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Article

Saïda region plants diversity (West of Algeria): First typological study of its forest and pre-steppe habitats

Sid Ahmed Aouadj [1], Mohamed Zouidi [2,*], Ayoub Allam [3], Belgacem Nouar [1], Hanane Degdag [4], Yahia Nasrallah[5], Okkacha Hasnaoui [1], Hadj Khatir [6], Saifi Merdas [2,7]

[1] Laboratory of Ecology and Management of Natural Ecosystems, Abou Bakr Belkaid University, Tlemcen-Algeria. sidahmed.aouadj@univ-tlemcen.dz
[2] Centre de Recherche en Aménagement du Territoire (CRAT), Campus Zouaghi Slimane, Route de Ain el Bey, 25000 Constantine, Algérie. mohamed.zouidi@crat.dz
[3] Centre de Recherche en Technologies Agro-Alimentaires (CRTAA). Campus universitaire Tergua Ouzemour.Bejaia.06000. Algeria. all-4@hotmail.fr
[4] Laboratory for the Eco-Development of Spaces, Djillali Liabes University of Sidi Bel Abbes-Algeria. hanane.degdag@univ-sba.dz
[5] Laboratory of Biotoxicology, Pharmacognosia and Biological Valuation of Plants, University of Saida-Dr Moulay Tahar-Algeria. ynasrellah@yahoo.fr
[6] Private scientific consultant and a head of Reprodbiotech and stem cells. Montréal, Qc, Canada. khatir_hj67@hotmail.ca
[7] Centre de recherche scientifique et technique sur les régions arides CRSTRA, Biskra. saifieco@gmail.com
* Correspondence: sidahmed.aouadj@univ-tlemcen.dz; mohamed.zouidi@crat.dz

Abstract : In the present work we assessed the different facets of biodiversity in 10 habitats using the phytosociological method. The aim of this study was to characterize the most suitable habitats for biodiversity in Saida Mountains. The Matorral with *Tetraclinis articulata* (Vahl) Mast. and *Phillyrea* sp, the Matorral with *Tetraclinis articulata*, *Rosemarinus* sp, and *Quercus coccifera* L. scrub plant community appeared to be the most diversified in terms of biodiversity and Pre-steppe formation is poor (in terms of plant diversity). However, and generally speaking, biodiversity is maximal for the more or less open tree matorrals; which decreases in the case of degradation and ecosystem fragmentation. It should be stressed that all habitats present a particular flora that is very important for the conservation of the Saida Mountains.

Keywords : Saida Mountains; plants diversity; typology study; habitats; phytosociological method.

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1. Introduction

Quézel and Santa [1] have divided the Algerian territory into 20 biogeographic sectors and sub-sectors, the majority (15) of them are located in the north of Algeria. The endemism rate and rarity vary from one sector and/or sub-sector to another. The number of endemic taxa recorded is 464 while the number of rare taxa is estimated at 1818 [2].

According to [3] the Coastal Sahels sub-sector (O1) belonging to the Oran sector (O) is the richest in endemic species with 103 taxa and the Little Kabylie sub-sector (K2) belonging to the Kabyle and Numidian sector (K) is the richest in rare taxa with 487 species. This high rate of endemism and rarity in Numidia (K2) and the Coastal Sahel sub-sector (O1) is explained by the fact that these two areas make two hotspots of phytodiversity "Kabylies-Numidie-Kroumirie" for the first zone and "Betico-rifain complex" for the second one [2].

These two hotspots belong to the refuge areas of the Little Maghreb, which is considered a region with high phyto-diversity due to a large orographic and bioclimatic complexity varying from the South to the North. At the dynamic level, phytodiversity in Algeria is in irreversible decline due to global changes, especially as a result of strong anthropogenic and climatic pressures [4-6].

The ecosystems of the Saida Mountains, as with all the other formations of Tellian Atlas (Tlemcen, Sidi Bel Abbes, Mascara, Tiaret...etc) have known a continuous shrinkage due to the fires, the anthropic actions, the inadequate management and a weak rainfall related to their geographical position. This critical situation is requiring urgent restoration and rehabilitation strategies [5, 7, 8, 9, 10, 11, 12, 13, 14, 15].

Fennane et al [16], Letreuch-Belarouci et al [17], and Aouadj et al., [9, 18] all agree on the importance of establishing a directory of natural habitats for the appropriate management of phytodiversity. Without this catalog, it will be difficult for managers to make decisions that are executable. The contribution of scientists will certainly help managers by providing them with a practical guide to a very nuanced and complex natural reality. Thus, the creation of "habitat catalogs" in the Mediterranean region is gaining more and more ground. Indeed, the Directorate General of Forests has just launched a call for tender for the inventory and mapping of habitats in Algeria. This first stage is devoted to collecting information on habitats (typology of stations). Another step has been envisaged for the identification of the most diversified endangered habitats that need immediate protective action. It is within this context that this present study aims to propose a method for assessing the biodiversity of habitats in an attempt to define the most sensitive types.

2. Materials and Methods

2.1 Study area

The area of Doui Thabet is located in the northwest of Algeria occupying mountainous areas of the massifs. It represents a small part of a whole forest complex of the Saida Mountains, where it occupies the mountainous hills, stretching for about twenty kilometers west of Saida town.

The study area is located according to the longitude/latitude-type projection (WGS84) between: (34.9674 degrees north), (34.8068 degrees South), (0.149499 degrees East) and (-0.1120236 West) (Fig.1). According to the DFM (Digital field Model), the study area has a heterogeneous relief, mainly rocky, with a total area of about 5624 hectares, an altitude between 580 and 1203 meters and an average altitude of 950 meters. The western sub-area is characterized by a low elevation between 580 meters and 900 meters (generally valley bottoms and foothills areas), while the high elevation distinguishes the eastern sub-area between 800 meters and 1203 meters. More than 40% of the area is dominated by low slopes (0% - 5%) which characterize the whole of the valley bottoms (lands located on the plains, Wadi “river” spreading areas) and low pedestrians. Twenty-five percent of the area has moderate slopes (5% - 15%) and characterizes the low pedestrian areas of hills (djebels and hilly areas). The remaining area (25%) has steep slopes (> 20%), particularly at the east, which causes erosion of the soils characterizing the high foothills and the summits of the mountain chains. In general, the studied area is exposed to all directions. The eastern and southern parts receive a significant amount of sunshine. While the north-facing part is exposed to a significant amount of humidity. These two factors are one of the parameters that can explain the type of vegetation and land-use in the area covered by the study. The main soil and lithological units characterizing soils in the Study Area are [19,20]:

A. Lithosols: Are fairly extensive and are found on almost all denuded versants. They are shallow (generally less than 20 cm in thickness) and very fragmented.

B. Brown-red soils: Among these soils, we can distinguish brown-red soils with a humus horizon and Mediterranean brown-red soils with a slight texture. These soil types occupy the hillsides. They are formed on calcareous or dolomitic materials. They are fersialitic (rich in iron and silica) that have evolved under a caducifoliated forest in fresher and moister conditions. Their rubefaction corresponds to a warmer phase with sclerophyllous vegetation and results in red fersialitic soils or "Terra rossa". The Ombro-Thermal Diagram (OTD) of the Saida climate station between 1980 and 2015 (Fig. 2) shows that the climate is of the Mediterranean type with a long period of drought. A drought lasts 6 to 8 months, from the beginning of May to the end of October (the current dry period is one and a half months longer than the former one). The thermal regime of the region is characterized by very high temperatures in summer and low temperatures in winter. The highest temperatures are recorded during the months of July and August, with a maximum of between 34°C and 36°C on average for the ancient and new periods respectively. As a consequence, this corresponds to high evaporation. Low temperatures occur in February with an average temperature of 9°C for the new period and 8°C for the ancient one. The minimum average temperature recorded is between 2.5°C and 2.8°C for the ancient and new periods respectively. The Emberger rainfall index classifies the Doui Thabet State Forest as upper semi-arid (Q2 =39) with a fresh variety [21;22].

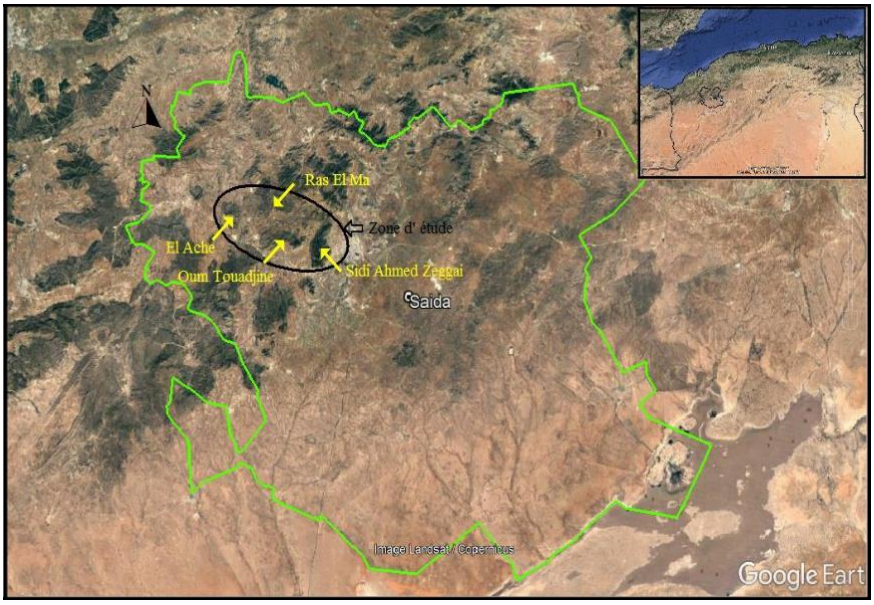

Figure 1. Geographic map of the Saida Mountains.

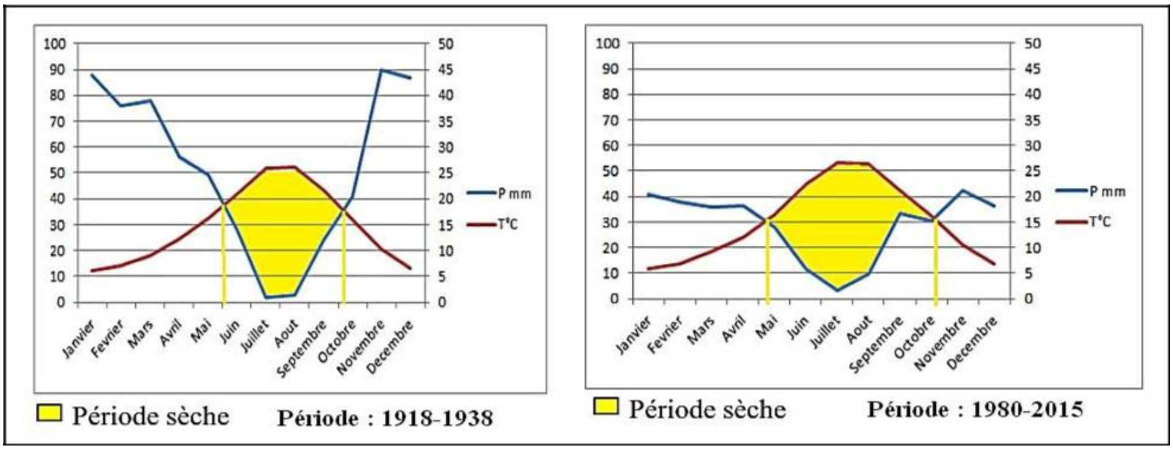

Figure 2. Ombro-thermic diagram of the study area of the ancient [23] and the new Period [24].

2.2. Methodology

Fieldwork for the plant inventories was held during the autumn and spring of the 2017 until 2019 (some plants are autumnal flowering, others spring flowering: early and late).

Floristic statements were performed in the different species of plants covering the entire area of study. The number of readings in each homogeneous zone depends on the diversity of ecological descriptors and the extent of each vegetation formation. At the level of each record, we mentioned the geographic location, pedological characteristics, orographic, substrate, structure, and covering rate of each stratum, as well as the abundance-domination coefficient (ADC) and the sociability of each species (Fig. 3).

2.2.1.Technique

In this study, we evaluated the phytodiversity of the habitats of the Saida Mountains using some indices developed by different authors. During these analyses, it is easier to use the number rather than the name of the association and the habitat. The correspondence between group numbers and the names of associations and habitats is defined in the following outline.

2.2.2. Biodiversity Indices

On the basis of the hierarchy proposed by Whittaker [25] and Vanpeen [26], the analysis of specific richness was carried out on four levels: specific richness by record or landscape, local richness, global richness, and original richness:

One-off richness: is the number of species found in a habitat. This wealth is instantly calculated habitat by habitat.

Local richness: is the average number of species per record of the same category according to one of the selected agglomerations (in this case, the type of habitat is taken into account). It reflects, for a given sample category, the average of the one-off richness per record and thus allows taking into account the heterogeneity of the records.

Global richness: is the sum of the species present in the studied category. It can be estimated for each type of habitat. Comparison of the different lists of related categories provides an indication of the heterogeneity and the degree of distinction between categories. The species common base is a list of the species present in all habitats. It, therefore, represents the number of species found throughout the spatial aggregation categories. It also reflects the homogeneity of vegetation and the species most commonly prevalent or having no particular ecological requirement.

Original richness: represents species that are present in one habitat. This diversity reflects the heterogeneity of the environments and their significance in the floristic heritage. A habitat will definitely contribute to the global richness of the area according to the originality of its species. In this study, we have used the punctual richness of each record in order to define: 1) the profiles of the punctual richness, 2) the average of this richness for every association or habitat (local richness), and finally, 3) the total number of species inventoried in all habitats (global richness).

To the previous analyses we included the following indices:

Specific diversity: Many authors have argued that the frequencies of categories should be considered when measuring biodiversity. Shannon-Weaver [27], proposed an index correcting wealth "richness" by the relative frequencies of the categories. If this index is very small (porch of 0); the number of species is low and only one or a few species dominate. On the other hand, if the index is higher, then the number of species is important and they will be equitably distributed.

The similarity index: Similarity indices allow a comparison between two sites. They assess the similarity between two groups of readings by relating the common species to both readings to the species-specific to each reading. Commonly used indices include:

- The Dice or Czekanowsi index of Guinochet [28]: This index is between 0 (no species common to both habitats) and 1 (identical habitats).

S= 2nt/ ax+bx+cx+…+nx

Where

a = number of species common to record 1 and record n

b - Number of species present only in record 1

c - Number of species present only in record n

3. Results and Discussions

The forest groups of the Saida Mountains belong to a series of 4 species, namely: *Pinus halepensis* Mill, *Tetraclinis articulata, Juniperus phoenicea* L., and *Quercus coccifer*a. The syntaxonomic study conducted by some authors [29, 30] identified 9 habitats corresponding to 9 plant associations (Tab. 1).

Table 1. Matching group numbers and names of associations and habitats.

No	Habitat	Association	Place
1	Matorral à Pin d'alep	*Pinutum halepenis*	Sidi Ahmed Zeggai
2	Aleppo Pine Reforestation	*Aleppo Pine Reforestation*	Ras El Ma
3	Matorral to Thuya and Filary	*Tetraclino articulatae-Phillyreetum latifoliae*	El Ache and Lardjeme
4	Matorral in Thuya and Rosemary	*Rosemary tournefortii-Tetraclinetum articulatae*	El Ache and Oum Touadjine
5	Frustrated with Lentisques	*Clear low matorrals at Pistacia lentiscus*	Sidi Ahmed Zeggai and Ras El Ma
6	Matorral to Thuya, calicotome and lavender stoechas	*Calycotomo intermediae-Tetraclinetum articulatae lavandulotosum stoechadis*	El Ache
7	Matorral to Thuya calicotome, and Aleppo pine	*Calycotomo intermediae-Tetraclinetum articulatae pinetosum halepensis*	El Ache and Sidi Ahmed Zeggai
8	Matorral in Thuya and calicotome and wild olive tree	*Calycotomo intermediae-Tetraclinetum articulatae oleetosum*	El Ache and Sidi Ahmed Zeggai
9	Kermes oak scrub	*Quercetum shardsae*	El Ache and Sidi Ahmed Zeggai
10	Pre-steppe	*Stippa tenacissima*	El Ache

The floristic richness

The overall richness of the different forest habitats varies from 78 for Group 3 to 20 for Group 6. This discrepancy is partly responsible for the differences in overall wealth observed. This variation in the number of inventories is due to the size of the areas occupied by each habitat. Groups 3, 4, and 9 are by far the groups that occupy the largest areas, while groups 5, 10, and 11 remain much localized. Some groups, such as Group 4, have almost half the overall richness of Group 3 with the same number of records.

Local richness

Groups 3, 4, and 9 have the highest local richness (62, 81 species/100 m² respectively) followed by groups 2, 6, and 8. The lowest values recorded are 28 and 24 in groups 1 and 7 respectively. Local richness is lower in closed environments and more important in open environments.

Original richness

Among the combinations of habitats studied, only 5 species constitute the common fund of these areas. These species are: *Pinus halepensis* Mill, *Tetraclinis articulate, Cistus* sp, *Lavandula* sp and *Pistacia lentiscus* L. These species also have very high sums of abundance coefficients. 344 species are present only once in the combinations. Only 3 habitats have a significant native richness (group 3: 78 species, group 4: 41 species, and group 9: 39 species). Four additional habitats have a medium original richness (between 09 and 25 species). The rest of the habitats have very low rates of native richness.

Floristic diversity

Graphic representations of percentages of species expressed by biological type give an idea of the structure of forest habitats in the region. Therophytes are best represented in most groups, with the exception of group 8 where Nanophanerophytes dominate. This biological type is well represented in more or less dense forest groupings including Phanerophytes. The Chamephytes seem to be related to forest groups and matorrals rich in Cisto-Rosmarinitea traits. Geophytes do not exhibit any particular tendency. The highest rates are observed at the level of groups 4 and 3 (Table 2), both very close to the coast.

Table 2. Results of biological indices for each habitat.

Habitat	(S)	(H')
1	24	0.97
2	22	0.90
3	78	2.10
4	41	1.80
5	22	0.90
6	20	0.85
7	34	1.10
8	30	1.00
9	39	1.40
10	18	0.87

4. Conclusions

The different facets of phytodiversity were assessed for each habitat. The main highlights can be stated as follows: Groups 3, 4, and 9 show a very important global, original and local richness. Remarkable flora is also rich in these groups. However, the Shannon Weaver index is very high in groups 3, 4, and 9 while it is average for the other group. In general, it can be said that all the habitats of the Saida Mountains present an important flora requiring the conservation and restoration of this area. Numerous rare and endemic species are specially assigned to certain types of habitats. We can also make one more important observation that the floristic richness of the habitats is maximal for the more or less open tree matorrals, and it decreases in the case of degradation and the closure of the environment as well. Despite the importance of the original and remarkable flora at Saida mount, the constancy and abundance of certain species should not be neglected. The latter form the backbone of the plant formations of the Saida Mountains. The presence of these species is often related to the importance of certain disturbances.

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