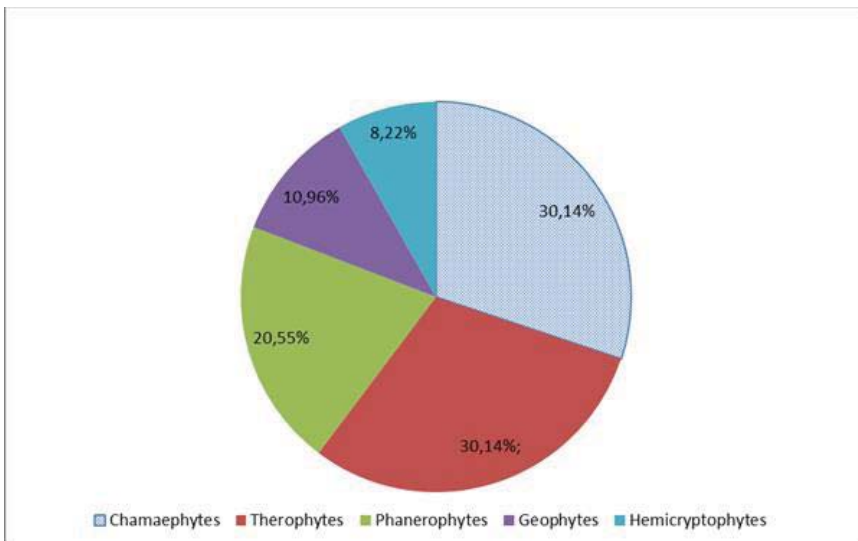


Figure 3. Biological types

We note in Table 2 and Figure 3, a clear dominance of Chamaephytes and Therophytes which have the same rate 30.14%.

Chamaephytes occupy an important place in the plant formations of our area. Among the species encountered we have:

Ammophila arenaria

Ampelodesma mauritanicum

Aristolochia baetica

Asteriscus maritimus

Calycotome villosa

Chamaerops humilis

Cistus albidus

Cistus ladaniferus

Cistus monspeliensis

Cistus salvifolius

Daphne gnidium

Erica arborea

Erica multiflora

Genista tricuspidata

Globularia alypum

Helichrysum stoechas

Helianthemum helianthemoïdes

Lavandula dentata

Lavandula stoechas

Thymus algeriensis

Pallenis spinosa

Ulex boivini

Therophytes are represented by the following species:

Ammoides verticillata

Euphorbia peplis

Anagalis arvensis

Fagonia cretica

Atractylis cancellata

Fumana thymifolia

Bellis annua

Fumaria capreolata

Brachypodium distachyum

Hordeum murinum

Bromus lanceolatus

Papaver rhoeas

Centaurea pullata

Phagnalon rupestre

Centaureum umbellatum

Prasium majus

Convolvulus althaeoides

Sedum sediforme

Erodium moschatum

Teucrium fruticans

Euphorbia paralias

Teucrium polium

Phanerophytes have a percentage of the order of 20.55% among the species encountered we have:

Arbutus unedo

Pinus halepensis

Ceratonia siliqua

Quercus coccifera

Juniperus phoenicea

Quercus ilex

Lonicera biflora

Quercus suber

Myrtus communis

Rosmarinus officinalis

Olea europaea

Rosmarinus tournefortii

Phillyrea angustifolia

Tetraclinis articulata

Pistacia lentiscus

Geophytes are represented with a rate of 10.96%. The species encountered are as follows:

Arisarum vulgare

Asphodelus microcarpus

Asparagus acutifolius

Scilla lingulata

Asparagus altissimus

Stipa tenacissima

Asparagus stipularis

Urginea maritima

Hemicryptophytes remain poorly represented at 8.22%. Among the species encountered we have:

Dactylis glomerata

Eryngium tricuspidatum

Inula montana

Marrubium vulgare

Plantago lagopus

Rubia peregrina

4.1.2.3 Disturbance Index (PI)

The disturbance index calculated according to Loizel et al. (1993) makes it possible to quantify the therophytisation of a medium.

$$PI = \frac{\text{Number of Chamephytes} + \text{Number of Therophytes}}{\text{Total Number of species}}$$

The calculated disturbance index in the study area is about 60%. This highlights a degradation of the natural environment due to human activity, including fires, clearing and grazing. In addition, *Merioua et al.* (2013) found a disturbance index of around 68% for the Beni Saf study area, which is considerable. This finding highlights a disturbance and an imbalance of plant stands, resulting from the high anthropozoogenic pressure.

Similarly, El Hamrouni (1992), after studying forest and preforest vegetation in Tunisia, observed a therophytization rate of 70%. This same author concluded that this index was high.

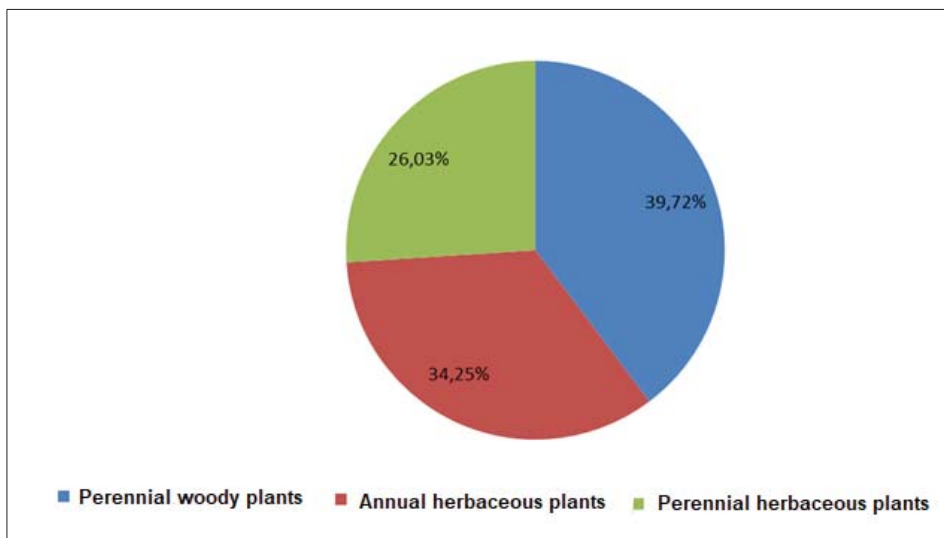
4.1.3 Morphological classification

Strong environmental degradation has a significant impact on the regeneration process of plant species. The lack of regeneration of perennial plants leads to changes in the botanical composition of the environments, which results in poorly resilient pathways and also alters potential production.

The biological type of plants corresponds to their natural form, which is influenced by variations in their environment. Romane (1987) observed a close correlation between biological types and many phenomenological traits, suggesting that biological spectra can serve as indicators to assess the distribution of other morphological traits. Plant shape is a fundamental criterion for classifying species into biological types, with categories including perennial, woody, herbaceous and annual species. The physiognomy of a plant formation is determined by the predominance or absence of certain species with different morphological types.

Table 3: Morphological types in the study area

Morphological types	Number of species	Percentage %
Perennial woody plants	29	39.72
Annual herbaceous plants	25	34.25
Perennial herbaceous plants	19	26.03
Total	73	100

**Figure 4.** Morphological types

From a morphological point of view, the plant formations in the study area exhibit great diversity, with a significant proportion of woody and herbaceous plants, as well as variability between perennial and annual species, as illustrated in Table 3 and Figure 4.

Perennial woody plants largely dominate, accounting for 39.72% of vegetation cover. They are followed by annual herbaceous plants, which occupy the second position with 34.25%, and finally perennial herbaceous plants, representing about 26.03% of the plant cover.

Analysis of the results suggests that plant formations in the study area are likely under relatively low anthropogenic pressure, although this pressure appears to be gradually increasing due to intensified clearing in the area.

4.1.4 Biogeographical Classification

Since Maire's first phytogeographical synthesis (1926), it has been recognized that Algeria's botanical territories are located in the Holarctic Empire, the Mediterranean region and the Saharan region. However, several researchers, including Eig (1931), Monod (1957), Quézel *et al.* (1963) and Zohary

(1966), have examined subdivisions of the Mediterranean region, particularly the transition zone to the Paleotropical Empire. Gaussen (1954) described this area as a Saharo-Sindian zone, while Quezel (1965) designated it as a Saharo-Sindian region, and finally, Barry *et al.* (1974) described it as a Saharo-Sindian sub-region.

The phytogeographical study is crucial for understanding regression processes according to Olivier *et al.* (1995). For Quézel (1991), such a study is essential for any initiative aimed at preserving biodiversity. Several researchers have studied this subject, including Walter *et al.* (1970), Axelrod (1973), Axelrod *et al.* (1978), Pignatti (1978) and Quézel (1978, 1985 and 1995). Zohary (1971) highlighted the diversity of the origins of Mediterranean flora, thus attracting the attention of plant geographers. In 1983, Quézel explained that the biogeographical diversity of Mediterranean Africa was the result of major climate changes since the Miocene, resulting in migrations of tropical flora. The biogeographical distribution of species in our study area was determined using the flora of Algeria (Quézel and Santa, 1963).

Table 4: Biogeographic types in the study area

Types biogeographical	Representations	Number of species	Percentage %
Med	Mediterranean	32	43.83
W.Med	West Mediterranean	8	10.96
End.N.A	North African endemic	4	5.48
Ibero-Maur	Ibero-Mauritanian	4	5.48
Circum-Med	Mediterranean Circum	3	4.11
Eur-Med	European-Mediterranean	3	4.11
Canar-Med	Canary-Mediterranean	2	2.74
Cosmop	Cosmopolitan	2	2.74
Macar-Med	Macaronesian-Mediterranean	2	2.74
Atl-Med	Mediterranean-Atlantic	2	2.74
Paleo-temp	Paleo-temperate	2	2.74
Circumbor.	Circum-boreal	1	1.37
End	Endemic	1	1.37
End.Alg.Mor	Endemic-Algerian-Moroccan	1	1.37
Eur	European	1	1.37
Euras-Afr-Sept	Eurasian-Septentrional African	1	1.37
Merid-A.N	Meridional-North African	1	1.37
Paleo-subtrop	Paleo-Sub-Tropical	1	1.37
Sub-Cosm	Sub -Cosmopolitan	1	1.37
W.Med-Sub-Atl	West-Mediterranean-Sub-Atlantic	1	1.37
Total		73	100

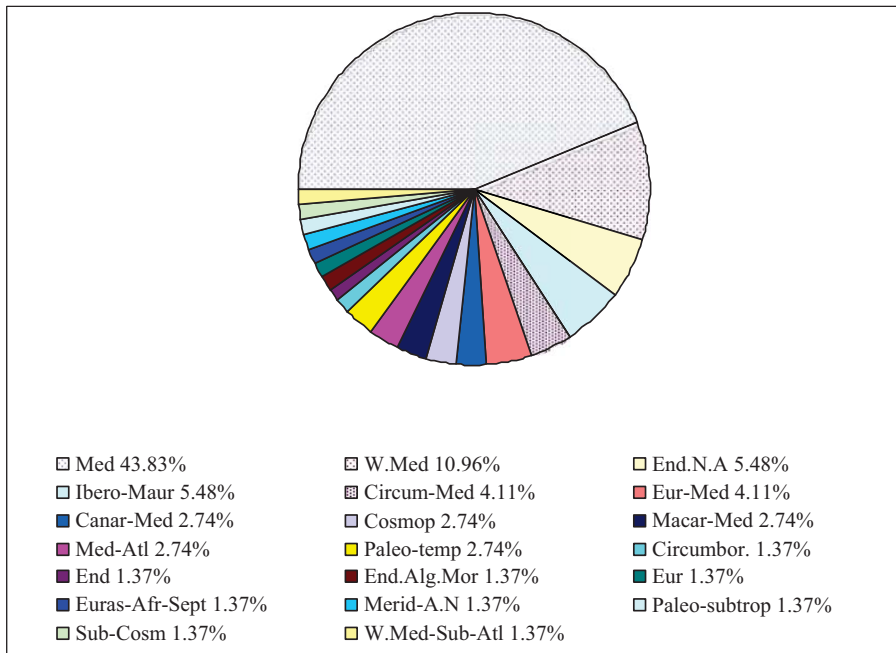


Figure 5. Biogeographic types

Phytogeographically, the vegetation of the study area consists of a varied mixture of elements from different origins, namely Mediterranean, northern and southern.

Based on the data presented in the table and figure, the following observations can be made:

- Strictly "Mediterranean" elements largely dominate the flora of the region studied, accounting for about 43.83%.
- In second position, we find the element "West Mediterranean", with a presence of about 10.96%.
- The North African and Ibero-Mauritanian Endemic elements together represent about 5.48%.
- The Circummediterranean and European-Mediterranean species are present at about 4.11%.
- The Canary-Mediterranean, Cosmopolitan, Macaronesian-Mediterranean, Mediterranean-Atlantic and Paleo-temperate species are less abundant, accounting for about 2.74%.
- The other elements have an even lower presence, their rate being less than 1.38%.

5. CONCLUSION

The development of mountain areas is a strategic challenge for Algeria. These areas, due to their size, contain enormous potential in terms of natural resources. They are currently compromised by an ecological imbalance, of human and climatic origins, which is increasingly threatening and which

risks seriously hampering the future and the socio-economic development of these areas. The diversity of endemic species of Mediterranean flora stems from its ancient geological history as well as the multiple ecological changes that have taken place over millions of years. Indeed, the establishment of this flora dates back to a distant period, and the environmental factors that have prevailed during its evolution have helped to shape its current diversity. In addition, it is important to consider the intrinsic evolutionary criteria that have played a role in the formation and adaptation of these species over time (Quézel, 2000). Médail and Quézel (1999) identified about 25,000 species in the Mediterranean region, making this region one of the most biodiversity-rich areas in the world, with an endemism rate of about 50%. The analysis of the vegetation allowed us to specify the distribution of the species and to identify the botanical components. The duality between the different areas of the Mediterranean region is reflected by the dominance of five groups of families: Lamiaceae (12.33%), Asteraceae (10.96%), Poaceae (9.59%), Liliaceae (8.22%) and Cistaceae (8.22%). These families represent more than 49% of the flora studied. The flora studied shows a clear dominance of Chamaephytes and Therophytes with a rate of more than 60%; Phanerophytes come second with a rate of more than 20.55%. Geophytes and Hemicryptophytes have a rate of less than 20%. On the biogeographical level, the overall distribution of species shows a dominance of the strictly "Mediterranean" element represent a very important part of the flora of the study region with a rate of around 43.83%.Mediterranean.

The results of the physiognomic survey highlight the importance of the shrub layer in the different formations. The Honaine region has a great diversity of vegetation cover, which underlines the importance of conducting a thorough inventory. It may be necessary to increase the number of plant surveys by moving in the field, especially where plant stands are difficult to reach, where other species (rare, endemic) could be found, whether characteristic, indicator or companion. Could this exploration be developed further ?

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