sciendo

Contemporary Agriculture, Vol. 72, No. 1-2 (2023): 82-88
DOI: 10.2478/contagri-2023-0011
UDC: 615.32

Original scientific paper

ARISTOLOCHIA BAETICA L. (ARISTOLOCHIACEAE): NEW RECORDS OF RARE MEDICINAL SPECIES FROM NORTHWESTERN ALGERIA

ISSN 2466-4774
https://www.contagri.info/

OPEN ACCESS

LAHOUARIA MOUNIA MANSOURI[1], *ABDENOUR KHELOUFI*[1,3*], *MOHAMED BOUKHECHA*[2]

[1]Department of Ecology and Environment, University of Batna 2, 05078 Batna, Algeria
[2]Department of Biology, University of Oran 1, 31000 Oran, Algeria
[3]Laboratory of Biotechnology for Food and Energy Security, University of Oran 1, Oran 31000, Algeria
[*]*Corresponding author*: a.kheloufi@univ-batna2.dz

Submitted: 21.01.2023.
Accepted: 13.03.2023.

SUMMARY

Based on vegetation surveys made in 2020 and 2021, the present paper reports the first records of Andalusian pipevine - Aristolochia baetica L. (Aristolochiaceae) in Oran (northwestern Algeria). This species has been previously recorded only in Sidi Bel Abbès and Tlemcen (Algeria). Therefore, this statement can be considered as an addition to the flora of Algeria. The species was found in 10 out of 26 municipalities from the city of Oran. A distribution map of these new records is included. The paper describes its reproduction, ecology, and phenology. Photographs of different plant organs at different seasons of the year are also provided for this poorly known species. The recorded populations were very small in size (<3 populations per municipality) and in the number of individuals (<5 ind.). Conservation efforts may be necessary to protect and increase the population size of this species.

Key words:
Aristolochia baetica, Aristolochiaceae, distribution, ecology, Algeria, Andalusian pipevine

INTRODUCTION

The genus *Aristolochia* (Aristolochiaceae, Piperales) includes 500 species distributed throughout the world with centers of diversity in tropical and subtropical regions (Ohi-Toma et al., 2006; Wanke et al., 2017). The genus *Aristolochia* consists of perennial, herbaceous or woody plants that often climb by means of twining stems. They are characterized by their large, showy flowers, which are often trumpet-shaped and have a distinctively curved or twisted shape. The leaves of *Aristolochia* species are typically simple, alternate, and sometimes heart-shaped, with a smooth or slightly hairy texture. Overall, the morphological characteristics of the genus *Aristolochia* vary depending on the species, but they are generally characterized by their climbing habit, large flowers, and distinctive curved or twisted shape (Takhtajan, 2009). *Aristolochia* species are rich in alkaloids based on benzyl isoquinoline, and some have been used in traditional medicine for their medicinal properties. However, some species contain toxic compounds that can be harmful to humans and animals if ingested. *Aristolochia* species contain aristolochic acid and its analogs, an interesting and highly toxic class of phenolic derivatives. In traditional Chinese medicine, plants of the genus *Aristolochia* are used to treat some forms of acute arthritis and edema (Depierreux et al., 1994; Nortier et al., 2000). Additionally, epidemiological and laboratory studies have identified *Aristolochia* species as the cause of severe kidney disease, associated with more than 100 cases of renal failure (Cosyns, 2003).

Aristolochia baetica L. (1753) [synonyms *Aristolochia subglauca* Lam. (1783); *Aristolochia glauca* Desf. (1799)], also called Andalusian Pipevine, is an endemic plant of the Iberian Peninsula (Maire, 1961; Quézel & Santa, 1962; Berjano et al., 2011). It is a very common plant along the Mediterranean coast, especially in Granada, Malaga, Cadiz and in the Guadalquivir depression, and less on the Atlantic coast (Rivas-Martinez et al., 2002). In Africa, it occurs

© 2023 Author(s). This is an open access article licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 3.0 License (https://creativecommons.org/licenses/by-nc-nd/3.0/).

as a common species in Morocco (Quézel & Santa, 1962; De Groot et al., 2006). *A. baetica* is represented by small, localized populations with a small number of individuals. This is likely caused by a number of factors, including difficulty in germination and low rates of natural regeneration (Schemske et al., 1994; Colas, 1997). In addition to this species, only two other species of the same genus were reported by Quézel & Santa (1962) in Algeria, *vis.*, *A. longata* and *A. altissima*. Also, two subspecies of *A. longata* are recorded, *A. longata* subsp. *paucinervis* and *A. longata* subsp. *fantanesii*.

A. baetica was first described in 1753 by Linnaeus in the first issue of Species Plantarum. He distinguished *A. sempervirens* from *A. baetica* by its yellow and brown striped flowers. He recorded *A. baetica* with brown flowers in Spain and Crete. *A. baetica* is an evergreen perennial vine that blooms from winter to spring (Rix, 2010). It has an elongated and fasciculated root system (Berjano et al., 2011).

A. baetica is a very rare species in Algeria, with the only reported sampling sites located in the northwest, i.e. 82 km south of the city of Oran, in the Tessala Mountains of Sidi Bel Abbes (Latreche et al., 2015; Hakemi et al., 2018; Hakemi et al., 2020) and Hafir Forest in Tlemcen, 140 km southwest of Oran (Hanaoui & Bouazza, 2012).

Therefore, the aim of this study is to show the newly discovered sites of *Aristolochia baetica* in the northwest of the Mediterranean city of Oran (northwest Algeria), and to give some indications in terms of ecology, habitat, biology, reproduction, and medicinal properties.

MATERIAL AND METHODS

Study area

Oran is a remarkable Mediterranean city located on the southern coast of the Allegro Provence basin in northwestern Algeria, 432 km west of the capital, Algiers (Fig. 2). It covers an area of 212 100 ha and is located at 35°41'28" north latitude and 0°38'30" west latitude. Oran is characterised by a mixture of six different natural formations, and one can distinguish its coastal boundaries, extending from the mountains of Arzew to the sandy beaches of the Andalusians, plus a series of high hills bordering all the cliffs from Arzew to Canastel, with the low coastal plain of Bousfer. Oran is located at an average altitude of about 60 m. The climate of the city is a typical Mediterranean climate. Oran's climate tends to be mild and the city is known for its long, hot, and humid summers with little rainfall. A subtropical anticyclone covers the region of Oran for almost four months. In Oran, the climate is warm and temperate. Rain in Oran is much more important in winter than spring. The climate of Oran is semi-arid (Benammar, 2016).

The identification of *A. baetica* individuals was based on the taxonomic classification provided by Quézel & Santa (1962) and Dobignard & Chatelain (2010-2013). In our scientific investigation (during 2020-2021), we conducted a survey of 26 municipalities located in the region of Oran city, which is situated in the northwestern part of Algeria. The survey was conducted in areas that featured varying levels of tree and shrub vegetation, with an average surface area of 20 km^2 per municipality. The creation of the actual and potential distribution maps was solely founded on on-site observations conducted across the entire Oran city. Geographical positions were recorded using a Magellan eXplorist 200 GPS Receiver.

The climatic data presented in Table 1 were provided by the World Climate Data Tutiempo (www.tutiempo.net). The data were obtained from the meteorological station 604900DAOO (Airport Sénia, Oran, Algeria), which is located at 35.63 north latitude, -0.6 west latitude, and an altitude of 90 m a.s.l.

Table 1. Average climatic data values recorded in Oran, Northwest Algeria during 2020-2021.

Climatic data	**Year 2020** (366 days)	**Year 2021** (362 days)
Annual average temperature	18.8 °C	18.7 °C
Annual average maximum temperature	24.5 °C	24.4 °C
Annual average minimum temperature	13.3 °C	13.4 °C
Annual average humidity	68.7%	69.6%
Total annual precipitation	247.14 mm	259.85 mm
Number of rainy days	63	79
Number of snowy days	0	0
Number of hail days	2	2

RESULTS AND DISCUSSION

Morphology

Aristolochia baetica is a perennial herbaceous plant. *A. baetica* has a tuberous root system, which allows it to survive adverse weather conditions and low nutrient availability (Quézel & Santa, 1962). Stems are aerial, vining, climbing, twining, fleshy, and glabrous (Fig. 1A, 1B). The stems are not straight, but twisted and grow on shrubby species up to 5 m in height. *A. baetica* forms branched stem clumps in which branches from different individuals are often intermingled, making it sometimes impossible to distinguish individuals.

The leaves are alternate and the base is heart-shaped (Fig. 1C). Evergreen, glabrous, shiny above, glaucous below, a little leathery, heart-shaped to kidney-shaped, acute or obtuse, 5-10 cm long, 5-8 cm wide, with cracks at the base, lobes about 1/4 leaf length (Berjano et al., 2011). The leaves of *A. baetica* lack neither the typical palisade structure nor the typical spongy parenchyma, however, some intercellular spaces are present at the abaxial side of the mesophyll. The petiole is 2 to 3 cm long. The leaf structure of this plant, although due to the mesophyll arrangement and sunken stomata, appears to be xeromorphic (Christodoulakis et al., 2019).

The flowers of *A. baetica* are large, purple, solitary in the leaf axils, axillary with short peduncles (Fig. 1D-1F). The flowers are saxophone-shaped, 2 to 7 cm long, hermaphroditic, zygomorphic with filamentous, green peduncles, 5-6 cm long. *A. baetica* has strong smelling flowers (Berjano et al., 2011). The flowers have 6 stamens and a glabrous lower ovary. The calyx tube is reddish-brown, with narrow dark bands, curved to 90°, widening at the base, then narrowing and gradually widening toward the leaves (Berjano et al., 2011). The flowers are reddish brown, purple brown or black. The fruits are oblong, on average 7 cm long, and contain an average of 40 seeds. The fruit is a capsule with 6 cells, opened by 6 valves (Fig. 1G-1H-1I). The seeds are brown, warty, obovate-triangular, flattened, 6-7 mm long, 5-6 mm wide (Fig. 1J-1K-1L) (Berjano et al., 2011). The seeds have a concave raphe and a flat or slightly convex opposite raphe (Quézel & Santa, 1962).



Figure 1. *Aristolochia baetica*, Oran (NW-Algeria), 2020-2021
A-aspect of a population; B-climbing aspect of stems; C-leaves; D-flowers;
E-longitudinal section of a flower; F-development of flowering; G-fruits;
H-cross-section and longitudinal section of a fruit; I-fruit development;
J-dehiscent dry fruit; K-longitudinal section in a dry fruit; L-appearance of seeds.

Distribution in the region of Oran

Out of 26 municipalities that were surveyed, *A. baetica* populations were found in ten of them. These municipalities include Bir El Djir, Sidi Chahmi, El Kerma, Oran, Misseghine, Aïn El Turk, Bousfer, El Ançor, Boutlelis, and Aïn El Kerma (Fig. 2). At our study site and in our personal observations, this species is represented in minority populations (<3 populations per municipality). This rarity can be explained by climatic conditions, especially the dry seasons leading to water deficit, impacts of fauna and human activities leading to habitat fragmentation and loss of species and populations, but also by the lack of data on the seed vigor and germination. Indeed, a limited number of studies have been conducted on the plant's reproductive biology and seed ecology, which hinders the development of effective conservation strategies.

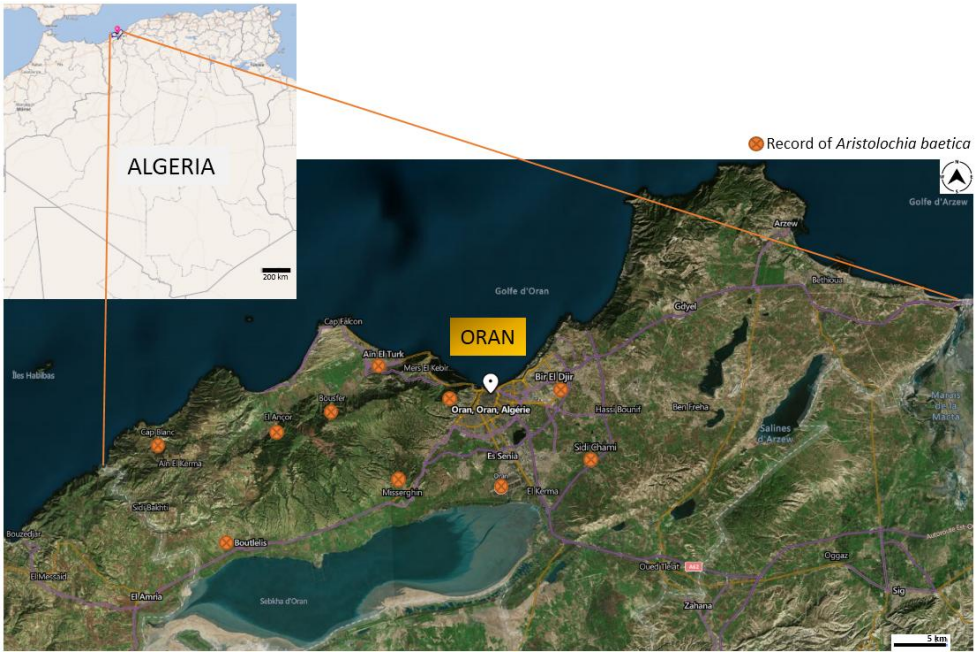


Figure 2. Records of *Aristolochia baetica* in the city of Oran (NW-Algeria)

Soil is important in the studied site as the area is primarily agricultural. Different soil types at different locations where *A. baetica* populations were recorded were classified into three types. Soil with iron sesquioxides is red or red-brown soil. Its texture is usually balanced, and their structure lumpy. The second soil type is calcareous brown type with heavier texture. The last type is black or dark brown heavy soil, characterised by a silty loam texture and often blocky structure, located on low slopes. According to Berjano et al. (2011), individuals of *A. baetica* grow best in dry coastal regions. *A. baetica* evolved in semi-arid, sub-humid, and humid bioclimate (Maire, 1961; Fennane & Ibn Tattou, 1999; Orch et al., 2013). *A. baetica* can escape the shade using its climbing properties (Maire, 1961), and is commonly found on calcareous soils, rocky slopes, near roads and in irrigated fields. It grows on rocky and sandy soils (Fennane & Ibn Tattou, 1999). *A. baetica* is generally distributed in low-middle plains and mountains at an altitude of 50-1000 m (Orch et al., 2013), Fig. 3.



Figure 3. Some sampling sites where *Aristolochia baetica* was found in Oran (NW-Algeria) during 2020-2021

In the Tessala Mountains in Sidi Bel Abbès, the results of Latreche et al. (2015) showed that flora containing *A. baetica* is rich in flora characterised by the dominance of Hemicryptophytes and Therophytes throughout the biological spectrum. The landforms are usually low, herbaceous, or shrubby. Regarding the soil, the analysis indicated that sand dominated the structure. Soil organic matter depends on the topography of the site (Galàn de Mera, 1993). According to Rix (2010), *A. baetica* thrives in well-drained, high pH garden soil, placed on a low fence in a very sheltered location to be protected from frost.

Ecology and reproductive biology

The main soil types formed by surface geological structures (rocksource) where *A. baetica* was found are characterized by heavy and poorly developed soils with mid-slope, down slope and steep slopes, and the general erosion phenomenon is relatively strong (personal observation, 2020-2021). *A. baetica* is a plant species that is adapted to a specific ecological niche. It is a perennial herbaceous vine that prefers rocky, calcareous soils and is often found in scrublands, oak forests, and other similar habitats. All areas, whether natural or productive, are relatively threatened by erosion. Reddish-brown and lime-brown soils are affected by diffuse and linear runoff (Benyahia et al., 2001).

The flowering season of *A. baetica* is very long, starting from October to November and ending in May (De Groot et al., 2006; Berjano et al., 2009). The flowers of *A. baetica* are pollinated primarily by small flies mainly belonging to the families Drosophilidae and Phoridae. However, these flies appear to have limited flight aptitude. The flower acts like a trap, attracting flies first by its smell and then by its brown color. Downward hairs guide flies into the traps where they are held until anther detachment (Berjano et al., 2009).

According to the survey by Berjano et al. (2011), fruits of *A. baetica* may take up to 8 months for autumn-starting fruit to ripen and 3 months for spring-starting fruit. However, all fruits, regardless of the fruiting date, will reach full size about two months after the flowering ends and remain immature until summer.

Drought and summer temperatures are probably the cause of fruit ripening. Summer is the best time for seed dispersal of *A. baetica*, as the seeds are dispersed by ants. *A. baetica* seeds have two types of dormancy, embryonic and integumentary dormancy (Hakemi et al., 2020). Extended seed germination period and seed morphophysiological characteristics are adaptively important for species conservation and survival (Nakonechnaya et al., 2018).

Medicinal properties

Many *Aristolochia* species are used to treat various diseases, and several phytochemical studies have been performed on many mainly tropical *Aristolochia* species (WHO, 2002). *A. baetica* is a wild species that has long been used in Morocco for various diseases, including roots prepared with water for cancer and digestive disorders (Rhattas et al., 2016). The roots are also used to treat heart palpitations, constipation, and intestinal disorders. The leaves are used for their analgesic and antipyretic effects and also used to treat miscarriages (González-Coloma et al., 2005). The floral part is used to treat rheumatism. The whole plant of *A. baetica* is boiled in water and used as an anti-inflammatory and antiseptic in many regions from Morocco (Ouarghidi et al., 2013). *A. baetica* has been used in herbal medicine throughout the world as a remedy and in childbirth by stimulating uterine contractions (Bellakhdar, 1997). The roots are used as an antidote for snake bites and scorpion stings. Additionally, it has been used to treat malaria and colic, and as a powerful insect repellant (Heinrich et al., 2009).

Qualitative and quantitative analyses of the roots revealed the presence of alkaloids, tannins, polyphenols, saponins, and flavonoids (Bourhia et al., 2019). The phytochemistry, antioxidant activity, antiproliferative effect, and acute toxicity of a methanolic extract of the roots of *A. baetica* was explored by Bourhia et al. (2019), who reported that these plants are widely used in folk medicine to treat numerous diseases, including rheumatism, a disease caused by hyperuricemia. These authors noted that free radical scavenging as well as cytotoxicity were observed in cancer cell lines and that no signs of toxicity or death were observed in an *in vivo* study of mice given 2000 mg/kg of *A. baetica* extract orally.

In agriculture, methanolic extracts of *A. baetica* have been used as insecticides for the control of *Tribetina chinensis* (Coleoptera: Pleurocaridae) (Jbilou et al., 2006).

CONCLUSION

In the Oran region (Algeria), *A. baetica* is a rare species. The population size was very small in the number of individuals (<5 ind.). These traits make this species a suitable model, especially for studying its germination and regeneration in the wild to assess conservation issues for rare species. The discovery of *A. baetica* further enriched Algeria's natural vascular flora. Several batches of seeds have been collected to increase the germination rate of this species. Our research on *Aristolochia baetica* will continue with an investigation into seed germination, by applying multiple testing methods. Additionally, we will conduct an examination of the plant's anatomy and ecology to gain a better understanding of its characteristics and behavior. To ensure the survival and growth of this species, it may be essential to implement conservation measures. These measures could include actions aimed at preservation and increasing the population size of the species. It is important to note that plant medicinal properties must be monitored and used with caution. While many plants have medicinal properties that can be used to treat various health conditions, it is important to remember that not all plants are safe for consumption and some can even be toxic.

***Acknowledgements*:** The authors are very grateful to Dr. Errol Vela (University of Montpellier in conjunction with CIRAD, International Agricultural Research Centre for development, Paris, France) for his assistance in confirming the identification of *Aristolochia baetica.*

Conflict of interest: The authors declare that they have no conflict of interest.

REFERENCES

Bellakhdar J. (1997): La pharmacopée marocaine, traditionnelle. Médecine arabe ancienne et savoir populaire - Ed. Le Fennec. Casablanca, Maroc, 129-533.

Benammar A. (2016): Climat d'Oran. Available at: https://www.guideoran.com/guide-pratique/information-utiles-sur-oran/79-climat-d-oran.html (accessed on 28.12.2022.)

Benyahia M., Benabdali K., Moueddene K. (2001): Géologie pédologie et système de production dans les monts de Tessala (Sidi Bel Abbes). *Revue Science de la Nature et de l'Environnement: Ecosystème*, 1(1) : 70-75.

Berjano, R., Arista, M., Ortiz, P.L., Talavera, S. (2011): Persistently low fruiting success in the Mediterranean pipevine *Aristolochia baetica* (Aristolochiaceae): a multi-yearstudy. *Plant Biology*, 13: 109-117.

Berjano R., Ortiz P.L., Arista M., Talavera S. (2009): Pollinators, flowering phenology and floral longevity in two Mediterranean *Aristolochia* species, with a review of flower visitor records for the genus. *Plant Biology*, 11(1): 6-16.

Bourhia M., Haj Said A.A., Chaanoun A., El Gueddari F., Naamane A., Benbacer L., Khlil N. (2019): Phytochemical screening and toxicological study of *Aristolochia baetica* Linn roots: histopathological and biochemical evidence. *Journal of Toxicology*, 2019: 1-7.

Christodoulakis N.S., Kotsironi K., Tsafantakis N., Stefi A.L., Fokialakis, N. (2019): Leaf structure and phytochemical analysis of *Aristolochia baetica*, a traditionally used pharmaceutical plant. *Journal of Herbs, Spices & Medicinal Plants*, 25(2) : 88-103.

Colas B. (1997): *Centaurea corymbosa*: Chronique d'une extinction annoncée. Thèse de Doctorat. Université de Tours, France, p. 179.

Cosyns J.P. (2003): Aristolochic acid and 'Chinese herbs nephropathy'. *Drug safety*, 26(1): 33-48.

De Groot H., Wanke S., Neinhuis C. (2006): Revision of the genus *Aristolochia* (Aristolochiaceae) in Africa, Madagascar and adjacent islands. *Botanical Journal of the Linnean Society*, 151(2) : 219-238.

Depierreux, M., Van Damme, B., Vanden Houte, K., Vanherweghem, J.L., & Abramowicz, D. (1994): Pathologic aspects of a newly described nephropathy related to the prolonged use of Chinese herbs. *American Journal of Kidney Diseases*, 24(2): 172-180.

Dobignard A. & Chatelain C. (2010-2013): Index synonymique de la flore d'Afrique du Nord. Genève.

Fennane M. & Ibn Tattou M. (1999): Observations sur la flore vasculaire endémique, rare ou menacée du Maroc. *FL Medil*, 9: 113-124.

Galàn de Mera A. (1993): Flora y vegetación de los términos municipales de Alcalá de los Gazules y Medina Sidonia (Cádiz, España). Thesis doc. de la Universidad Complutense de Madrid, Facultad de Farmacia, España, p. 534.

González-Coloma A., Reina M., Sánchez-Moreiras A.M., Rivas-Gonzalo, J.C. (2005): Analysis of the essential oils from the leaves of *Aristolochia baetica* and *A. pistolochiaefolia*. *Journal of Essential Oil Research*, 17(2), 139-141.

Hakemi Z., Mehdadi Z., Cherifi K., Latreche A., Aisset A. (2018): Habitat characterization of *Aristolochia baetica* L. in Tessala Mount, Western Algeria. *Biodiversitas Journal of Biological Diversity*, 19(5): 1632-1641.

Hakemi Z., Mehdadi Z., El Mestari O., Dellaoui H. (2020): Study of the germinative behaviour of *Aristolochia baetica* L. seeds of Tessala mount (west of Algeria). *Journal of Stress Physiology & Biochemistry*, 16(1): 39-49.

Hanaoui S.E. & Bouazza M. (2012): The current state of the plant diversity in the Tlemcen region (Northwest Algeria). *Open Journal of Ecology*, 2(4): 244-255.

Heinrich M., Chan, J., Wanke S., Neinhuis C., Simmonds M.S. (2009): Local uses of *Aristolochia* species and content of nephrotoxic aristolochic acid 1 and 2 - A global assessment based on bibliographic sources. *Journal of Ethnopharmacology*, 125(1): 108-144.

Jbilou R., Ennabili A., Sayah F. (2006): Insecticidal activity of four medicinal plant extracts against *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *African Journal of Biotechnology*, 5(10): 937-940.

Latreche A., Mekhfi N., Mehdadi Z. (2015): Ecological study of natural habitat of endemic specie *Aristolochia baetica* L. in Tessala mountains (western Algeria). International Conference on Agricultural, *Ecological and Medical Sciences* (AEMS-2015) April 7-8, 2015 Phuket (Thailand).

Maire R. (1961): Flore de l'Afrique du Nord, 7 : 220-224.

Nakonechnaya O.V., Nesterova S.V., Voronkova N.M. (2018): Germination of *Aristolochia* seeds (Aristolochiaceae). *Moscow University Biological Sciences Bulletin*, 73(4): 209-216.

Nortier J.L., Martinez M.C.M., Schmeiser H.H., Arlt V.M., Bieler C.A., Petein M., Depierreux M.F., De Pauw L., Abramowicz, D., Vereerstraeten P., Vanherweghem J.L. (2000): Urothelial carcinoma associated with the use of a Chinese herb (*Aristolochia fangchi*). *New England Journal of Medicine*, 342(23): 1686-1692.

Ohi-Toma T., Sugawara T., Murata H., Wanke S., Neinhuis C., Murata J. (2006): Molecular phylogeny of *Aristolochia sensu lato* (Aristolochiaceae) based on sequences of rbcL, matK, and phyA genes, with special reference to differentiation of chromosome numbers. *Systematic Botany*, 31(3): 481-492.

Orch H., Douira A., Zidane L. (2013): Étude ethnobotanique des plantes médicinales utilisées dans le traitement du diabète, et des maladies cardiaques dans la région d'Izarène (Nord du Maroc). *Journal of Applied Biosciences*, 86: 7940-7956.

Ouarghidi A., Gary J.M., Abbad A. (2013): Botanical identification and ethno-medicinal uses of some underground part of medicinal plants collected and traded in Marrakech region. *Journal of Medicinal Plants Research*, 7(29): 2165-2169.

Quézel P. & Santa S. (1962): Nouvelle flore de l'Algérie et des régions désertiques méridionales. C.N.R.S. Paris. Tome I (1962), p. 1170.

Rhattas B., Touzani, A., Taleb, M.S., Ainassou, R., Benhoussa, A., Ibijbijen, J., Msanda, F. (2016): *Aristolochia baetica* L. populations in north-western Algeria: genetic diversity and conservation implications. *Acta Botanica Gallica*, 163(3): 225-233.

Rivas-Martínez S., Díaz T.E., Fernández-González F., Izco J., Loidi J., Lousã M., Penas A. (2002): Vascular plant communities of Spain and Portugal. Addenda to the syntaxonomical checklist of 2001. *Itinera Geobotanica*, 15(1-2): 433-922.

Rix M. (2010): *Aristolochia baetica*: Aristolochiaceae. *Curtis's Botanical Magazine*, 27(2): 117-122.

Schemske D.W., Husband B.C., Ruckelshaus M.H., Goodwillie C., Parker, I.M., Bishop J.G. (1994): Evaluating approaches to the conservation of rare and endangered plants. *Ecology*, 75(3): 585-606.

Takhtajan A. (2009): Flowering Plants. Second Edition. Springer

Wanke S., Mendoza C.G., Mueller S., Guillén A.P., Neinhuis C., Lemmon, A.R., Moriarty-Lemmon E., Samain M. S. (2017): Recalcitrant deep and shallow nodes in *Aristolochia* (Aristolochiaceae) illuminated using anchored hybrid enrichment. *Molecular Phylogenetics and Evolution*, 117: 111-123.

WHO (2002): World Health Organization. WHO monographs on selected medicinal plants (Vol. 2).