

Rediscovery of *Tulipa sylvestris* subsp. *primulina* (Baker) Maire & Weiller in the Belezma National Park (north-eastern Algeria)

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Abstract. In the spring of 2022, botanical surveys carried out in the Belezma National Park allowed the rediscovery of *Tulipa sylvestris* subsp. *primulina*, a rare and endemic Algerian-Moroccan species. The provided photographs as well as an accurate description of the plant facilitate its identification. The added map shows its distribution throughout Algeria.

Key words: tulip, *Tulipa sylvestris* subsp. *primulina*, systematics, cedar forest, Algeria

1. Introduction

The genus *Tulipa* L. (Liliaceae) includes herbaceous bulbous plants with variable vegetative and floral traits. Some of the traits, such as flower and bulb morphology, have been used to describe and define new taxa (Christenhusz *et al.* 2013). According to the same authors, within this genus, 76 species are accepted. They are of great ecological and taxonomic interest (Veldkamp & Zonneveld 2012; Hajdari *et al.* 2021), as tulips are grown for several purposes: the production of bulbs, forcing as cut flowers and potted plants, and landscaping (Le Nard & De Hertogh 1993). Also, their attractive flowers have been widely used as ornamental garden plants (Ocak *et al.* 2004). Tulips first appeared in the Netherlands in 1593, specifically in the city of Leiden. This happened when Carolus Clusius moved there with his tulips to take charge of the city's university garden, presently known as the Hortus Botanicus. Despite his best efforts to preserve the bulbs, they were stolen several times due to their extreme importance

as an essential raw material in the production of Dutch bulbs (Staffeu 1963; Segal & Roding 1994). Clusius dispersed the bulbs throughout his vast network and thus played a role in the spread of tulips in Europe (Egmond 2007). Around 1630, tulips became very popular and the rarest ones were extremely expensive. The highest price recorded in 1637 for a single tulip bulb was 5200 guilders (equivalent to about 2360 euros now) (Dash 1999). Chorologically, tulips are generally regarded as associated with the Netherlands and are considered their unofficial flowers (Hoog 1973). However, the primary centre of diversity of the genus *Tulipa* is located in the Pamir Alai and Tien Shan Mountains of Central Asia (Botschantzeva 1962; Hoog 1973; Beshko *et al.* 2013; Ozodbek *et al.* 2020). The diversification that took place in this region led to its spread from North Africa to Western Europe and from East to Western China (Dash 1999). The secondary centre is found in the Caucasus (Botschantzeva 1962).

In North Africa, this genus is very restricted as it contains only 6 taxa, of which *Tulipa agenensis* DC. is

considered as extinct by Dobignard & Chatelain (2010). In Algeria, this genus is represented by *T. sylvestris* subsp. *australis* (Link) Pamp, *T. sylvestris* subsp. *cuspidata* (Regel) Maire & Weiller, and *T. sylvestris* subsp. *primulina* (Baker) Maire & Weiller according to Dobignard & Chatelain (2010). Those authors questioned the presence of *T. sylvestris* subsp. *sylvestris* in Algeria and considered *T. sylvestris* subsp. *cuspidata* (Regel) Maire & Weiller as strictly endemic to Algeria. In contrast, they classified *T. sylvestris* subsp. *primulina* (Baker) Maire & Weiller as an Algerian-Moroccan endemic.

The taxon *Tulipa sylvestris* subsp. *primulina* (Baker) Maire & Weiller (= *Tulipa primulina* Baker), which was first reported by Maire (1958), has been the subject of systematic confusion that has divided authors and even some databases into 2 groups: one distinguishes it from *Tulipa sylvestris* subsp. *cuspidata* (Regel) Maire & Weiller (Maire 1958; Quézel & Santa 1962; Dobignard & Chatelain 2010; Euro-Med-Plant 2006-2022; APD 2023) and the other group considers them to be synonyms (Battandier 1919; Christenhusz *et al.* 2013; Bánki *et al.* 2023; POWO 2023). In the present work, we hypothesize that *T. sylvestris* subsp. *primulina* (Baker) Maire & Weiller is distinct from *T. sylvestris* subsp. *cuspidata* (Regel) Maire & Weiller, given the lack of phylogenetic studies detecting possible relationships between them.

The genus *Tulipa* L. and its subspecies are of great local and global importance as they increase biodiversity and the natural value of this protected area. The research carried out by Chabert (1897), Maire (1958), and (Quezel & Santa 1962) indicated the presence of *T. sylvestris* subsp. *primulina* in Algeria in general and in the Belezma National Park in particular, but those are old and limited works. Our article reports the presence of *Tulipa sylvestris* subsp. *primulina* in this Park. We focus on its ecology and, in addition, we try to delimit its distribution in Algeria.

2. Material and methods

2.1. Study area

The Belezma National Park is located at the western end of the Aurès Mountains, 7 km north-west of the city of Banta. Referring to the work of Quezel & Santa (1962-1963), Meddour (2010) proposed to create a new biogeographic sector called C2, in which the Belezma Mountains were included. Covering an area of 26 250 hectares, this park is divided into 3 sectors: Fisdis, Oued Chaaba, and Oued Imaa. It is a succession of small massifs wedged between the Aurès Mountains to the south-east and the Honda Mountains to the west, while to the north-west and south-west, it overlooks the Marouana plains and the Batna valley (Sahli 2004). This national park was created by Executive Decree 84-326

of 3 November 1984. In 2015, the park was classified as a biosphere reserve by the Man and the Biosphere Programme (MAB-Algeria 2016). Like in all protected areas, the main objective of its designation was to preserve the natural habitats and the plant and animal communities that live there. These environments host a floristic heritage containing the last vestiges of forests dominated by *Cedrus atlantica* (Endl.) Manetti ex Carrière, on the margins of the Sahara. The terrain of the Belezma massif was formed in the Triassic, Jurassic, and Cretaceous periods (Bentouati 1993). According to Schoenberger (1970) and Abdessamad (1981), the soils are diversified since, from the highest to the lowest altitudes, we can recognize: brown soils with a low calcareous content resting on sandstone, rendzinas found on slopes, brown calcareous soils located on a marly and calcareous substratum, and dolomitic rendzinas, which are less represented and located on dolomites. This diversity of substrates is combined with a multitude of bioclimates. The high altitudes and the northern slopes are subject to a Mediterranean climate, ranging from subhumid to humid. On the contrary, at low altitudes and on the southern slopes, the bioclimate is semi-arid or arid (Abdessamad 1981) (Fig. 1).

2.2. Methods

During our botanical surveys in the Belezma National Park from mid-March to the end of June 2022, we carried out 36 botanical surveys on rectangular plots of 20 m × 15 m each (300 m²), as this size is commonly used in a forest environment. The large area and plant diversity of the park made us combine 2 sampling methods: the random and systematic method. We harvested a number of valuable plants, including *Tulipa sylvestris* subsp. *primulina* (Baker) Maire & Weiller. We found this taxon at two stations: in the Fisdis sector on 12 April 2023 and in the Oued Imaa sector on 16 May 2022. We took plant samples from the second station.

For species not identified in the field, samples were taken and then determined in the laboratory, on the basis of the flora of North Africa (Maire 1952-1987) and the flora of Algeria and southern desert regions (Quezel & Santa 1962-1963). To update the botanical names, we used POWO (2023).

3. Results

3.1. Taxonomy

The tulip is a perennial, 20-25 cm high, with a round, hairy, tunnelled bulb, 5 cm in diameter. Flat, linear-lanceolate leaves 3-6, 10-15 cm long, on erect stems (Fig. 2). Flowers solitary (isolated, each on a single stem), fragrant and variable in colour: pinkish white or sulphur yellow with purplish, washed out dorsal surfaces of tepals (parts of the perianth). Internal

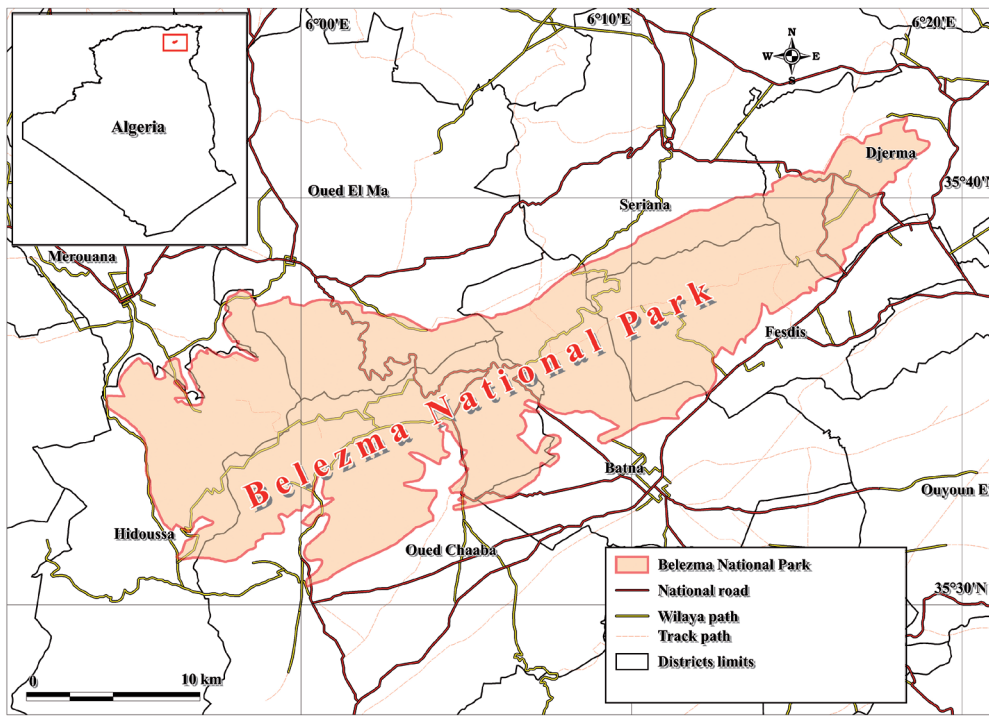


Fig. 1. Location of the Belezma National Park (Batna, north-eastern Algeria)



Fig. 2. Plant habit of *Tulipa sylvestris* subsp. *primulina*

Explanations: a-c – individuals in flower (photographs by N. Maalem, 16 May 2022), d – a specimen for the herbarium of the University of M'Sila

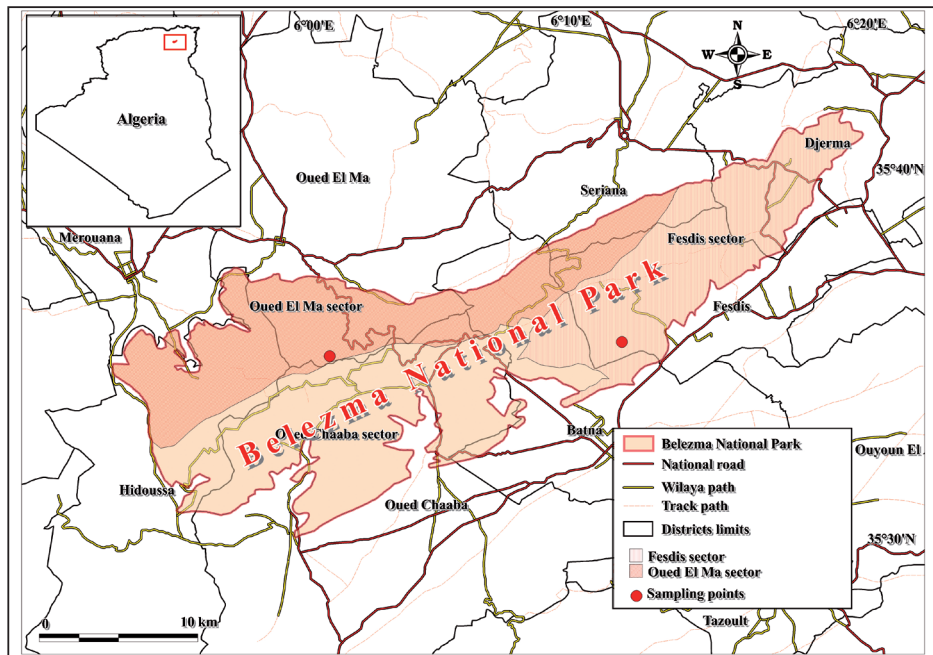


Fig. 3. Distribution map of the observation points (stations)

surfaces of tepals ciliated and yellow at base. We agree with Chabert (1897) who pointed out that the stigma is small and the stamens are half as long as the tepals. The fruit is a capsule with flattened, sub-triangular, and narrowly margined seeds according to Quezel & Santa (1962). To confirm our identification, we referred to the specimens of this tulip deposited in POWO (2023). Similarly, we consulted the photos of this species in the database of plant biodiversity of southwest Morocco <https://www.gbif.org/fr/species/5299357>

3.2. Habitat description

In the spring of 2022, we observed in the Belezma National Park this tulip species in 2 stations (Fig. 3). The first is located on the southern slope of Mount Kessrou at an altitude of 1117 m in the Fidis sector ($35^{\circ}35'45.0''\text{N}$, $06^{\circ}11'01.0''\text{E}$) (Fig. 4), where we observed only one individual. There, matorral (shrubland) with trees dominates, characterized by some *Quercus ilex* subsp. *ballota* (Desf.) Samp. and *Pinus halepensis* Mill. The numerous shrubs and bushes include *Helianthemum*



Fig. 4. Station 1: Fidis sector (photograph by N. Maalem, 18 April 2022)



Fig. 5. Station 2: Oued El Ma sector (photograph by N. Maalem, 16 May 2022)

hirtum (L.) Mill., *Juniperus phoenicea* L., *Juniperus oxycedrus* L., *Phillyrea angustifolia* L., and *Pistacia lentiscus* L. The herbaceous layer contains chiefly *Arenaria serpyllifolia* L., *Hippocrepis multisiliquosa* L., *Lotus ornithopodioides* L., and *Plantago lagopus* L. In 2009, this area suffered a fire that destroyed 3/4 of the plant cover, according to the park's technical managers. This contributed to the modification of the vegetation and landscape, where *Macrochloa tenacissima* (L.) Kunth. spread to the detriment of many forest species. The second station, which reaches an altitude of 1792 m, is located in the scree on the northern slope of Mount Bourdjem in the Oued El Ma sector (35°35'20.0"N, 06°01'18.0"E) (Fig. 5), where we found 20 individuals. It has favourable environmental conditions (humidity, elevation, northern exposure), which is reflected in the nature of the plant cover, marked by the presence of an endemic Algerian-Moroccan tree, the Atlas cedar, *Cedrus atlantica* (Endl.) Manetti ex Carrière. The shrub layer includes *Crataegus monogyna* Jacq., *Juniperus oxycedrus* L., and *Quercus ilex* subsp. *ballota*. The herb layer includes *Anacyclus clavatus* (Desf.) Pers, *Aphanes arvensis* L., *Bromus hordeaceus* L., *Cynoglossum creticum* Mill, *Erodium cicutarium* (L.) L'Hér., *Fumaria capreolata* L., *Polygala monspeliaca* L., *Sonchus oleraceus* L., *Torilis arvensis* (Huds.) Link, *Trifolium campestre* Schreb., and *Veronica agrestis* L.

3.3. Distribution

To understand better the distribution of *Tulipa sylvestris* subsp. *primulina* in Algeria, we referred to the works of Chabert (1897), Maire (1958), Quezel & Santa (1962), and our own observations. This allowed us to draw up a map on which we have indicated these reports (Fig. 6). The distribution of the species is limited to northern Algeria, where water conditions are favourable. From a biogeographical point of view, this taxon

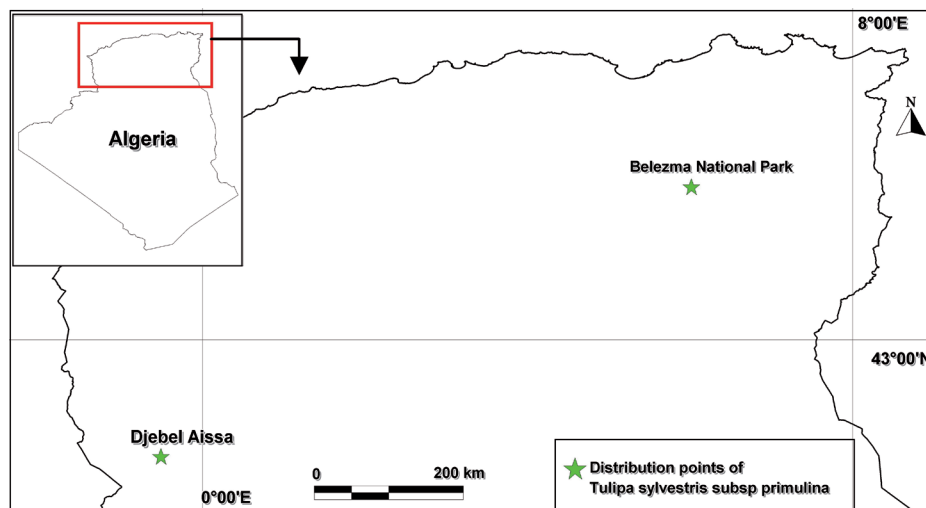


Fig. 6. Distribution map of *Tulipa sylvestris* subsp. *primulina* in Algeria

has a disjunct distribution, since it has been recorded in 2 distinct biogeographical sectors. The first one is more northerly and corresponds to C2 (Hodna Mountains and Belezma) according to the biogeographic division of Quezel & Santa (1963) modified by Meddour (2010). The second one concerns the Jebel Aïssa (Western Saharan Atlas), which constitutes its southern limit.

Tulipa sylvestris subsp. *cuspidata* had been reported from several localities: the Aurès, the Boutaleb massif (Sétif), El Kantara (south-western Aurès), Aflou (central Saharan Atlas), the Sersou plateau (near Tissemsilt), Ouled Abdenour (Tell Constantinos), and Djebel Aïssa (Maire 1958). Recently, the presence of this tulip has been confirmed in the Western Saharan Atlas (Gordo 2021).

3.4. Health status of the cedar forest

It should be noted that this cedar grove is subject to dieback that started in 1982. It turned out to be due either to repeated defoliation caused by a defoliating lepidopteran, the cedar processionary (*Thaumetopoea bonjeani*), or to a pair of parasites, one of which is a wood-decay fungus of the genus *Armillaria* and the other is an unidentified xylophagous insect of the family Buprestidae (Bentouati 2008; Guezlane 1982 in Boukeker 2016).

4. Discussion

Through our study, we have rediscovered *Tulipa sylvestris* subsp. *primulina* in the Belezma National Park after 6 decades, as it had not been reported despite the new plant inventory. The presence of this tulip subspecies in the park increases the diversity of the plant cover and the overall importance of this protected area. *Tulipa sylvestris* subsp. *primulina* is exclusively found in 2 regions of Algeria: the Mont Aïssa National Park and Belezma National Park. These regions are characterized by a variety of exposures, heights, and substrates, which support different plant formations and promote plant diversity. Mont Aïssa has a semi-arid to arid cli-

mate with hot, dry summers and cold winters (Gordo 2014). At the high altitudes and on the northern slope of the Belezma National Park, the climate changes from subhumid to humid with very cold winters, while the lower elevations have a semi-arid climate with mild to cold winters (PGPNB 2019). The difference in climate between these regions has led to the expansion of the points of spread of this subspecies in Algeria, which is not limited to semi-arid regions but extends to semi-humid regions.

5. Conclusions

The confirmation of the presence of this endemic bulbous plant reveals, on the one hand, the ecological value of the Belezma National Park (favourable habitats and exposures) and, on the other hand, the vulnerability of this tulip. The disagreement between scientists about whether *T. sylvestris* subsp. *primulina* (Baker) Maire & Weiller and *T. sylvestris* subsp. *cuspidata* (Regel) Maire & Weiller are synonymous, due to the convergence of morphological characteristics, must be resolved through the analysis of their phylogeny. Finally, the preservation of cedar forests, which give the park a special character and provide suitable conditions for this rare tulip subspecies, is considered one of the conservation priorities for this natural heritage site.

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Final approval of article: N. Maalem

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