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Aristolochia adalica (Aristolochiaceae), a new species from Anatolia, Turkey

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Aristolochia adalica Tosunoglu & Malyer *sp. nova* (Aristolochiaceae) is described and illustrated from southwest Anatolia, Turkey. It is morphologically close to the East Aegean endemic *A. hirta*; however, these species differ in some important characteristics, such as the perianth and leaf shapes and sizes, indumentum of the limb, and seed and pollen morphology. The taxonomic relationships are discussed.

Introduction

The genus *Aristolochia* has a limited distribution in the temperate areas of the northern hemisphere and is represented by up to 550 species worldwide. In Europe, *Aristolochia* has 20 species (Ball *et al*. 1993), which have mostly been reviewed by Nardi (1984, 1991, 1997). The 25 Near East *Aristolochia* species were described in detail by Davis and Khan (1961), and later 23 species were reported from Turkey and the East Aegean Islands (Davis 1982).

Aristolochia is quite diverse in the Mediterranean basin, especially in southern and western Anatolia of Turkey. Today, 27 species are known from Turkey, 15 of them being endemic and largely described after the 1960s (Davis & Khan 1964, Davis & Khan 1977, Davis 1980, Tan & Sorger 1987, Nardi 1993, Malyer & Erken 1997, Tosunoglu & Malyer 2012a). Anatolia is a unique locality in the Mediterranean basin where natural hybrids of *Aristolochia* species occur [*A.* × *guneri* and *A.* × *gypsicola* (Tosunoglu & Malyer 2012b)], as well as a possible hybrid between *A. paecilantha* and *A. bottae* (Davis & Khan 1961, Davis 1982).

Material and methods

The material reported here was collected from ten localities in southwest Anatolia, especially from Antalya. The collected specimens were dried and flowers maintained without crushing in a 70% ethanol: glycerin mix (5%) to preserve the flower shape for later study. The leaf and flower measurements were performed on completely developed leaves and flowers, and the limb measurements were performed on fresh and alcohol-preserved samples. The values are given as min–(mean)–max. The specimens were checked using the literature of the East Mediterranean species (Davis & Khan 1961, Davis 1982, Nardi 1991, 1997). The taxon described here and the morphologically close *A. hirta* were studied from specimens collected by us in the field and from herbarium samples deposited in BULU, ESSE, ANK, GAZI, E, and B.

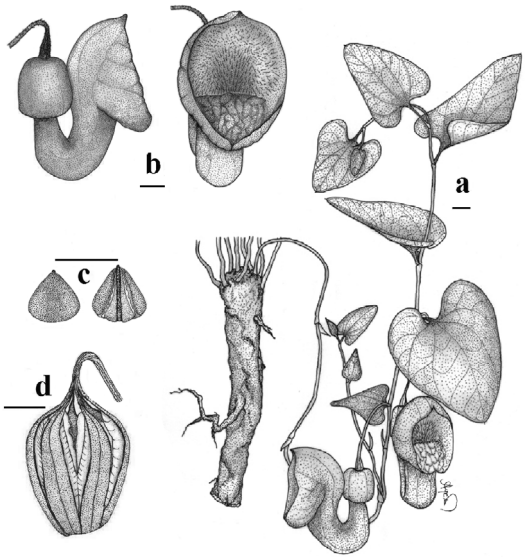

Fig. 1. *Aristolochia adalica* (from the holotype) — **a**: Habit. — **b**: Flower. — **c**: Seed. — **d**: Fruit. Scale bars: 1 cm.

The specimens selected for pollen and seed surface analyses were as follows: *A. hirta*: B1-Aydın: Dilek Peninsula National Park, Karacasu beach, *A. Tosunoglu & H. Mal*yer *34456* (BULU); *A. adalica*: paratype *A. Tosunoglu & H. Malyer 34441* (BULU).

The pollen grains were examined by light microscopy and measured from non-acetolysed samples prepared according to the method of Wodehouse (1935). The long axis, short axis, exine thickness and intine thickness were measured from at least 50 samples of pollen grains. The pollen-grain dimensions are presented as means ± SDs. All of the measurements were performed using CARNOY 2.0 (Schols *et al*. 2002). For the SEM analysis, pollen grains were transferred directly to a stub with double-sided tape and images were obtained using a Carl Zeiss Evo-40 scanning electron microscope and operated at 20 kW. In general, the pollen terminology follows Faegri and Iversen (1975) and Punt *et al*. (2007).

Mature seeds were mounted on SEM stubs using a double-sided tape and coated with 40–50 nm gold in a BAL-TEC-SCD 005 coater, and the surface patterns of seeds were obtained using the same electron microscope. The terminology of seed characters used in this work follows Stearn (1985), Corner (1976) and Adams *et al*. (2005).

Results

Aristolochia adalica Tosunoglu & Malyer, *sp. nova* (Fig. 1)

HOLOTYPE: Turkey. C2 Antalya: Kumluca: Rhodiapolis Ancient Site, 36°23´34´´N, 30°15´50´´E, alt. 146 m. a.s.l., 28 Mar. 2008 *A. Tosunoglu & H. Malyer 34444* (BULU). — PARATYPE: Turkey. C2 Antalya: Olympos Ancient Site, 36°23´40´´N, 30°28´17´´E, alt. 25 m. a.s.l., 27 Mar. 2008 *A. Tosunoglu & H. Malyer 34441* (BULU).

ETYMOLOGY: The epithet comes from the ancient name (Adalia) of the distribution area.

Perennial herb. Rootstock cylindrical, 10–25 mm diameter. Annual stems 15–55 × 0.2–0.3 cm, procumbent, mostly branched in underground parts. Leaves ovate, auriculate, 4.0–(6.5)–11.5 × 3.5–(6.4)–10.5 cm; length/width ratio 0.8–(1.0)–1.2; mucronulate, cordate; auricles 1.0–(1.6)–2.5 × 1.6–(2.6)–4.1 cm; sinus 1.0–(1.6)–2.5 × 1.3–(2.0)–3.0 cm; minutely hirsute on both sides; margins ± revolute, ciliate or papillose. Petiole 0.9–(2.0)–4.2 cm, hispid. Flowers solitary and axillary. Pedicels (including ovary) 2.4–(5.0)–7.5 cm, hirsute, densely hairy towards ovary. Perianth large, 11.7–(13.8)–18.5 cm long, brownish outside, minutely hirsute; utricle 1.7–(2.2)–2.4 × 1.4–(1.7)–2.5 cm, oblong ovoid, length/width ratio 1–(1.3)–1.6, plumose inside; tube strongly U-curved and 2.4–(8.8)–11.5 cm long, narrow at base 0.6–(0.9)–1.5 cm diam., abruptly widening at neck 1.5–(1.7)–2.1 cm diam., not dilated through throat 1.5–(1.8)–2.5 cm diam.; limb 3.9–(4.3)–5.4 × 3.0–(3.6)–5.0 cm, quite concave at top and margins, obtuse, retuse or mucronulate, maroon, rarely with yellowish-green spots inside, hispid white long hairy from throat to upper limb, ± auriculate, auricles and auricle margins glabrous. Gynostemium 0.5 × 0.6 cm. Septicidal capsule oblong-ovoid, 3.4 × 2.5 cm, dehiscing from top. Seeds (Fig. 2a and b) obovate and flattened, 6.0–(6.8)–7.0 × 6.0–(6.6)–7.5 mm, length/width ratio 0.93–(1.03)–1.17, yellowish-brown, surface verrucose and reticulate. Pollen grains (Fig. 3a and b) inaperturate, microareolate; long axis 47.28 ± 4.12 μm, short axis

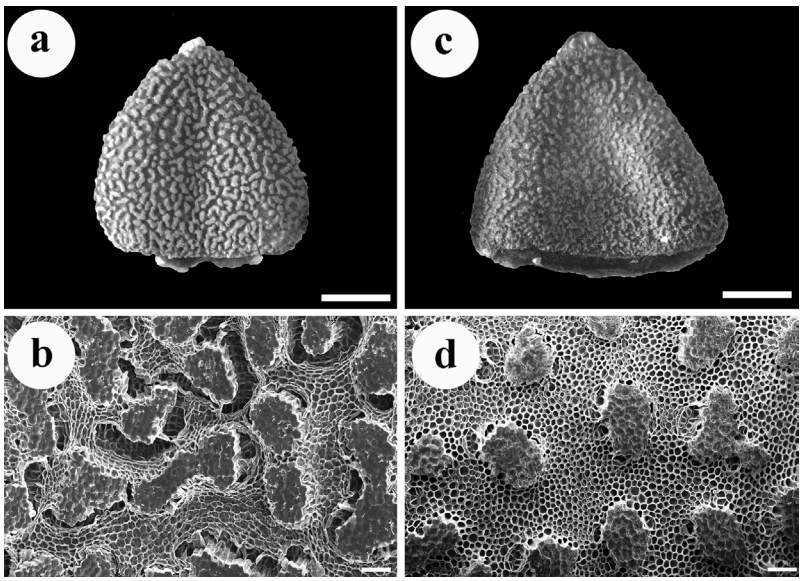

Fig. 2. Seed and seed surface photographs (SEM) of *Aristolochia adalica* (**a** and **b**) and *A. hirta* (**c** and **d**). Scale bars: 2 mm for **a** and **c**, 100 μm for **b** and **d**.

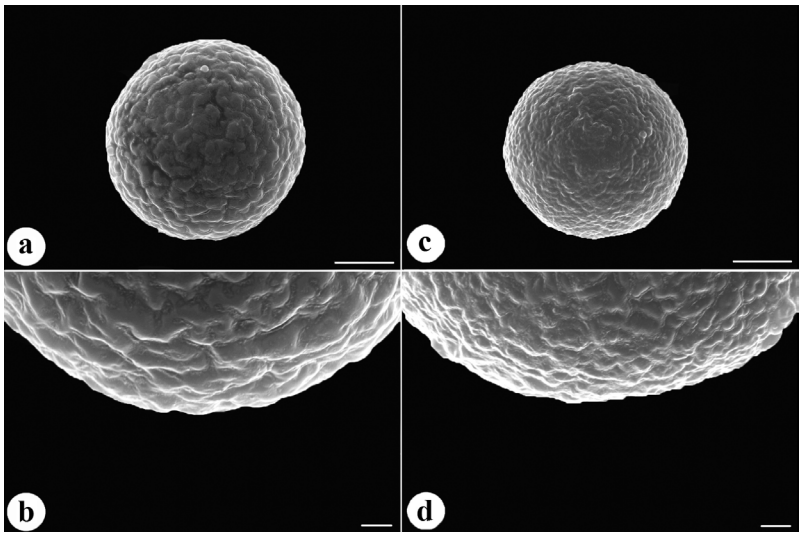

Fig. 3. SEM photographs of *Aristolochia adalica* (**a** and **b**) and *A. hirta* (**c** and **d**) pollen grains. Scale bars: 10 μm for **a** and **c**, 2 μm for **b** and **d**.

46.42 ± 4.14 μm, long-to-short axis ratio 1.02, prolate-spheroid; exine 1.26 ± 0.24 μm thick, intine 1.30 ± 0.25 μm thick, exine-to-intine ratio 0.97. Flowering in March–April, fruiting in June.

Aristolochia adalica is found at archaeological sites and in conservation areas. It prefers south-facing slopes towards the sea, and thrives especially around natural springs, sometimes under the shade of *Pinus brutia,* often together with *Asphodelus aestivus* at an altitude of 0–600 m a.s.l. It is endemic to southwestern Anatolia (Fig. 4) and represents a Mediterranean flora element.

Identification of dried *Aristolochia* specimens, especially of the east Mediterranean taxa, is difficult due to the loss of the flowers' colour and three dimensional shape. Some basic characters used in identification keys, such as the existence of biauriculate or exauriculate limbs, vanish upon pressing and drying or tend to change with maturity of the flower. The combination of such non-stable characters and large variation within the species creates problems for identification. On the other hand, some extensive descriptions

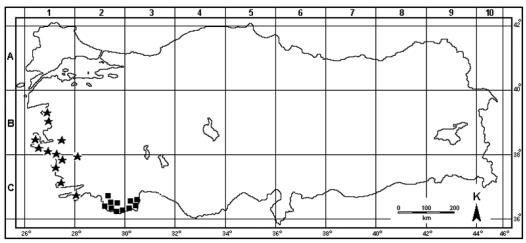

Fig. 4. Distribution map of *Aristolochia hirta* (stars) and *A. adalica* (squares).

in the *Flora of Turkey and East Aegean Islands* (Davis 1982) and *Flora Hellenica* (Nardi 1997) of some species, such as *A. hirta,* may lead to incorrect identifications. This necessitates studying living specimens in the field. Due to the lack of field studies on living populations many taxonomic questions and problems remain.

The so-called "*Aristolochia hirta* complex" has been treated by different authors (e.g. Davis & Khan 1961, Davis 1982, Nardi 1991) and their taxonomic concepts stemmed mostly from the north Aegean and Greek populations of *A. hirta* and their similarities with *A. bodamae*. The species described here has been completely overlooked, except for a small note in the *A. hirta* description by Davis (1982), which refers to specimens collected from Antalya-Adrasan and Island Kostellorizo (16638 ATH; E!), stating that their leaf shape resembles that of *A. pontica*.

On the other hand, *A. adalica* was probably overlooked before because of the extensive morphological descriptions by Davis and Khan (1961) and Davis (1982), which are still the most comprehensive sources on Near East and Turkish *Aristolochia*. In those descriptions, the concept of *A. hirta* encompasses nearly all Mediterranean species with large flowers, U-shaped tubes and ovate to deltoid leaves. The authors emphasized particularly an easy confusion among *A. hirta*, *A. bodamae*, *A. pontica* and *A. paecilantha* (Davis & Khan 1961, Davis 1982, Nardi 1991). This confusion is probably the result of a lack of well-preserved material.

Aristolochia hirta is morphologically closest to *A. adalica*, but differs from it sharply by its flower, leaf shape and hair composition etc. (Table 1).

Seed morphology. There are very few published reports on the seed morphology of *Aristolochia*. Corner (1976) described the seeds as being typically flattened, sometimes winged, and rather small to medium-sized. The seeds of *A. clematitis* were reported as triangular and flat (Mohana Rao 1989). The seeds are ovate in *A. adalica*, while those of *A. hirta* are triangular (Fig. 2), and also larger (Table 1). In general, the surface of *Aristolochia* seeds is reported as being either smooth or uneven, with the outer epidermis primarily composed of uniformly thick- or thin-walled cells, or as thick-walled cells scattered throughout (Corner 1976, Adams *et al.* 2005). The seed surfaces of *A. adalica* and *A. hirta* are reticulate, and verrucate ornamentation is present on the reticulate ornamentation. In addition the seed surface of *A. adalica* has elongated shallow depressions around the warts, unlike in *A. hirta* (Fig. 2).

Pollen morphology. There are not many studies on the pollen morphology of *Aristolochia*, partly due to the limited pollen production (Mulder 2003). The pollen grains in the Aristolochiaceae are eurypalynous (Nair 1970). In *A. adalica* and *A hirta* the pollen grains are symmetrical and isopolar, prolate-sphaeroid and inaperturate. The pollen grains of *A. adalica* are bigger than those of *A. hirta* (Fig. 3 and Table 1) and the exine thickness and exine/intine ratio are also different (Table 1). Different pollen ornamentations have been reported for the Aristolochiaceae: verrucate (Heusser 1971, Roubik & Moreno 1991), verrucate-areolate (El Ghazali 1993), scabrate-reticulate (Huang 1972), rugulate-fossulate (Perveen & Qaiser 2008) and psilate (Bertsch 1942). We found the pollen ornamentation of *A. adalica* to be microareolate, while that of *A. hirta* is sparsely granulate-rugulate (Fig. 3).

Representative specimens examined: — ***Aristolochia adalica***: **C2**: *P.H. Davis & O. Polunin 25518* (E); *A. Tosunoğlu & H. Malyer 34452* (BULU); *E. Stamatiadou 16638* (ATH; E); *A. & T. Baytop 39060*, *39037* (ISTE); *A. Tosunoglu & H. Malyer 34445*, *34446*, *34447*, *34448*, *34449* (BULU). **C3**: *H. Peşmen & A. Güner 4260* (HUB; E); *A. & T. Baytop 44183* (ISTE); *H. Malyer & M. Öğütveren 6311* (ESSE); *A. Tosunoglu & H. Malyer 34439*, *34440*, *34442*, *34443, 34450, 34451, 34453, 34454* (BULU); *H. Mahfoud 31* (DR). — ***Aristolochia hirta***: **B1**: *P.H. Davis 40446* (E); *J.R. Edmonson & M.A.S. McClintock 2179* (E); *Sven & Britt Snogerup 6808* (B); *Dudley 34902* (E); *A. Tosunoglu & H. Malyer 34457* (BULU); *A. Tosunoglu & H. Malyer 34458*

Table 1. Comparison of morphological characters of *Aristolochia adalica* (n = 58) and *A. hirta* (n = 51). Pollen dimensions are means ± SDs, other values are min–(mean)–max.

		Aristolochia adalica	*A. hirta*
Leaf	Shape (cm)	ovate	oblong ovate–oblong deltoid
	Length (cm)	4.0–(6.5)–11.5	4.7–(7.3)–10.2
	Width (cm)	3.5–(6.4)–10.5	3.2–(5.3)–7.5
	Length/width	0.8–(1.0)–1.2	1.1–(1.5)–2.2
Utricle	Length (cm)	1.7–(2.2)–2.4	1.0–(1.4)–1.6
	Width (cm)	1.4–(1.7)–2.5	0.7–(1.0)–1.3
Tube width	At base (cm)	0.6–(0.9)–1.5	0.4–(0.5)–0.6
	At throat (cm)	1.5–(1.8)–2.5	0.8–(1.1)–1.6
Perianth	Length (cm)	11.7–(13.8)–18.5	7.1–(9.5)–11.4
Limb	Indumentum	glabrous below side of limb;	densely short hirsute in entire limb; sparsely long hirsute just through throat
	Auricle margin	glabrous	papillose/ciliate
Seed ($n \geq 30$)	Shape	ovate	triangular
	Length (mm)	6.0–(6.8)–7.0	7.4–(8.3)–9.1
	Width (mm)	6.0–(6.6)–7.5	6.6–(7.2)–8.0
Pollen ($n \geq 50$)	Long axis (μm)	47.277 ± 4.121	36.837 ± 3.821
	Short axis (μm)	46.418± 4.139	35.350 ± 3.629
	Long-to-short axis ratio	1.02	1.04
	Exine (μm)	1.263 ± 0.238	1.731 ± 0.257
	Intine (μm)	1.296 ± 0.252	1.413± 0.330
	Exine-to-intine ratio	0.97	1.23

(BULU); *A. Tosunoglu & H. Malyer 34459* (BULU); *A. Tosunoglu & H. Malyer 34460* (BULU); *A. Tosunoglu & H. Malyer 34461* (BULU); *A. Tosunoğlu & H. Malyer 34466* (BULU). **C1**: *F. Ertuğ 578* (GAZI); *D. Coll & U. Rückbrodt* (E); *P.H. Davis 41481* (E); *A. Tosunoğlu & H. Malyer 34455*, *34456*, *34462*, *34465* (BULU). **C2**: *M. Koyuncu & Tuna Ekim 10611* (AEF); *P.H. Davis 41271* (E); *A. Tosunoglu & H. Malyer 34463*, *34464* (BULU).

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