

Quercus faginea subsp. *tlemcenensis* Stands in the Moutas Reserve (Tlemcen, Northwest Algeria)

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Abstract

The Zeen oak (*Quercus faginea*) is a forest species endemic to the western Mediterranean, very remarkable in Algeria; it is an oak with deciduous or semi-persistent leaves. *Quercus faginea*, is very polymorphic, especially in terms of leaf characteristics, so it would be represented in Algeria by two subspecies: *Quercus faginea* subsp. *baetica* (Webb) DC and *Quercus faginea* subsp. *tlemcenensis* (DC). The latter, which is of major taxonomic interest, is a species that still resists climatic fluctuations. This stand is a formation at the climatic stage, which covers a large part of the Moutas reserve (488 ha), appears from an altitude of 1100 m and is frequently found where humidity is high. For a decade, our attention has been drawn to its particular behaviour, linked to major processes of change in both climate and biological components. Through this study, we show the importance of this stand, which is in a regressive dynamic phase on which the incidence of disturbances is only the action of anthropogenic climatic factors. Despite its good adaptive strategy, *Quercus faginea* subsp. *tlemcenensis* is a species threatened by multiple anthropozoogenic impacts; the latter constitutes a direct threat to the preservation and renewal of biological resources as well as to the ecological balance of the area [1], but the dynamic value of *Quercus faginea* subsp. *tlemcenensis* remains appreciated with particular attention by scientists, foresters, conservators and local populations in the region.

Keywords

Stand, Moutas Reserve, Taxonomy, Anthropozoogenic Impacts, Preservation

1. Introduction

In Algeria, Zeen oak forests covered 66,000 ha in 1950 [1] and 65,000 ha in 1990 [2]. Most of these stands are located in the East of the country. On the other hand, it is less widespread in the West part of the country more exactly in the Tlemcen Mountains where it appears in the disseminated state in various degraded formations of the sub-humid level [3].

The systematics of this oak is complex, especially since it hybridizes easily and is an extremely polymorphic species, particularly with regard to leaf characteristics [4] [5]. It would be represented by two subspecies, according to Quézel and Santa (1962) [6], clearly different: *Quercus faginea* subsp. *baetica* (Webb) D. C. and *Quercus faginea* subsp. *tlemcenensis* (D. C.) [7]; the latter is the most common and dominant in the Tlemcen Mountains.

The Moutas Reserve is a highly heterogeneous biogeographic unit and the interpretation of ecological factors involved in the evolution of these *Quercus faginea* subsp. *tlemcenensis* will help us better understand its structure and dynamics.

In most cases, we face a very significant biological return of *Quercus faginea* subsp. *tlemcenensis*, associated with a proliferation of chamaephytic and therophytic species difficult to handle. A thorough knowledge of taxonomy is necessary to establish the connections between the plant architecture and the ecological characteristics of this vegetation.

The excess moisture (water compensation) more than cold seems to play in favor of a progressive dynamics of this stand which is characterized by shrubland species.

However, based on a large number of the environment indicator species, which belong to taxa in which biogeographic and biological values are known and which we have indexed, we have been able to interpret this evolution process.

2. Method

Study site:

The Moutas reserve is located in the north-western part of Algeria part of Algeria about 46 km as the crow flies from the sea and 26 km southwest of the city of Tlemcen (Figure 1).

It is part of the Hafir Forest, and occupies the highest mountain area of Tlemcen. It is located at the intersection of the parallels 34°41' to 34°49' north latitude and meridians 01°25' to 01°35' west longitude.

Bioclimate:

The available data are in favor of the Hafir region and the Moutas reserve. The method used is that of Bagnouls and Gaussen (1953) [8].

The comparison of the ombrothermic diagrams for the periods 1913-1938 and 1975-2016 (Figure 2) shows that the range between the two curves is greater for the recent period. This region is in the subhumid level with cool winters and a 5 to 7 months' dry season. We observe an increase in drought for the new period (1975-2016).

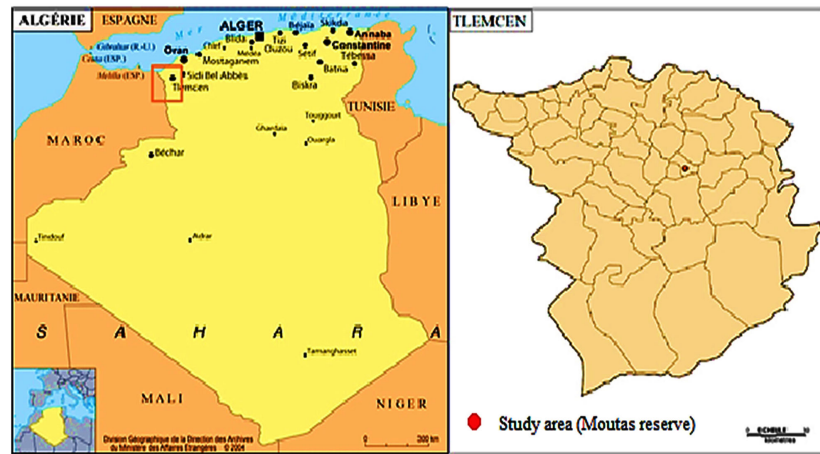


Figure 1. Map of the study area.

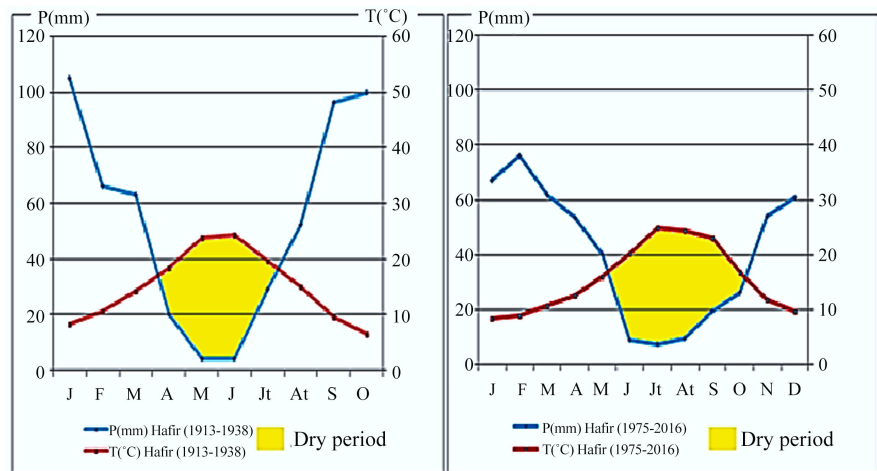


Figure 2. Bagnouls and Gausson ombrothermic diagrams. (1913-1938, Old period, Source SELTZER, 1946 and 1975-2016 recent period, Source Tlemcen National Parc). P (mm): precipitation; T (°C): temperatures.

Experimental plan

Quercus faginea subsp. *tlemcenensis* is an endemic species in the Tlemcen Mountains and eastern Morocco [9]. It has long been considered a hybrid of *Quercus faginea*.

Currently, phytogeographers give it a *Quercus faginea* subspecies status, it is endemic to this sub-area.

To fully understand the evolution of *Quercus faginea* subsp. *tlemcenensis* (D. C.), an ecological transect was used to indicate the structure of the sylvas in the Moutas Reserve. This method allowed us to relate the existing vegetation and the environment according to the gradients of ecological variability observed in a meticulous way in the field: topography, altitude, recovery rate, substrate, etc.

This study of linear vegetation goes in the same direction as that proposed by Gounot [10] and Romane [11] who used the notion of linear surveys. For our case, we have enriched this ecological transect by a floristic mesh with 100 m²

plots, according to the Braun-Blanquet method [12].

-Identification of species: Not all plant species are identifiable in the field (either one refrains from confusing one species with another or the species itself is so original that its recognition is impossible), so, in this case, identification is based on the botanical description in the laboratory. The works used for this identification are: the Flora of Algeria [5] and the Flora of North Africa [6] ...

3. Results and Discussion

Taxonomic history:

This species is similar to *Quercus faginea*. It has long been considered a hybrid. Phytogeographers give it a *Quercus faginea* subspecies status, it is endemic.

In this overview, we choose some references to illustrate the zeen oak taxonomy in Algeria and in Tlemcen region:

- [13] Desfontaines (1798-1799): the zeen oak is named *Quercus pseudo-suber*, according to the author its biotope would be the Tlemcen Mounts only.
- [14] Pomel (1875): *Quercus pseudo-suber* is intertwined here and there with the *Quercus ilex* on the mountains of Tlemcen and Beni Snous.
- [15] Cosson (1879): the False-Cork Oak (*Quercus pseudo-suber* Desf.), intermediate between the deciduous and evergreen species, generally found only in isolated or small groups in the forests of the middle mountainous region of the Constantine province to reappear in the Oran province, as well as in the forests between Tlemcen and Sebdou.
- [16] Battandier and Trabut (1888-1890): the zeen oak belongs to the *Quercus mirbeckii* Dur. where subsp. *boetica* is included; it is found at a more higher altitude in the Aures mounts, the Mahdidas, the Atlas of Blida, Teniet, Ouarsensis, Tlemcen and Ghar Rouban. This oak presents in Algeria a rather large number of hybridization forms: the form *brevipetiolata* (Tlemcen to Terni) and the form *tlemcenensis* (= *Quercus pseudo-suber* var. *tlemcenensis* D. C., Prodr. = *Quercus lusitanica* var. *tlemcenensis* Warion and a hybrid between *Quercus lusitanica* and *Quercus broteri* Pereira Coutinho) quite common in the region of Tlemcen, between Terni and Sebdou.
- [17] Saint-Laurent (1926): the oaks living in Algeria and Tunisia in the spontaneous state are: *Quercus lusitanica* Lamk. var. *mirbeckii* (Dur.) DC. and *Quercus tlemcenensis* Warion, *Quercus afares* (Pomel), *Quercus suber* L., *Quercus ilex* L., and *Quercus coccifera* L. varieties.
- [18] Jahandiez and Mayor (1931-1934): the zeen oak grouped in *Quercus faginea* where the authors distinguish it from the varieties *mirbeckii*, *spinosa*, *marocana* and *tlemcenensis* in which the latter is characterized by adult leaves of average size different from the other.
- [19] Camus (1938): the author distinguishes taxonomic series where the *tlemcenensis* and *marocana* varieties are attached once again to *Quercus mirbeckii*.
- [20] Huget del Villar (1949): zeen oak from the Tlemcen region is proposed

as *Quercus tlemcenensis* (D. C.) This taxon is rejected by Algerian foresters who consider it as a systematic individuality and place it as a form of hybridization between *Quercus mirbeckii* and *Quercus maroccana*.

- attaches zeen oak to *Quercus faginea* with four major subspecies and several varieties and forms: subsp. *eu-faginea* (Mayor), subsp. *baetica* (Webb) D. C., subsp. *alpestris* (Boiss.) P. Coutinho and subsp. *tlemcenensis* (D. C.) Mayor and Weiller.

The subspecies *tlemcenensis*, the variety *tlemcenensis* and the *maroccana* form are fairly widespread in the Tlemcen Mountains.

- [6] Quézel and Santa (1962): consider that zeen oak (*Quercus faginea* Lamk.) is represented in Algeria by two subspecies: subsp. *baetica* (Webb) D. C., Prodr. and subsp. *tlemcenensis* (D. C.) Mayor and Weiller.
- [7] [21] [22] [23] For Achhal *et al.* (1980); Quézel and Bonin (1980); Zine-El-Abdine (1987); Zine El Abidine and Fennane (1995): the zeen oak forms are related to three subspecies belonging to a single entity in term of morphology (*Quercus faginea* Lamk.):
 - *Quercus faginea* subsp. *eu-faginea* (Mayor).
 - *Quercus faginea* subsp. *tlemcenensis* (Mayor and Weiller).
 - *Quercus faginea* subsp. *canariensis* (Willd) = subsp. *baetica*.

The three subspecies are distinguished by the size of the leaves and branches, the tomentum and the hairs.

- [24] Alcaraz (1991): uses the taxon “*Quercus faginea* subsp. *tlemcenensis*” for the zeen oak of the Tlemcen Mountains ...
- [25] [26] [27] [28] Meddour, Messaouden and Djema, Laribi *et al.* and Messaoudène *et al.*: name the eastern zeen oak of Algeria *Quercus faginea* Lamk. subsp. *canariensis* (Willd.) or simply *Quercus canariensis* after Willdenow (1809).
- [29] Dobignard and Chatelain (2012): in Synonymic Index of the Flora of North Africa, Zeen oak is represented by two taxa in Algeria:
 - ✧ *Quercus canariensis*.
 - ✧ *Quercus faginea* subsp. *broteroi* (Cout.) A. Camus and includes all *Quercus maroccana* (Braun-Blanquet and Mayor) Villar.; *Quercus tlemcenensis* (D. C.) Trab. and *Quercus faginea* subsp. *tlemcienensis* (Mayor and Weiller).
- [30] [31] Babali *et al.* (2013a and b) specify in their work that the Zeen Oak (*Quercus faginea* Lamk.) is a deciduous oak and it would be represented in the Tlemcen Mountains by the subspecies *Quercus faginea* subsp. *tlemcenensis* (D. C.) M. In contrast, the taxon *Quercus faginea* subsp. *broteroi* (Cout.) A. Camus remained as a synonym for *tlemcenensis*.
- Taxonomic history [32] [33] [34] add that the proximity of *Quercus broteroi* has been questioned, with other taxa of the Galliferae group living in North Africa, in particular *Quercus tlemcenensis* (D. C.).
- Finally, the zeen oak of Tlemcen includes in the *Quercus broteroi* (Cout.) Rivas-Martínez and Sáenz and the subsp. *tlemcenensis* (D. C.) Vázquez and Coombes (new combination) [32].

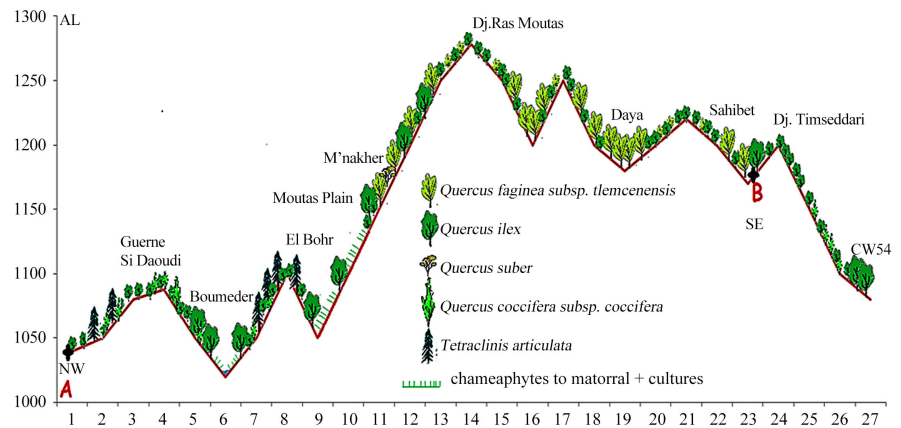


Figure 3. Schematic structure of the Moutas Reserve sylvas.

Dynamic aspects

This structure of vegetation (**Figure 3**) is marked by the presence of *Quercus faginea* subsp. *tlemcenensis* at high altitudes (1100 m to 1300 m and in shallows). During the drought periods, this stand benefits from maximum rainfall, which is largely due to water compensation, at which level this stand remains dominant 2 to 3 abundance-dominance indices on the Braun-Blanquet scale and characterized by faithful species such as:

- *Ruscus aculeatus* L.
- *Phillyrea angustifolia* L.
- *Viburnum tinus* L.
- *Asparagus acutifolius* L.
- *Rosa canina* L.
- *Cistus villosus* L.
- *Cistus salviifolius* L.

We also observe the presence of *Quercus ilex* L., *Quercus suber* L., *Quercus coccifera* L. and *Tetraclinis articulata* Vahl. The latter confirms the xericity of the environment (thermophilic species). The association of *Tetraclinis articulata* Vahl. with *Quercus faginea* subsp. *tlemcenensis* (D. C.) is very common on the southern side of the reserve.

From an altitude of 1100 m, *Quercus faginea* subsp. *tlemcenensis* (D. C.) competes with *Quercus ilex* L. and *Quercus suber* L. We found that at high altitudes this stand is about 70% pure; with an average circumference of 83 cm and an average height of 9 meters.

This dynamic is accompanied by an unappetizing chamaephytial stratum (*Genista*, *Calycotme*, *Asparagus* etc.) very resistant and gregarious; which favors a very resilient mixed stand. It is worth noting the importance of shrubland species compared to the rarity of forest species. This is a thermophilic set which, with the maturation of the sclerophyllous pre-forest, creates new biotic assemblages more evolved at the trophic level; with a different biodiversity [35].

Quercus faginea subsp. *tlemcenensis* (D. C.) is good at the northern and wetter slopes. In general, it is associated more easily to the oak-green and some-

times, at the level of the basins, to the cork oak.

This settlement probably represents the most diversified sylvatic and asylvatic structure. Its dynamics is obvious and well correlated by the effect of the climate but also with the anthropozoogenic pressure and which is translated by the following diagram:

Forest → pre-forest → shrubland → therophytisation.

- Its presence with Mediterranean species groups shows an extremely rich phytodiversity with: *Quercus ilex* L.; *Quercus suber* L.; *Tetraclinis articulata* (Vahl) Masters and *Juniperus oxycedrus* (Link) Deb; a shrubland based on chamaephytes or nanophanerophytes such as: *Chamaerops humilis* André, *Ampelodesmos mauritanicus* (Poiret) Durand and Schinz, *Pistacia terebinthus* L., *Thymus munbyanus* Boiss. and Reuters, *Fumana thymifolia* (L.) Webb, *Calycotome intermedia* (Salzm) C. Presl, *Rhamnus lycioïdes* L. and *Cistus salvifolius* L.; an undergrowth with an herbaceous layer at Thero-Brachypodieta on calcareous substratum; characterized by *Rhaponticum coniferum* (L.) Greuter, *Bombycilaena discolor* (Pers.) Lainz, *Trifolium stellatum*, *Ophrys lutea* subsp. *lutea* (Cav.) Gouan, *Carex halleriana*, *Briza maxima*. *Ruscus aculeatus* L., *Phillyrea angustifolia* L., *Viburnum tinus* L, *Asparagus acutifolius* L. and *Rosa canina* L.

The appearance of the sylvatic atmosphere exists and persists. It tends to change from year to year by an invasion of asylvatic species that migrate to the north of the Moutas reserve.

- **Biological aspects:**

The classification of the species listed according to their biological type (Figure 4) shows that the therophytes have a very high rate and dominate the whole area.

Therophytes have a very high rate and dominate the whole area.

Hemicryptophytes are also well represented, this can be explained by the high altitude and of the soil organic matter richness [36].

The geophytes are well-received and besides they constitute a good refuge for Orchidaceae with 4.84% [31]. In this respect, [37] also find greater proportions of geophytes in the Mediterranean than in the steppe area.

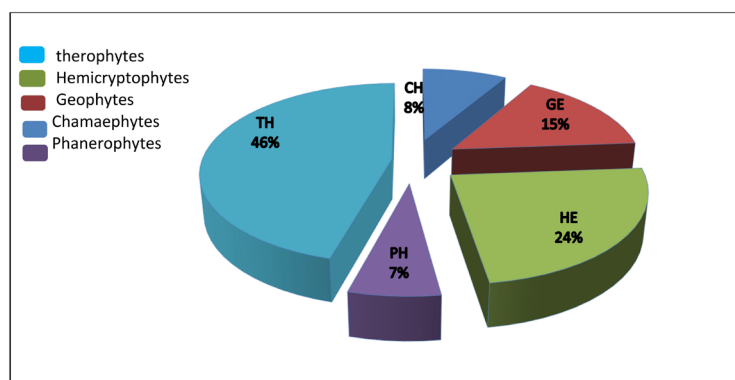


Figure 4. Biological types.

Chamaephytes are better adapted to drought than phanerophytes. They are more xerophilic, and usually produce a lot of seeds [38] Phanerophytes, in spite of their weak presence, sometimes dominate by their phytomass, this is the case of *Quercus faginea* subsp. *tlemcenensis* (D. C.).

It is striking to note that this stand differs from the other sylvatic groups by the presence of Alfa (*Stipa tenacissima* L., 1 to 2 of abundance-dominance index on the Braun-Blanquet scale), with a very particular current biological type. The presence of this species is an original characteristic.

The vegetation studied is currently characterized by the succession of biological types as follows:

Therophyte > Hemicryptophyte > Geophyte > Chamaephyte > Phanerophyte

Quercus faginea subsp. *tlemcenensis* (D. C.), is in a progressive dynamic in the reserve of Moutas. In fact, germination occurs where the anthropozoogenic pressure is visible and can be achieved by seeds (underground and aerial bank) but also and especially by the vegetative route (strain release). This demographic evolution remains very slow, but is very resistant to ecological stress (Figure 5 and Figure 6). Some rejections at the mountain tops are transformed into coppice; it is a form of adaptive strategy used by this species to occupy the land abandoned by *Quercus suber* and sometimes by *Quercus ilex* L. The germination ratio remains between 20% and 25%. This form of vitality is ensured by the mass of acorns which is a determining factor in seedling growth. It should be noted that the acorns are almost always annual, their growth is faster than that of *Quercus suber* L.



Figure 5. Germination of the acorns of *Quercus faginea* subsp. *tlemcenensis* (DC). (*Babali*)



Figure 6. Natural regeneration of *Quercus faginea* subsp. *tlemcenensis* (DC). (*Babali*)

4. Conclusions

At present the *Quercus faginea* subsp. *tlemcenensis* (D. C.) maintains and evolves without major constraint and this partly thanks to its rigorous protection, but also and especially thanks to its adaptation and resilience. This species, more demanding in water, remains confined in more humid places and where water compensation is important. By this phenomenon, it manages to maintain itself appropriately with some withdrawals towards the South.

Its association with some xeric chamaephytes remains harmonious. Moreover, this stand differs from those of other styles by the abundance of chamaephyte species such as: *Chamaerops humilis* L., *Ampelodesmos mauritanicus* (Poir); *Thymus munbyanus*, *Cistus villosus* L. and *Cistus salvifolus* L.

It should also be noted that the other oak groups are characterized by the presence of *Ruscus aculeatus* L., *Phillyrea angustifolia* L., *Viburnum tinus* L., *Asparagus acutifolius* L. and *Rosa canina* L.

Chamaephytes, such as *Quercus suber* L. and *Quercus ilex* L., are becoming increasingly rare. *Quercus faginea* subsp. *tlemcenensis* (D. C.) adapts and its resilience is partly due to invasion by toxic and/or thorny species (natural protection).

The preservation of the originality of this *Quercus faginea* subsp. *tlemcenensis* (DC) stand requires adequate regulation in the choice of introduction of animal and plant species, pastoral load, the mode of rotation and application of small area management.

In any case, man is not taken as a destabilizing element, but rather as part of the whole and should play its role in the conservation, sustainable use and equitable sharing of biodiversity [39].

Keeping this stand in its current state is a serious challenge for managers.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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