ADVANCED RESEARCH IN LIFE SCIENCES
4, 2020, 48-53

www.degruyter.com/view/j/arls

DOI:10.2478/arls-2020-0018
Research Article

Systematic Position of *Pistacia atlantica* Desf. Subsp. *atlantica* in North-West Algeria: Anatomy and Biometry of Leaves

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Received August, 2020; Revised October, 2020; Accepted November, 2020

Abstract
The area of Algerian western north already subjected to a strong climatic rigour and an excessive anthropic activity for several decades, has been confronted with the threats of the alarming degradation of its natural resources, following the example *Pistacia atlantica* which occupies today only one quite thin proportion of the territory.
The study method was based on the phytoecological approach on a very large scale by approaching the anatomical and biometric study of the leaves of *Pistacia atlantica* in order to identify and confirm the name of the subspecies.
The analysis of the results obtained revealed that this subspeciesis *atlantica,* phenotypically very variable.

Keywords:*Pistacia atlantica* Desf. Subsp. *atlantica,* North-west Algeria, Leaves,anatomy, biometry.

Introduction

Pistacia atlantica Desf. is a woody and spontaneous species that can reach 10 m in height. The tree has a well-defined trunk with hemispherical foliage [1]. This species is common to both the Mediterranean and Iranian-Turanian regions. Its compound leaves are composed of seven to nine leaflets, the flowers are loosely clustered, the fruits are pea-sized drupes [2]. Zohary [3] used leaf morphology, especially shape and number, size and orientation of leaflets as the first morphological characteristic in the classification of *Pistacia* species. In fact, in the Butmela section, the taxons are hardly differentiated by leaf morphological characters alone. Several specimens of the same taxon may present intermediate characters and they are differentiated only by the number of leaflets and their size [4]. Zohary [3] reported its presence in Algeria, in the north-east (Constantine) and north-west (Tlemcen). The Atlas pistachio tree could be used as a pioneer reforestation species as well as for the restoration of highly degraded environments. In addition, this tree has many useful characteristics as a fodder by its foliage [5] or as a suitable root stock for cultivated pistachio trees. Other uses are possible, such as the production of aromatic compounds [6]. At present, the genetic resources of the Atlas pistachio tree are seriously threatened by degradation and overgrazing.

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In this ecologically stressful environment, are we dealing with new subspecies or varieties, or are we simply adapting to the climate, thus creating different ecotypes? In order to respond to this problem and for the maintenance of genetic diversity, its conservation as well as the perspectives of its development, we have identified the subspecies on an anatomical and biometric level.

Material and Methods

The Study Area

The study area is located in the western part of north-western Algeria. (State of Tlemcen) The study area is located between 34°25' and 35°25' North latitude and 0°55' and 2°30' West longitude, with a surface area of 9017.69 Km^2 (Figure 1). Climatically, the majority of stations are located in the semi-arid stage, and are characterized by a temperate winter. The thermal area of *Pistacia atlantica* in the study area is between 32°C < M < 35.25°C and 3.21°C < m < 6.7°C.

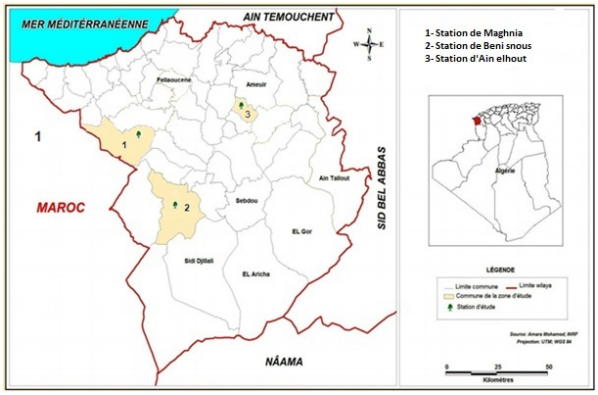


Figure 1. Geographical location of the study area

The climatic conditions of the extreme north-western Algeria since the former period to date are still favourable for a better rehabilitation of *Pistacia atlantica* [6].

Sampling

The sampling adopted is subjective, taking into account the floristic and ecological homogeneity of the station.

The choice of the three stations (Maghnia, Benisnous and Ainelhout) was justified by the presence of good *Pistacia atlantica* subjects most representative of the study area. The analysis is based on ten individuals from each station. The method used is also based on the inter-station comparison of biometric parameters of *Pistacia atlantica* leaves in the study area.

Leafbiometry

The study of variability is based on 5 quantitative parameters:

- Number of leaves / branches
- Number of leaflets per leaf
- Leaves length
- Leaflets length
- Leaflets width

The measurements of these parameters were carried out using a graduated ruler.

Leaves were randomly collected from 10 male and female trees at each station for two months (April and May).

Measurements were made on 10 twigs/individual with more than 7 replicates; i.e. an average of 700 measurements for each parameter and per station.

Leaf anatomy

The anatomical sections were performed for the leaves of 11 random samples of *Pistacia atlantica*. Sample collection was performed at the base of the tree crown [7-9].

Results and Discussion

According to Trabut [10] the name of the pistachio tree differs from one region to another (Betoum and bettam).

This tree is called tisemlal in Berber and b'toum in Arabic. B'toumis a collective name. In the singular we say el botma and el botmaia [11].

This species, one of the characteristics of the high latitudes of the Sahara, is also known by nomads as Btom or Dejig [12].There are also other names such as, btem, igg, ijj, atnu [13].

Pistacia atlantica has been studied by many taxonomists such as [3-14], who consider this species as the only representative of theButmela section.

In this section, the taxons are difficult to differentiate by leaf morphological characters alone. Several specimens of the same taxon may present intermediate characters and they are differentiated only by the number of leaflets and theirsize [4].

According to Zohary [3] the varieties of *Pistacia atlantica* constitute the Butmela section of the genus *Pistacia*:

Pistacia atlantica Desf. var. *Atlantica* with lanceolate leaflets, in 3-5 pairs.

Pistacia atlantica Desf. var. latifolia D.C. with larger leaves

Pistacia atlantica Desf. var. Kurdica Zoh. Whose leaves are up to 20 cm long.

Rechinger [14] has classified *Pistacia atlantica* in to three sub species:

- Subsp. mutica (Fishand May) [14]:

The leaflets are narrowly oblong, 3-8cm X 1.5-3cm, at the ciliate margin (Figure 2).



Figure 2. The Leaves of *Pistacia atlantica* Subsp. *Mutica*

- Subsp. *kurdica* (Zohary) [14]:
The rachis are wingedtothe terminal leaves, oval leaves, 4-9 x 2-5 cm.hairless or rarely ciliated at the margin (Figure 3).



Figure 3. The Leaves of *Pistaciaatlantica* Subsp. *Kurdica*

- Subsp. *cabulica* (Stocks) [14]:
Leaflets (2) 3-4 pairs,which are lanceolate,attenuated at the tips, 3-4 times longer than broad (Figure 4).



Figure 4. The Leaves of *Pistacia atlantica* Subsp. *Cabulica*

Pistacia atlantica Subsp. *atlantica* (Figure 5) is a microphilic and phenotypically highly variable variety; Monjauze [15] reported the existence in Algeria, in the dayas region, of a variety with round and black fruits, resembling those of the kurdica variety Zoh. (sensu P. Eurycarpa Yalt.). Similarly, Zohary [3] reported the presence, in the North-East (Constantine) and North-West (Tlemcen), of a variety with leaves and fruits larger than those of the *atlantica* variety, resembling those of the latifolia Zoh variety. (sensu P. mutica Fisch. &Mey).



Figure 5. The Leaves of *Pistacia atlantica* Subsp. *atlantica*

Anatomically Monjauze [16] reported that some Algerian Atlas pistachio trees, were not ciliated at the margins, and studies of [17] , thus indicated that the leaves of *Pistacia atlantica* are hairless.
Taxonomically trichomes in anacardiaceae have been reported to be important in the classification of genera and species [18].
Al-Saghir et al. [19] adds that Anatomical difference can be used as a taxonomic key to distinguish between two species.
Komarov [20] indicated that the leaf midrib of subspecies *atlantica* is covered with hairs, while the ribs are rarely hairy.
Our results (Figure 6) [7-9], therefore, confirm that subspecies *atlantica* is the subject of our study.
Biometrically [3] used leaf morphology, especially the shape, number, size and orientation of leaflets as the first morphological characteristic in the classification of *Pistacia* species.
Our results showed that leaf length average is 7.07 cm; The highest value reported in the station Ain el hout is 14.5 c.

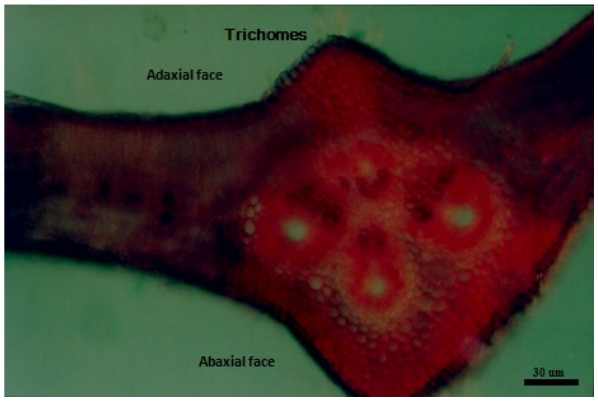


Figure 6. Cross-section of the leaf of *Pistacia atlantica*

The range of leaf length found (2 - 14.5) remains closer to that found by [16] (2.5 - 12) and [21] (3.4 - 14.7) (Table1).

Table 1.

Characteristics of the quantitative parameters measured for *Pistacia atlantica* leaves

Sites	Ainelhout		Benisnous		Maghnia		Studyarea	
Parameters	Avr ± Standard deviation	Extended: Avr.Max - Avr.Min	Avr ± Standard deviation	Extended: Avr.Max - Avr.Min	Avr ± Standard deviation	Extended: Avr.Max - Avr.Min	Avr ± Standard deviation	Extended: Avr.Max - Avr.Min
Leaveslength (cm)	6.18 ± 0.78	7.48 - 5.02	7.48 ± 0.35	7.97 - 6.93	7.57 ± 0.77	10.05 - 6.39	7.07 ± 1.00	10.05 -5.02
Leafletslength (cm)	3.83 ± 0.42	4.61-3.2	4.532 ± 0.36	5.04 - 3.83	4.64 ± 0.39	5.73 -3.88	4.34 ± 0.56	5.73 - 3.2
Leafletswidth (cm)	1.33 ± 0.17	1.54 - 1.1	1.61 ± 0.15	1.94 - 1.35	1.65 ± 0.09	1.82 - 1.41	1.53 ± 0.20	1.94 -1.1
Number of leaves / branches	7.81 ± 0.40	8.4 - 7.3	8.83 ± 0.57	9.7 - 8.10	9.08 ± 0.59	10.8 - 8.30	8.57 ± 0.82	10.8 - 7.3
Number of leaflets / leaf	8.10 ± 0.66	8.8 - 6.6	8.55 ± 0.66	9.5 - 7.80	8.38 ± 0.62	10.1 - 7.20	8.34 ± 0.72	10.1 - 6.6

Avr : Average.Avr. Max : Average of maximums Avr.Min : Average of minimums.

For leaf letlength, the extreme values recorded ranged from 1.5 to 8.9 cm at Benisnous. This is the largest interval compared to those found by [1,16, 22].
But for the latter, these values coincide with the general averages of the minima and maxima of leaflet length and width.Leaves have between 1 and 6 pairs of leaflets, with an average of (8.38) pairs for all individuals. In general, the most common number of pairs for all stations is 3.
The average number of leaves per twigis 8.57, for leaflets the maximum number of leaflets is 13 leaflets recorded in the Maghnia station.
At the national scale our results (3-13 leaflets) are closer to the results of measurements found by Belhadj et al. [21] (Table 2).

Table 2.

Comparison of data collected in theliterature for *Pistacia atlantica*

Measures	Our results	Other authors
Leaves length	Max-Min: 2 – 14.5 Avr.Max - Avr.Min 10.05 -5.02	(2.5 – 12) (Manjouz.1980) (8 – 20) (Boulos. 2000) (10.8 – 17.6) (Kafkas et al. 2002) (3.4 – 14.7) (Belhadj et al.2008)
Leaflets length	Max -Min 1.5 – 8.9 Avr.Max - Avr.Min 5.73- 3.2	(3 – 5) (Quezel et Santa.1963) (2.5 – 6) (Manjouz.1980) (3.6 – 6.5) (Kafkas et al. 2002)
Leaflets width	Max -Min : 1 – 3 Avr.Max - Avr.Min 1.94 -1.1	(1 – 1.5) (Quezel et Santa.1963) (0.5 – 1.5) (Manjouz.1980) (1.2 – 2.4) (Kafkas et al. 2002)
Number of leaflets	Max -Min 3 – 13	(5 – 7) (Mouterde 1970) (7 – 11) (Manjouz.1980) (3 – 15) (Belhadj et al.2008)

At the local scale we recorded a slight differentiation between the mean and the minimum and maximum values of leaves and leaflets measured at the Benisnous and Maghnia stations.

On the other hand, the Ain elhout station is characterized by the smallest leaves in the study area.

The ratio (Max Length / Max Width) for leaflets of *Pistacia atlantica* de to Maghnia remains the highest (3.15) followed by Ain Elhout (2.99) and Benisnous (2.60). This means that the shape of the leaflets for the latter is wider than it islong. And in Maghnia the leaflets are longer than wide.

The reduction of leaf size is correlated with the reduction of transpiration, the more aridity increases and the more the leaf size decreases [23].

Based on these results obtained in this study, we conclude that there is variation within individuals of the same population and between the three stands.

In general, despite this variability, our results are similar to those of [1,16,21].

According to Zohary [3] the species *Pistacia atlantica* Desf. var. *Atlantica* is characterized by lanceolate leaflets, in 3-5 pairs of (2.5-6)X(0.6-1.5)cm, which is close to our measurements of (3.2-5.73)X(1.1-1.94)cm (Table 2).

Our results of measurements of the morphological characteristics used in the classification do not exclude the systematic position of *Pistacia atlantica* Desf. on the one hand and confirm on the other hand that it is the subspecies *atlanlica* .

Conclusions

We concluded that the Atlas pistachio tree in the Tlemcen region shows significant ecotypic diversity related to its biotope and local climatic conditions. The Benisnous and Maghnia stations are essentially distinguished by long and wide leaves and leaflets and the Ain elhout station by small leaves and leaflets.

The extreme variability observed through our results may also be due to the age difference of thes elected individuals.

It is preferable to integrate also the phylogenetic character in addition to the morphological and anatomical characters for a better botanical description.

Pistacia atlantica subsp. *atlantica* in the north western region of Algeria is phenotypically highly variable, reflecting the degree of resistance of this species in a stressful environment. This speciesis currently threatened by several factors that contribute to its degradation, for which it is necessary to safe guard and enhance it.

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