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Cartography and spatial distribution of the genus *Pistacia* in Souk Ahras, Northeast Algeria

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Abstract. *Barour AA. 2021. Cartography and spatial distribution of the genus* Pistacia *in Souk Ahras, Northeast Algeria. Biodiversitas 23: 286-290.* In 2020, a study mapped two species of the genus *Pistacia*, viz. *Pistacia atlantica* Desf. and *Pistacia vera* L. in the Wilaya of Souk Ahras situated in the northeast of Algeria. The study was based on the determination of the geographic coordinates of each individual and mapping their spatial distribution by using MapInfo Pro 12.0.2 software. The results showed that Atlas Pistachio was mainly distributed over four localities viz. Batoum, Ben Attia, Sidi Fredj and Ouled Moumen. However, the Pistachio nut species were distributed over two localities in the south of the Wilaya of Souk Ahras, viz. Ben Attia and Sidi Fredj. The locality of Ben Attia was characterized by a more or less random distribution of trees, mostly young plants. At the same time, the structure was heterogeneous across the other stations, with the dominance of large and old trees. The spacing between the trees of the Atlas Pistachio varied from one region to another, ranging from 3 to 189 m. At the Ouled Moumen area, the distribution of wild Pistachio trees formed circles with very close distances between neighboring feet. On the other hand, the trees were spaced and distributed in a linear manner across the other stations.

Keywords: Biogeography, cartography, *Pistacia atlantica*, *Pistacia vera*, species distribution

INTRODUCTION

The genus *Pistacia* (family Anacardiaceae; order Sapindales) was named and described by Carl von Linné in 1753, after its Persian name "Pisteh" or "Pesteh" (Rahmanpour et al. 2016). It includes a dozen other species and spontaneous subspecies, many of which are traditionally used for different purposes (food, pharmacopeia, crafts, fuel) (Al-Saghir and Porter 2012; Rauf et al. 2017). In Algeria, several endemic species are found to be distributed over the territory which, includes the Atlas Pistachio (*Pistacia atlantica* Desf.), the Terebinth Pistachio (*Pistacia terebinthus* L.), the Lentiscus Pistachio (*Pistacia lentiscus* L.), and the Fruit Pistachio (*Pistacia vera* L.) (Labdelli et al. 2020).

Plants of the Atlas Pistachio or “El Betoum” (Arabic appellation), are located in North Africa (Morocco, Algeria, Tunisia), as well as in the Canaries, Libya (Cyrenaica), Cyprus, Iran, Iraq and in the Middle East (Asma 2019; Médail and Quézel 2003; Rahmanpour et al. 2016,). A robust species can reach up to 20 m in height, with a well-individualized deciduous trunk (Yousefi et al. 2020). Trees of this species represent an important resource on which populations depend the most, due to their drought tolerance (Mashizi et al. 2021). It has been used by the nomads since ancient times (Mahdavi 2015; Médail and Quézel 2003). In the drylands of this country, this species has economic importance for rural people (Mashizi et al. 2021).

The Atlas Pistachio tree is used for different purposes like firewood, fodder and medicine (Mahdavi 2015). The similar uses of products from this species and from other species of the genus *Pistacia* are reported by several authors from the Canaries, Turkey, Syria, Iran, West Pakistan and Afghanistan (Lakhdar and Koulder 2019).

The Pistachio nut (*Pistacia vera* L.) is cultivated in the arid and semi-arid regions of Asia (Middle East) and Africa (Maghreb) but also in Australia, in some countries of North America (the United States and Mexico), and in the regions of Mediterranean Europe (Ayatollahi et al. 2021; Malakhov and Islamgulova 2021). It is widely used in food industries, particularly in pastry and confectionery and represents a species of reforestation potential given its tolerance to drought (Hesam et al. 2021). The world production of pistachio is estimated at 10,057,566 tons and the principal world producers are United States of America (406,646 tons), Iran (315,151tons), Turkey (170,000 tons), China (83,310 tons), and Syria (56,833 tons) (Ennouri et al. 2020). Salinity affects the plant growth and development; and affects the developmental stage of the male gametophyte which affects crop yields (Sadeghirad et al. 2018).

The studies presented by Maire (1930); Quezel (1961); Quezel and Santa (1962); Monjauze (1968); Médail and Quézel (2003) and Yahia (2011) did not mention the existence of the Atlas Pistachio in Souk-Ahras region. This study aims to highlight the presence and spatial distribution of the Atlas Pistachio tree at the Wilaya of Souk Ahras, more precisely in the Southeast of study area. This is an update of the map of Monjauze which dates back more than half a century, among other things to assess the state, the structure of these populations and the distribution of individuals.

MATERIALS AND METHODS

Study area

The Wilaya of Souk Ahras is located in the northeast of Algeria, at the limit of the Tunisian border on a strip of 88 km east. The Wilaya occupies an area of 4,365.59 km² (Bouali et al. 2021). Geographically, it sits in a basin, surrounded by complex mountainous relief (500 to 1400 m), forming part of the Tell Atlas to the north and the high plains to the south.

The Wilaya of Souk-Ahras is limited to the north by the Wilayas of El-Taraf and Guelma, to the west by the Wilaya of Oum El, Bouaghi, to the south by the Wilaya of Tébessa, and to the east by Tunisia (Touati et al. 2021) (Fig. 1).

The northern part of the region is exposed to Mediterranean climatological influences, while the southern part is characterized by a semi-arid climate. The Wilaya is distinguished by a hot and dry summer with an average of 33 °C recording peaks of 42 °C and cold and wet winter with an average of 12 °C. Rainfall averages 600 mm per year (250 mm in the south and 700 mm in the north), often poorly distributed. At the same time, the heights register a significant snowfall during the winter (Bouali et al. 2021; Yozmane et al. 2019).

The Souk Ahras region is located on the northern edge of the Atlas and in contact with the Tellian domain carried along from the Maghrebid chain. The Saharan atlas is characterized by thick Mesozoic folded and fractured formations (about 2500 m), presenting the peculiarity of a Stratigraphic gap from the Jurassic, and large Triassic masses in outcrop arranged parallel to the chain. The Tellian atlas is formed by a stack of thrust layers from different palaeo-geographic domains (Chabbi et al. 2016; Mahdadi et al. 2018). The forest cover is very dense in the north on the northern massifs called: mountains of Medjerda and strongly degraded as one progresses towards the south (Bouroubi-Ouadfel et al. 2016).

In this Wilaya, the wooded area totals 82,375 ha. It comprises two very distinct parts, separated by the Medjerda wadi: to the north, forests of Cork oak (*Quercus suber* L.) and Zean oak (*Quercus canariensis* Willd.) and to the south, the pine area of Aleppo (*Pinus halepensis* Mill.) whose northern limits are those of limestone soils. This wooded area is made up of a forest of Aleppo pine forming the dominant level, with the undergrowth of Holm Oak (*Quercus rotundifolia* Lam.) which is bushily mixed with the usual secondary species (Ganaoui et al. 2020; Touati et al. 2021).

Cartographic study

Vegetation mapping, identifying the type and distribution of plant species, is important for analyzing vegetation dynamics, quantifying spatial patterns of vegetation evolution, analyzing the effects of environmental changes and predicting spatial patterns of species diversity. It is for this reason that during the spring of 2020, we made several field trips along the Center-South, South-North-East transect of nearly 100 km in the Wilaya of Souk Ahras.

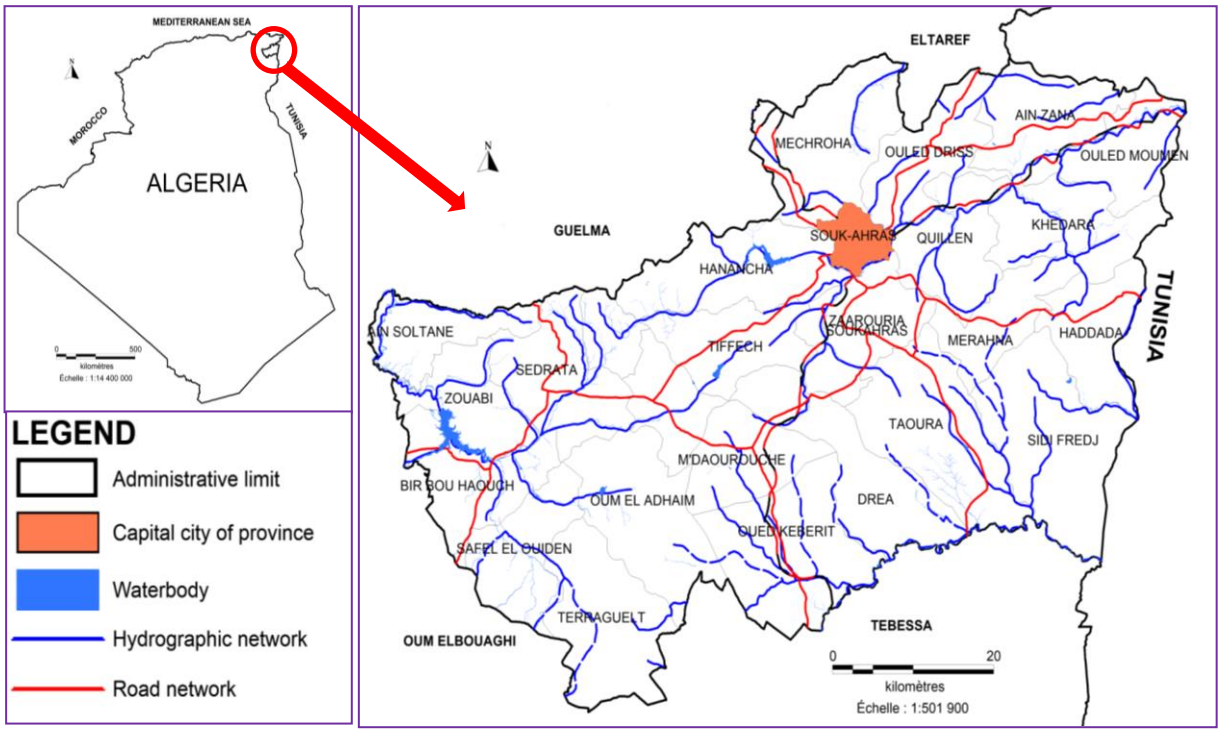

Figure 1. The geographical location of the study area (realized with Mapinfo Pro 12.0.2, 2021)

In our work, we have studied the distribution of the two species of Pistachio namely Atlas Pistachio and Pistachio nut in the Wilaya of Souk Ahras by adopting the following steps: The geographical coordinates of each individual and each group of individuals of the two above-mentioned species were determined using GPS and plotted with Google Earth PRO 2020. Further, a GIS map was created with the derived coordinates using MapInfo Pro 12.0.2 software (downloaded from: https://www.pitneybowes.com/us/location-intelligence/geographic-information-systems/mapinfo-pro.html) and associated geospatial details (Kotsur et al. 2019).

RESULTS AND DISCUSSION

Mapping of Atlas pistachio (*Pistacia atlantica*)

Figure 2 shows the geographical distribution of the Atlas Pistachio tree over four localities, namely the localities of Batoum, Ben Attia, Sidi Fredj and Ouled Moumen. We noted that the locality of Ouled Moumen had the largest representation of Atlas Pistacia (502 trees), followed by the locality of Batoum (78 trees) then by the locality Sidi Fredj (51 trees) and at the end of the locality of Ben Attia with 30 trees.

At Ouled Moumen station, Atlas Pistachio formed circles with very close distances. On the other hand, at the level of other stations, the trees were widely spaced and distributed in a linear manner. The capital of the locality of Ben Attia was characterized by a more or less random distribution of trees, mainly young plants. Observations made at other stations revealed that the structure of Atlas Pistachio populations was heterogeneous. The latter was mainly characterized by the dominance of sturdy and aged trunks. The distribution of Atlas Pistachio trees in our study region also varied, and the spacing between the trees ranged from a minimum average distance of 3 m up to a maximum average of around 189 m.

Mapping of Pistachio nut (*Pistacia vera*)

Figure 2 shows the geographic distribution as well as the concentration of Pistachio nut trees. We noted that this cultivar is to be concentrated in two localities in the south of the Wilaya of Souk Ahras, namely the locality of Ben Attia and the locality of Sidi Fredj. The locality of Ben Attia had three plots classified in descending order as follows: plot 1 contained 153 trees, plot 2 had 40 trees and plot 3 had 25 trees. The locality of Sidi Fredj had a single plot with 50 trees. The greatest concentration was observed in the first plot with 153 trees.

Mapping of the genus *Pistacia*

The combination of distributional map of Atlas Pistachio and Pistachio nut, allowed us to establish a general distribution map of the genus *Pistacia*, which is presented in Figure 2.

Figure 2 shows the concentration of the genus *Pistacia* in four localities, namely the localities of Batoum, Ben Attia, Sidi Fredj and Ouled Moumen. We noted that the locality of Ouled Moumen had the largest number of trees (502), followed by the locality of Ben Attia (248 trees), Sidi Fredj (101 trees) and Batoum (78 trees).

This study made it possible to highlight the presence of the Atlas Pistachio tree in the Wilaya of Souk Ahras, more precisely in the south, at the level of the localities raised. This existence was not mentioned in previous studies viz. Maire (1930), Quezel (1961), Quezel and Santa (1962), Monjauze (1968), Médail and Quézel (2003) and Yahia (2011).

It is important to note that the locality of Ouled Moumen differed from the other localities of Batoum, Ben Attia and Sidi Fredj by the fact that the former is a rugged mountainous forest region, of high altitude (800-1100 m) influenced by a subhumid climate while the other localities are steppe regions, of medium altitude (650-795 m) influenced by a semi-arid climate, these differences between the localities seem to be the most probable explanation for the high concentration of the Atlas Pistachio trees at the Ouled Moumen localities compared to the other localities.

However, the concentration of the Pistachio nut species in two localities in the south of the Wilaya of Souk Ahras, namely the localities of Ben Attia and Sidi Fredj, was the result of the Algerian agricultural policy focusing on the strategy of introducing new crops to minimize the exorbitant import fees.

Given the methodology adopted for this study, the distribution map of the genus *Pistacia* produced allowed us to learn about the biogeography of Pistachio species in the Wilaya of Souk Ahras and especially their plasticity. Indeed, even if the distributional area of the species is very disjointed, paleogeographic approaches (anthracology, palynology) can provide some answers as to the evolution of this geographical area.

To understand this geographical distribution and the potential of the species to extend or at least to remain in a disturbed territory, it is necessary for us to follow a dynamic approach of a few populations. This approach led us to ask the question about regeneration and dispersion problems.

Regeneration by seed is greatly reduced because the kernel, which is too oily, quickly becomes rancid and cannot, therefore, be kept long enough in nature (no more than one spring) (Monjauze 1968). It is for this reason that we found the geographical distribution of Atlas Pistachio in the Wilaya of Souk Ahras limited only to four localities, namely the locality of Batoum, Ben Attia, Sidi Fredj and Ouled Moumen with varied spacing between trees. This distribution could be due to propagation by birds (ornithochory) and to the acidity of the soil caused by the fallen leaves of *Ziziphus lotus* (L.) Lam. and *Calicotome spinosa* (L.) Link which would facilitate the germination of seeds Pistachio from the Atlas. This natural phenomenon is the essential element in the regeneration of the Atlas Pistachio tree (Lakhdar and Koulder 2019).

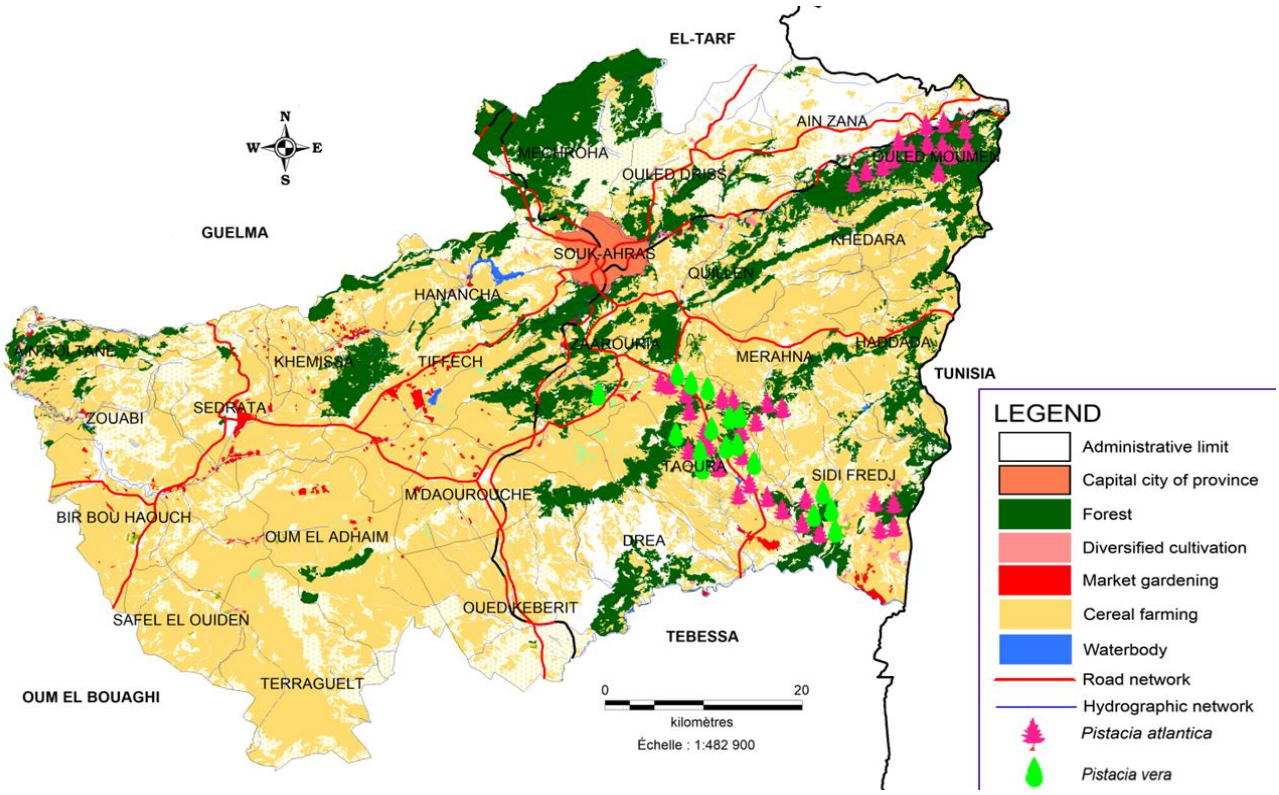

Figure 2. Mapping of the genus *Pistacia* (Atlas Pistachio and Pistachio nut) in the Wilaya of Souk-Ahras

Currently, it is assumed that the range of Pistachio species has declined due to increased anthropogenic pressure, exploitation of priced seeds and high-quality timber, besides the agricultural and forestry policy of the country. In Algeria, studies on the Atlas Pistachio tree, although numerous, remained fragmentary in knowledge and insufficient on an ecological level (Yahia 2011). Monjauze published in 1968 a detailed study of the distribution and ecology of Atlas Pistachio in Algeria in which he successively considered the general distribution of the species in Morocco, in the Middle East, the conditions of regeneration by seed and by shoots, growth, behavior and countryside flora in the different regions, climatic requirements, and finally resistance to competing species and to degradation by humans. As for the Mediterranean region, Médail and Quézel (2003) have drawn up a schematic distribution map of the Pistachio tree in this region. Other studies have focused on the biogeographic, taxonomic and ecological aspects (Amara 2014; Médail and Quézel 2003; Monjauze 1980). In addition, we noted that previous studies never addressed the ecodendrometric aspect of Atlantic Pistachio stands (Lakhdar and Koulder 2019).

In conclusion, this study, which we carried out on two species of the genus *Pistacia* existing in the Wilaya of Souk Ahras, enabled us to draw up a distribution map, update the map of Monjauze, which dates back more than half a century and aims to understand the spatio-temporal dynamics of these species, the distribution of individuals and to study the biogeography of these species in a disturbed environment of the Souk-Ahras region.

Mapping the species requires significant spatial precision and, therefore, the knowledge that is both geographically precise and over a very large territory. Despite the little work available and probably the few studies carried out on the biogeography of these species, we made a cartographic presentation of the existing data. The species Atlas Pistachio was never reported in all of the work as endemic to Souk Ahras. While from the distribution map that we propose, we noticed that the range of the species extends to various regions, which was not highlighted till now.

The species Atlas Pistachio was found to be available in four localities, namely the localities of Batoum, Ben Attia, Sidi Fredj and Ouled Moumen. At the Ouled Moumen station, the trees of Atlas Pistachio had a circular distribution, but the trees were grouped together and closer to each other. On the other hand, at the level of the other stations, the trees were very spaced and distributed in a linear fashion. The capital of the locality of Ben Attia was characterized by a more or less random distribution of trees, mainly young plants. Observations from other stations revealed the heterogeneous population structure of the Atlas Pistachio. These stations were essentially characterized by the dominance of large and old trees. The distribution of Atlas Pistachio trees in our study region was varied, ranging from a minimum average distance of the order from 3 m to a maximum average of around 189 m. However, the Pistachio nut species was distributed over two localities in the south of the Wilaya of Souk Ahras,

namely the locality of Ben Attia and the locality of Sidi Fredj. These species may be regarded as a precious species for the deprived areas and which, although disjointly disseminated, must be effectively protected with the involvement of local populations who use its habitats.

This work would constitute, in perspective, a basis for further research on the spatio-temporal evolution and ancient Pistachio landscapes of the Atlas. In addition, research on the current distribution of Pistachio tree species will provide new answers on the behavior of species with regard to quaternary climate change and its potential to respond to future climate warming.

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