

Additional records on the occurrence of two alien Leguminosae in Algeria

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Key words: alien species, new records, Fabaceae, escapes, cultivation, naturalization, habitat invasion, North Africa.

Ključne besede: tujerodne vrste, novi podatki, Fabaceae, pobegle rastline, gojenje, stopnja naturalizacije, napaden habitat, Severna Afrika.

Abstract

During field surveys, carried out between 2021 and 2022 in northeastern Algeria, two populations of *Tipuana tipu* (Benth.) Kuntze were discovered. One population was located in the middle of a quite natural habitat in the Filfilla region (wilaya of Skikda). This population seems more or less established and can be considered to be at the beginning of the naturalization process, a degree of naturalization not previously reported in Algeria and mainland North Africa. The surveys also revealed several populations of *Paraserianthes lophantha* (Vent.) I.C. Nielsen, a species that was recently reported as naturalized in Algeria but for which details on its naturalization were lacking. Details about the localities in which the two species were observed are given, including a present map of their distribution and field photographs. A key for the identification of both genera is also provided.

Izveček

Med letoma 2021 in 2022 smo s terenskimi raziskavami odkrili dve populaciji vrste *Tipuana tipu* (Benth.) Kuntze. Ena populacija se nahaja v skoraj naravnem habitatu v regiji Filfilla (vilajet Skikda) in se zdi bolj ali manj ustaljena. Očitno se je že začel proces naturalizacije, ki dosedaj v Alžiriji in celinski Severni Afriki še ni bil zabeležen. Z raziskavami smo odkrili tudi številne populacije vrste *Paraserianthes lophantha* (Vent.) I.C. Nielsen, o kateri so poročali kot naturalizirani vrsti v Alžiriji, vendar podrobnosti o tem še niso objavljene. Podajamo več informacij o lokacijah, kjer se ti vrsti nahajata in zemljevid njune razširjenosti ter terenske fotografije. Za oba rodova smo naredili tudi določevalni ključ.

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Received: 5. 11. 2022
Accepted: 9. 2. 2023

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Introduction

The family Leguminosae (= Fabaceae) is one of the most important families of flowering plants. In terms of number of taxa it is the third largest family, only surpassed by the Orchidaceae and Asteraceae. (Tekdal, 2021), and includes several useful species grown as crops or fodder, for forestry or as ornamentals, or for medicinal purposes (Rathee et al., 2010; Vasconcelos et al., 2020).

Given the diversity of their interest and the importance of their socioeconomic impact, dozens of exotic species of this family were introduced into Algeria during the colonial period, some of which escaped cultivation and became permanently established in natural habitats. The naturalization of 13 legume species has already been reported in the country, the most common being *Acacia melanoxylon* R. Br., *A. saligna* (Labill.) H. L. Wendl., *Robinia pseudo-acacia* L. and *Vachellia karroo* (Hayne) Banfi & Galasso (Dobignard & Chatelain, 2012; Sakhraoui et al., 2019a), while another 10 species are considered casual. But the number of legume species that have escaped from cultivation is steadily increasing in Algeria: new records are reported from time to time such as *Leucaena leucocephala* (Lam.) De Wit, reported by Raus & Zeddami (2010) as a roadside weed near Algiers or *Wisteria sinensis* (Sims) Sweet, recently reported by El Mokni & De Belair (2020) to be cultivated on a large scale.

Consistent with the above, this study reports a new record of *Tipuana tipu* (Benth.) Kuntze for Algeria and continental North Africa, as well as several new localities of *Paraserianthes lophantha* (Vent.) I. C. Nielsen, a species already reported as cultivated / subsponaneous in continental North Africa, including Algeria (Dobignard & Chatelain, 2012; APD, 2022). Recently, Meddour et al. (2020) reported that the species is naturalized in Algeria, without providing precise locality information or data on its ecology in Algeria. Additional geographic and biological information to monitor growth dynamics and assess invasive potential and risks caused by spread are scarce in the current literature, so this study aims to fill these gaps.

In addition, the morphological characteristics that allow distinction, and some biological characteristics, especially related to the mode of propagation are provided. The latter will allow a better understanding of the success of its establishment and the naturalization of *P. lophantha*.

This record, as well as those already published by the first author (Sakhraoui et al., 2019b; 2019c; 2022a; 2022b), shed light on the need to document the exotic naturalized flora in Algeria, which is certainly much more important than previously demonstrated.

Material and methods

Considering that exotic species usually escape from cultivation, i.e. gardens and parks, the surveys were intensified, on the one hand in the peri-urban areas of the wilaya of Skikda and, on the other hand, extended to other wilayas in northeastern Algeria, especially Annaba and El Tarf.

Therefore, between January 2021 and October 2022, dozens of surveys were conducted in urban and semi-natural environments, mostly along national or secondary roads. This allowed us to register several populations of *Paraserianthes lophantha* and to discover *Tipuana tipu*.

The two species were identified using Maire (1987) and Salazar & Soihet (2001) and compared with the detailed descriptions in Flora and Funga of Brazil (2022) and Flora of Australia (GNP, 2022).

Various references and databases were consulted as follows: the Legume Phylogeny Working Group (2017) for the family and subfamily naming; World Flora Online (2022) for synonymous taxa verification; African Plant Database (2022), Global Biodiversity Information Facility (2022) and Plants Of the World Online (2022) for determining the general distribution of the two species.

Field photos were taken by the first author (N. S.) and additional observational data on the biology and ecology of the two species (including phenology and mode of reproduction), a description of the invaded habitats, and the geographic coordinates of the various populations that were recorded are also included in this work. The degree of naturalization was estimated according to Pyšek et al. (2004).

Results

Field surveys identified two populations of *Tipuana tipu*, consisting of 63 individuals, including three adults, and 8 populations of *Paraserianthes lophantha*, consisting of 25 adult trees and numerous juveniles, distributed throughout the study area (Figure 1). The various locations and a discriminative key for both genera are presented below.

1. *Paraserianthes lophantha* (Vent.) I. C. Nielsen ≡ *Paraserianthes lophantha* subsp. *lophantha*, ≡ *Acacia lophantha* Willd., ≡ *Albizia lophantha* (Willd.) Benth. = *Albizia distachya* (Vent.) J. F. Macbr.

Habitat, population data, and degree of naturalization

Naturalized in the residential area of Bouaabaz on the side of Djebel Mouadar (city of Skikda), where four trees were observed in flower on 28. 01. 2021 and in fruit on 14. 07. 2021 on the edge of the road mixed with native flora such as *Calicotome spinosa* (L.) Link, *Dittrichia viscosa* (L.) Greuter, *Rubus ulmifolius* Schott and *Tamarix* sp.

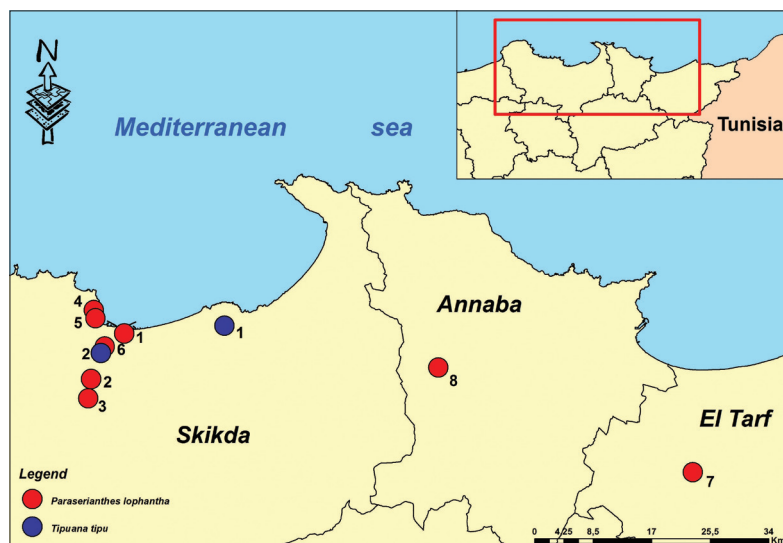


Figure 1: Localities where *Paraserianthes lophantha* and *Tipuana tipu* were recorded in northeastern Algeria. The numbers of localities correspond to Table 1.

Slika 1: Lokacije, kjer sta bili zabeleženi vrsti *Paraserianthes lophantha* in *Tipuana tipu* v severovzhodni Alžiriji. Številke nahajališč ustrezajo Tabeli 1.

(Table 1, locality no. 1) (Figure 2A). Dozens of seedlings were found at the same locality at distances ranging from 1 m to 20 m from the mother plants, indicating that the species spreads by seed (Figure 2C). Two other subpopulations, each with 2 to 3 adult individuals about 800 m apart, were observed in flower on 07. 02. 2021 on the edge of the road from El Hadaiek to Ramdan Djamel (Table 1, localities no. 2 and no. 3), where one of them is growing on the bank of a ‘chaâba’ (= small stream in a shallow depression). On 09. 02. 2021, another subpopulation of five individuals was observed in flower on the edge of the road to the port of Stora, where it grows among the native flora, especially

Acanthus mollis L., *Artemisia arborescens* L., *Pistacia lentiscus* L. and *Smilax aspera* L., as well as naturalized species such as *Arundo donax* L., *Ricinus communis* L. and *Tropaeolum majus* L. (Table 1, locality no. 4). On 01. 06. 2021, a small subpopulation, of three fruiting individuals was found at the edge of the Chadi wadi in the heights of Stora among *Rubus ulmifolius* Schott, *Antirrhinum majus* L. and *Pistacia lentiscus* L. (Table 1, locality no. 5). On 10. 03. 2022, the plant was again observed on the edge of the road leading to the housing agglomeration Messiouen 1, in a wasteland among native species. Two young trees 3 m high, colonize this site (Table 1, locality no. 6).

Table 1: Geographic coordinates of recorded localities of *Paraserianthes lophantha* and *Tipuana tipu* in Algeria.

Tabela 1: Geografske koordinate nahajališč vrst *Paraserianthes lophantha* in *Tipuana tipu* v Alžiriji.

Species	Id	Locality	Number of individuals	Habitat	Latitude	Longitude	Altitude (m)
<i>Paraserianthes lophantha</i>	1	Djebel Mouadar (Skikda)	4 trees and dozens of seedlings	wasteland	36° 52' 36.91"	6° 55' 42.95"	56
	2	El Hadaiek (Skikda)	3 trees	wasteland	36° 49' 0.37"	6° 52' 35.16"	47
	3	Ramdan Djamel (Skikda)	2 trees	Chaâba (= small stream)	36° 47' 28.62"	6° 52' 20.78"	144
	4	Road leading to Stora (Skikda)	5 trees	Coastal maquis	36° 53' 46.23"	6° 52' 52.27"	21
	5	Stora (Skikda)	3 trees	Maquis on the banks of the Chadi wadi	36° 54' 24.63"	6° 52' 41.38"	127
	6	Messiouen 1 (Skikda)	2 young trees	Wasteland on the road side	36° 51' 33.88"	6° 53' 51.07"	42
	7	village of El Besbes (El Tarf)	3 trees	Wasteland	36° 42' 29.38"	7° 51' 25.87"	16
	8	Entrance to the city of Berrahal (Annaba)	3 trees	Maquis	36° 50' 25.30"	7° 26' 27.55"	39
<i>Tipuana tipu</i>	1	Filfilla (Skikda)	3 trees and dozens of young individuals	Forest	36° 53' 23.64"	7° 05' 29.40"	227
	2	University of 20 August 1955, Skikda	10 young individuals	Along the road a few meters from the maquis	36° 51' 2.73"	6° 53' 28.69"	31

In June 2021, a small group of three trees was observed on the roadside in the wasteland of El Besbes village (wilaya of El Tarf) among other exotic species naturalized in the region, notably *Ricinus communis* L. and *Solanum elaeagnifolium* Cav. (Table 1, locality no. 7).

The species further expanded in the wilaya of Annaba, which is located about 100 km east of the city of Skikda. On 23. 06. 2022, three fruiting individuals of about 3 m high were observed on the roadside in a maquis with *Olea europaea* L., about 1 km from the main entrance of Berrahal city. At this site, the species grows among other naturalized exotic species, in particular *Eucalyptus camaldulensis* Dehnh. and *Vachellia karroo* (Hayne) Banfi & Galasso (Table 1, locality no. 8).

Phenology: in the observed populations, the flowering period of *P. lophantha* extends from early January to early February. Fruiting begins from early June to the mid-July, when the mature fruits are collected (Figure 2B).

2. *Tipuana tipu* (Benth.) Kuntze = *Machaerium fertile* Griseb. ≡ *Machaerium tipu* Benth. = *Tipuana speciosa* Benth.

Habitat, population data, and degree of naturalization

A population was found on 05. 04. 2021 on the edge of the road passing next to the ‘Bourchek Ziden’ primary school in the forest of Filfilla Mountain. It consisted of more than 50 young individuals varying in size from 70 cm to 3.50 m and was observed mixed with native species such as *Clematis cirrhosa* L., *Pistacia lentiscus* L., *Rubus ulmifolius* Schott and *Smilax aspera* L. This population was observed again on 06. 06. 2021 and on 29.10.2022 (Figure 3C. Another small subpopulation, consisting of three old individuals, one of which is about 7.50 m high, was found at the edge of the ‘chaâba’ passing under the small bridge (Figure 3A, 3B). This subpopulation is perfectly adapted to its environment and completely mixed with native forest plants such as *Alnus glutinosa* (L.) Gaertn., *Ceratonia siliqua* L., *Olea europaea* L., *Phillyrea*



Figure 2. *Paraserianthes lophantha* in Algeria. **A:** biotope of one of the populations observed at the Bouaabaz station (Skikda, north-eastern Algeria); **B:** fruit detail; **C:** young seedlings. Photos by N. Sakhraoui (15. 07. 2021).

Slika 2. *Paraserianthes lophantha* v Alžiriji. **A:** rastišče populacije na lokaciji Bouaabaz (Skikda, severovzhodna Alžirija); **B:** plod; **C:** mlade kalice. Fotografije N. Sakhraoui (15. 07. 2021).



Figure 3. *Tipuana tipu* in Algeria. **A** : a young tree in a 'chaaba' (= small stream in a shallow depression) in Filfilla (Skikda, northeastern Algeria); **B** : a young tree growing amidst native forest species; **C** : population of young self-sown individuals; **D** : adult tree responsible for the appearance of the species in the forest of Filfilla. Photos by N. Sakhraoui (19. 10. 2021); **E** : flowers; **F** : fruit details. Photos by N. Sakhraoui (18. 09. 2022).
Slika 3. *Tipuana tipu* v Alžiriji. **A** : mlado drevo v 'chaaba' (= majhen potok v plitvi depresiji) v območju Filfilla (Skikda, severovzhodna Alžirija); **B** : mlado drevo med avtohtonimi gozdnimi vrstami; **C** : populacija mladih, spontano rastočih osebkov; **D** : odraslo drevo, izvorni osebek vrste v gozdu na območju Filfilla. Fotografije N. Sakhraoui (19. 10. 2021); **E** : cvetovi; **F** : plod. Fotografije N. Sakhraoui (18. 09. 2022).

angustifolia L., *Pistacia lentiscus* L. and *Salix pedicellata* Desf. (Table 1, locality no. 1). More specimens could occur along the ‘chaâba’, which is very difficult to explore as it crosses an inaccessible mountainous zone to finally join the Righa wadi at the foot of the mountain. Three large trees observed in this locality, more than 10 m high and very likely planted since colonial times, are the reason for this appearance (Figure 3D). The species could be identified thanks to its yellow flowers observed at the end of May, beginning of June and its fruits in samaras observed on 25 July, when they were still green.

On 09. 03. 2022, another subpopulation was found on the edge of a clay road on the outskirts of the Joint Research Service of the University of Skikda. Ten young individuals, varying in size from 1 to 2 m, were growing among native herbaceous species such as *Borago officinalis* L., *Cerintho major* L., *Hyparrhenia hirta* (L.) Stapf, *Lagurus ovatus* L., and *Malva sylvestris* L., just a few meters from the maquis (Table 1, locality no. 2). The old trees that are planted in the University gardens are probably the origin of this subpopulation.

According to Pyšek et al. (2004), this species can be considered to be in the process of naturalization, because in the Filfilla region the species seems to be more or less established. One of the self-seeding individuals observed in the field bears fruit, indicating a self-sustaining population.

Phenology: in the study area, the flowering period of *T. tipu* was observed between late May and early June. Fruits appear in early July and mature in August. However, in cultivation, flowering of some individuals was observed as early September (Figure 3E, 3F).

Leguminosae Juss. Key to the genera

Leaves bipinnate. Flower with numerous stamens. Fruit a pod. Seeds with black and hard testa *Paraserianthes*
Leaves imparipinnate. Flower papilionaceous with 10 stamens. Fruit a samara. Seeds not hard coated... *Tipuana*

Discussion

Paraserianthes I. C. Nielsen is a genus in the mimosoid clade belonging to the subfamily Caesalpinioideae (LPWG, 2017). It was initially included in the genus *Albizia* (Fosberg, 1965). Originally, it consisted of four species divided into two sections: sect. *Paraserianthes* with *P. lophantha* (Vent.) I. C. Nielsen and sect. *Falcataria* with *P. falcataria* (L.) I. C. Nielsen, *P. pullenii* (Verdc.) I. C. Nielsen, and *P. toona* (F. M. Bailey) I. C. Nielsen (Nielsen et al., 1983). It was later divided into two genera (Brown et al., 2011), *Paraserianthes* and *Falcataria*. The species

of sect. *Falcataria* were renamed *F. moluccana* (Miq.) Barneby & J. W. Grimes (= *P. falcataria*), *F. pullenii* (Verdc.) G. K. Brown, D. J. Murphy & P. Y. Ladiges (= *P. pullenii*) and *F. toona* (Bailey), G. K. Brown, D. J. Murphy & P. Y. Ladiges (= *P. toona*).

Thus, at present, the genus *Paraserianthes* harbors a single species, *P. lophantha* with two subspecies, subsp. *lophantha*, which occurs naturally in Western Australia and subsp. *montana*, which is found on the Indonesian islands of Sumatra, Java, Bali, and Flores (Brown et al., 2011).

Paraserianthes lophantha is a phanerophyte native to southwestern Australia (Brown et al., 2020). It has been introduced as an ornamental in various parts of the world as an ornamental plant, most notably in Spain, Italy, Malta (Mifsud, 2022) and Morocco, and it has become a significant weed in the Canary Islands, Chile, New Zealand, Portugal, southern California, South Africa and South America (Brown et al., 2020). In the northern part of the Mediterranean region, *P. lophantha* has been reported naturalized in Italy (Villari & Zaccone, 1999; Galasso et al., 2018) and in Spain (Aymerich & Saez, 2019). In North Africa, on the other hand, it has been reported as cultivated/subspontaneous in Madeira, Morocco and Algeria (Dobignard & Chatelain, 2012; APD, 2022) and more recently, as naturalized, on the Algerian coast and Tell Atlas (Meddour et al., 2020).

Paraserianthes lophantha is a small deciduous tree of about 8 m, although specimens observed in the study area generally do not exceed 5 m in height. Leaves are petiolate, bipinnate and more than 20 cm long, each leaf bearing up to 30 pairs of sessile, opposite leaflets. The inflorescences are axillary racemes, pedunculate, the flowers greenish yellow, shortly stalked with numerous stamens that are connate basally and with eglandular anthers. Pods are flat, brown, can exceed 10 cm in length and are opening on both sides. Seeds are hard-coated.

This species is not only an ornamental plant, but also highly melliferous. In the field, the first author observed a large number of bees visiting the flowers, which probably encourages the inhabitants, in particular the beekeepers, to introduce it into their gardens where it was observed to provide a natural food source for their bees in the winter season.

The distribution in Algerian territory reported by Meddour et al. (2020) is probably based on personal observations, but no localities were provided. In addition, no data on population size or occupied habitats were provided. Similarly, information on how the species reproduces outside cultivation is lacking for Algeria. This is probably the first information recorded for Algeria.

The complete distribution of this species across the vast Algerian territory is difficult to estimate due to the lack of

surveys, but further studies to monitor the dynamics of populations across Algeria would provide further insight into the invasiveness of *P. lophantha*, which has already been reported as invasive in 28 other countries (GBIF, 2022), including regions with Mediterranean climate such as the Canary Islands (Verloove et al., 2019) and South Africa (Impson et al., 2011).

Tipuana Benth. is a genus with one species belonging to the subfamily Papilionoideae (=Faboideae), native to South America from Bolivia to southern Brazil and northern Argentina. It is planted from the Mediterranean to the tropics as an ornamental, timber, for soil stabilization, or in reforestation programs (TPD, 2022).

Tipuana tipu is a phanerophyte, native to Bolivia and Argentina (Salazar & Soihet, 2001). It has been introduced in tropical to warm temperate climates such as the Canary Islands, India, Iraq, Kenya, New Guinea, Spain, Tanzania, and Uganda (WFO, 2022). It is also cultivated as an ornamental in Malawi and Zimbabwe (Hyde et al., 2022). This species is becoming widely naturalized in southeastern and central Queensland and is possibly also naturalized in northern New South Wales (Weeds of Australia, 2022). In the northern part of the Mediterranean region, *T. tipu* has only been reported in Spain as casual (Aymerich & Sáez, 2019). In North Africa, the species has been reported as naturalized in the Canary Islands (Verloove, 2017), but the species does not seem to have been previously reported on the continent (ADP, 2022) making this record the first for the North African mainland.

Tipuana tipu is a semi-deciduous tree up to 20 m tall with fissured bark, flaking with age. When cut, the branches exude a red and sticky sap. Leaves are imparipinnate, with 11–31 leaflets, alternate to subopposite. Flowers are about 2 cm long, aggregated into axillary racemes, with 5 green sepals, petals yellow to slightly orangish, stamens 10, ovary 1–4 ovulated. The fruit a samara, pedunculate, about 6–8.5 cm long, brown at maturation with one to three reddish seeds.

Although the species cannot currently be considered completely naturalized in the study area, future naturalization is very likely, especially in Filfilla where old and productive individuals, at least one of them, grow spontaneously in a habitat similar to that of the species' area of origin. This species has been able to establish itself in a more or less natural forest area and was able to overcome competition from native tree species. It is probably only at the beginning of its expansion in the region, but its range is likely to increase over time, especially since it has invaded regions with a Mediterranean climate, particularly in South Africa (ISSA, 2022). In addition, *T. tipu* colonizes wet and dry habitats in its native range, tolerates a variety of soil types, and its seeds do not ex-

hibit dormancy that could inhibit germination (Cruz et al., 2002).

The edges of the wadis, shady ravines and zones where there are leaks of drinking or wastewater, constitute in Algeria zones that favour the establishment and development of exotic species that have escaped from cultivation because they provide humidity necessary for the maintenance of new plants, especially in summer when there are usually very high temperature peaks.

Paraserianthes lophantha and *Tipuana tipu* should continue to be monitored because they are potentially invasive in Algeria.

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