

## *Astragalus kamarinensis* (Fabaceae), a new species from Sicily

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Received 20 Oct. 2011, final version received 6 Nov. 2012, accepted 13 Nov. 2012

Brullo, C., Brullo, S., Giusso del Galdo, G., Minissale, P. & Sciandrello, S. 2013: *Astragalus kamarinensis* (Fabaceae), a new species from Sicily. — *Ann. Bot. Fennici* 50: 61–67.

*Astragalus kamarinensis* C. Brullo, Brullo, Giusso, Miniss. & Sciandr. *sp. nova* (Fabaceae) is described and illustrated from Sicily. It grows exclusively on sandy soils, near the ruins of Kamarina, located in the southern part of Sicily. Morphologically, it shows close relationships with *A. stella*, *A. raphaelis* and *A. tribuloides*, all belonging to *A. sect. Sesamei*. Several morphological features, chiefly regarding the flowers, legumes and seeds, as well as the micromorphology of the pod indumentum and seed coat, allow to well distinguish this species from the other taxa in the section. A phenetic analysis based on the morphological characters supports our taxonomic conclusions.

According to literature (e.g. Maassoumi 1998), *Astragalus* is one of the largest genera of angiosperms comprising about 3000 species hitherto known in the world. This genus is very rich in endemics, and one of its most important speciation centres is localized in Turkey and Irano-Turanian territories (Polhill 1981). Recently Podlech (2008) recorded for the whole Europe (excluding the former Soviet Union) about 120 species, which are mostly annual.

During field investigations carried out in Sicily, an interesting population of *Astragalus* was found in a small area of the southern sector of the island. It grew on abandoned fields characterized by poor sandy soils. Morphological analyses revealed that this population clearly belongs to *A. sect. Sesamei*, which includes 24 species mainly occurring in SW Asia and N Africa (Gazer 1993, Talavera Lozano *et al.* 2010,

Brullo *et al.* 2011). As the other taxa of the *A. sect. Sesamei*, also the Sicilian population consists of annual plants morphologically characterized by white basifixed hairs, usually mixed with black ones at least in the calyx, stipules adnate at the base of the petiole, capitate axillary inflorescences, and pods more or less dilated at the base. As concerns its relationships with other taxa in the same section, this population appears to be quite similar to *A. stella*, mainly in having long pedunculate inflorescences and pods arranged in a star-like formation, while in the flowers with small corolla, slightly longer than calyx, it resembles *A. raphaelis*. Several morphological features, mainly regarding the habit, stipules, leaves, inflorescence, flowers, pods and seeds, however allow to distinguish this population from the other known taxa of the *sect. Sesamei*. Therefore, it is here described as a species new to science.



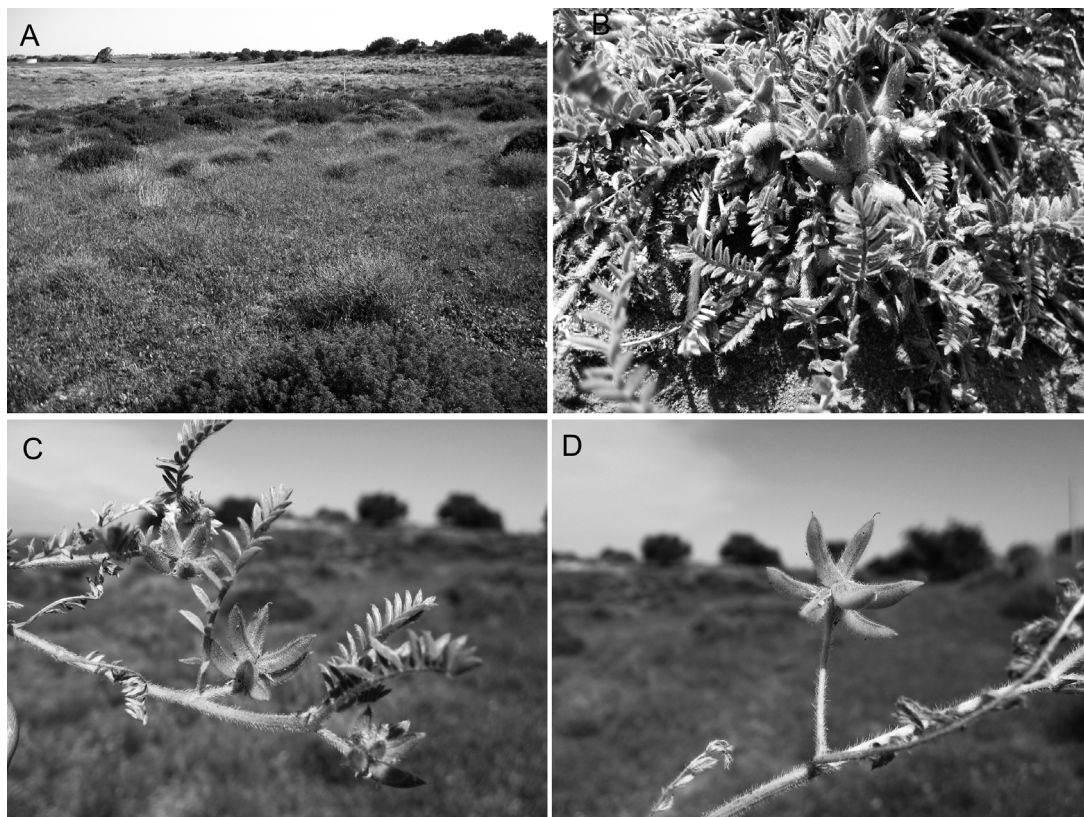
**Fig. 1.** *Astragalus kamarinensis* (from the holotype). — **A:** Habit. — **B:** Leaf. — **C:** Fructiferous inflorescence. — **D:** Bract. — **E:** Flower. — **F:** Open calyx (outer view). — **G:** Open calyx (inner view). — **H:** Standard. — **I:** Open keel. — **J:** Keel (lateral view). — **K:** Wings. — **L:** Stamens. — **M:** Pistil. — **N:** Stigma. — **O:** Pods (different view). — **P:** Seeds.

***Astragalus kamarinensis*** C. Brullo, Brullo, Giusso, Miniss. & Sciandr., *sp. nova* (Figs. 1 and 2B–D)

**Types:** Italy. Sicily, C.da Salina, presso Kamarina (Ragusa), su suoli sabbiosi, 24 April 2011 *S. Sciandrello s.n.* (holotype CAT; isotypes CAT, FI). — **Paratypes:** Italy. Sicily, C.da Salina, presso Kamarina (Ragusa), su suoli sabbiosi, 22 April 2010 *S. Sciandrello & S. D'Agostino s.n.* (CAT); C.da Salina, presso Kamarina (Ragusa), su suoli sabbiosi, 19 April 2011 *S. Sciandrello & P. Minissale s.n.* (CAT).

Annual plant, branched at base, hairy. Stems leafy, 8–15 cm tall, prostrate to ascending, densely covered by appressed to subpatent white hairs, 0.5–1 mm long. Stipules membranaceous at base and herbaceous in upper part, lanceolate-

ovate, acuminate, 2–3.5 mm long, adnate to petiole, covered with white subpatent hairs. Leaves petiolate, imparipinnate, 1.5–7 cm long; rachis covered with white hairs. Leaflets green, 6–12 paired, 2–7 × 1–2 mm, elliptical, with appressed or sub-appressed hairs on both sides, obtuse at apex. Inflorescence with a peduncle 5–12 mm long, hairy like stem, with 6–12 flowers in a compact head. Bracts membranaceous, cordate, 1–2 mm long, acuminate, with subpatent white hairs, up to 1 mm long. Flowers sessile or subsessile. Calyx 4.5–5 mm long, tubular, covered with basifixed hairs, 0.5–0.8 mm long, white and black in teeth, usually white in tube; teeth subequal, subulate, 1.3–1.5 mm long, shorter than tube. Corolla whitish, glabrous, slightly longer



**Fig. 2.** *Astragalus kamarinensis* (from the type locality). — **A:** Habitat. — **B:** Habit. — **C:** Branch. — **D:** Fructified inflorescence.

than calyx. Standard spatulate,  $4.4\text{--}5 \times 2.2\text{--}2.5$  mm, slightly retuse and apiculate at apex. Wings  $3.5\text{--}4.2$  mm long; limb oblong,  $2\text{--}2.5 \times 0.8\text{--}1$  mm, rounded-erose at apex, with auricle  $0.3\text{--}0.4$  mm long; claw  $1.8\text{--}2$  mm long. Keel  $3\text{--}3.5$  mm long; limb obovate, obtuse at apex,  $1.4\text{--}1.5 \times 0.8$  mm; claw  $1.4\text{--}1.8$  mm long. Staminal tube straightly cut,  $2.2\text{--}2.4$  mm long, with filaments  $0.5\text{--}1$  mm long and anthers  $0.2$  mm long, rounded at apex. Ovary short pedunculate,  $2.5\text{--}3$  mm long, covered by densely appressed hairs,  $0.5\text{--}1$  mm long; style glabrous,  $0.8$  mm long; stigma globose. Pods star-like spreading, linear-lanceolate,  $7.5\text{--}8 \times 2\text{--}2.3$  mm, straw-coloured to dark grey, dilated-bigibbous at base, ending into a patent short beak,  $0.5\text{--}0.7$  mm long, deeply grooved dorsally and keeled ventrally, covered with two kinds of white hairs: short ones subappressed,  $0.1\text{--}0.2$  mm long, long ones subpatent,  $0.4\text{--}1$  mm long, sitting on a little tubercle. Seeds compressed,  $3\text{--}5$  in each loculus, quadrangular,

pale yellow,  $0.8\text{--}1.2 \times 0.8\text{--}1.2$  mm, minutely pitted, rugose.

**DISTRIBUTION AND HABITAT.** *Astragalus kamarinensis* is restricted to a small area in southern Sicily, between the town of Vittoria (Ragusa) and the ruins of Kamarina, about 3 km from the sea shore. The population has ca. 120 individuals growing on sandy soils at an altitude of 65 m a.s.l. This species is a member of a therophytic plant community characterized by several thermo-xerophilous psammophytes, such as *Erodium laciniatum*, *Echium sabulicolum*, *Ononis diffusa*, *Coronilla repanda*, *Polycarpon dyphyllum* and *Lotus halophilus*, growing together with subnitrophilous therophytes, such as *Trifolium nigrescens*, *Plantago afra*, *P. lagopus*, *Vulpia ciliata*, *Anagallis arvensis*, *Trifolium arvense*, *Lagurus ovatus*, etc. Such a phytocoenosis usually forms a mosaic with the shrubby vegetation dominated by *Ononis ramosissima*, which colonizes the inland sandy stands, chiefly in aban-



doned fields (Fig. 2A). From the biogeographical viewpoint, the sites occupied by *A. kamarinensis* fall within the Camarino-Pachinense district, belonging to the Eusician sector (Brullo *et al.* 1995). Several endemics (e.g. *Leopoldia gussonei*, *Retama raetam* subsp. *gussonei*, *Helianthemum sicanorum*, *Torilis nemoralis*, etc.) occur in this district, and most of them have a southern Mediterranean distribution (Brullo *et al.* 2007, 2011). For its rarity and due to the small number of individuals, based on the criteria adopted by IUCN (2001, 2006), *A. kamarinensis* should be classified as a threatened species within the category CR B2ab (ii, iii, v), C1.

**TAXONOMIC REMARKS.** Within *Astragalus* sect. *Sesamei*, *A. kamarinensis* is morphologically well distinguished. It shows some similarity mainly to *A. stella*, in having a long fructiferous peduncle, pods bigibbous at the base and arranged in a star-like formation, as well as a prostrate-ascending habit, with the stems densely hairy and branched at the base. The main characters that allow to distinguish these two species are listed in Table 1. Another species fairly similar to *A. kamarinensis* is *A. raphaelis*, a very rare endemic occurring in central-southern Sicily, but growing on clayey soils in the badlands (Brullo *et al.* 2011). The most relevant affinity regards the small corolla slightly exerted from the calyx, a character rather unusual for the species of this section, while for the other features these species are well differentiated (*see* Table 1).

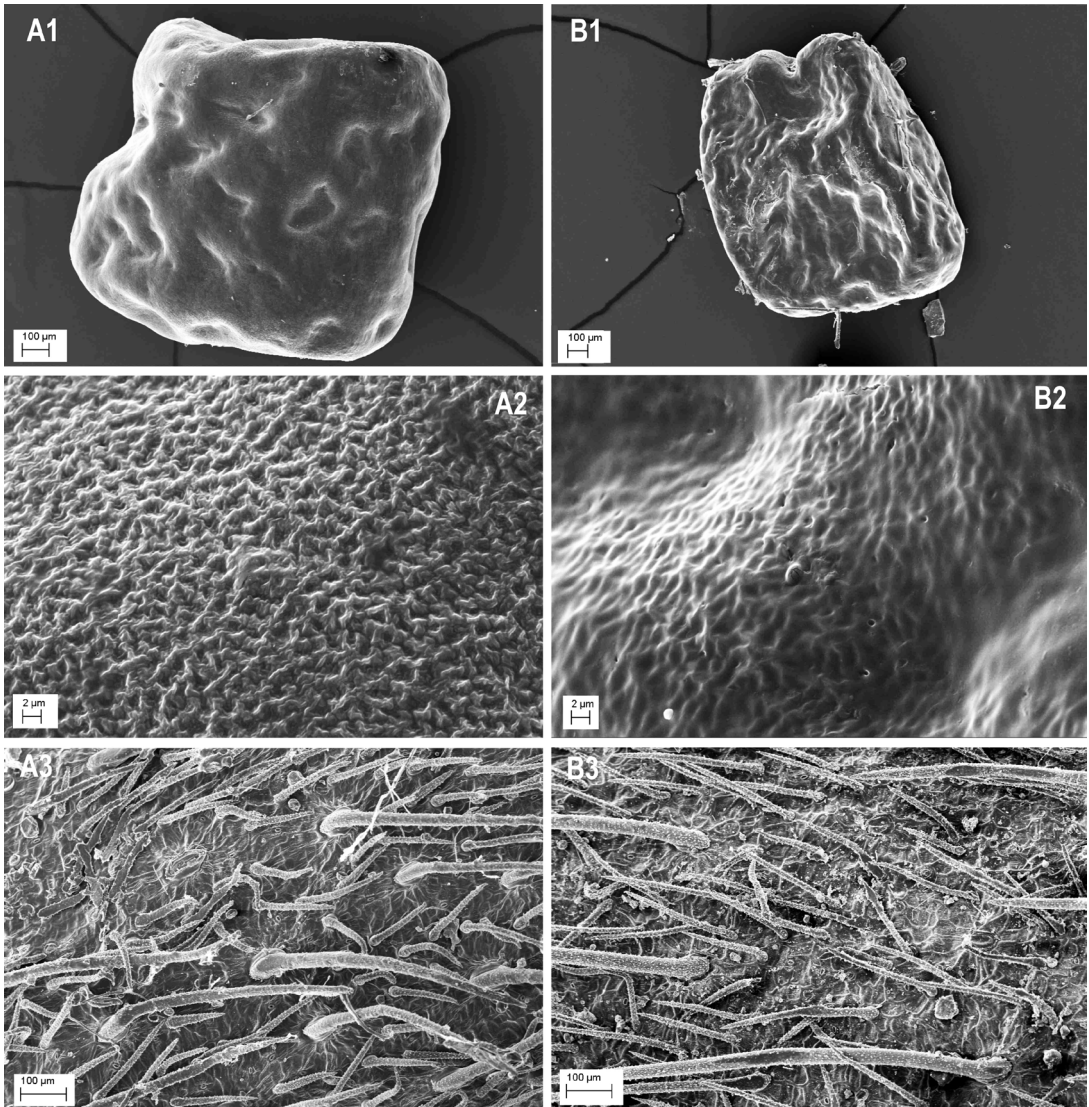
Micromorphological analyses of the seed coat and pod indumentum, carried out using the scanning electron microscope (SEM), are extremely useful and phylogenetically informative, since they have diagnostic value in *Astragalus*, as well as in other genera (Chuang & Heckard 1972, Barthlott 1981, Behnke & Barthlott 1983, Zarre 2003, Karamian & Ranjbar 2005, Vural *et al.* 2008). Seed testa is one of the most stable characters in the flowering plants, and therefore it has a remarkable diagnostic value. In fact, a comparison among *A. kamarinensis*, *A. stella* and *A. raphaelis* revealed remarkable differences in the micromorphology of the pods and seeds. In particular, *A. kamarinensis* is characterized by the seeds which are compressed, quadrangular, pale-yellow, minutely pitted, rugose, 1.5–2.0 mm long and 1.6–2.0 mm wide (Fig. 3A1), while the

testa sculptures look irregularly rugulate-interlaced (Fig. 3A2). The pod surface is loosely and slightly rugose with numerous sub-appressed, short and entire hairs, mixed to scattered long and entire hairs, obliquely inserted on a very small tubercle not surrounded by an annulus; all hairs are densely and markedly papillose (Fig. 3A3). *Astragalus raphaelis* is characterized by the pod coat being slightly rugose, with the indumentum constituted of short and long, minutely and sparsely papillose hairs, the shorter ones being several and sub-appressed, with a deep groove ending into a basal fovea, mixed to scattered long entire hairs, obliquely inserted on a prominent tubercle, and surrounded by a rugose semi-lunar annulus (Brullo *et al.* 2011: fig. 6-A3). *Astragalus stella* has pods with a markedly reticulate-rugose surface, with several appressed, short, entire and densely papillose hairs, mixed with similarly entire and densely papillose long hairs, obliquely inserted on an inconspicuous tubercle not surrounded by an annulus (Brullo *et al.* 2011: fig. 6-B3.). Furthermore, both these species are clearly different from *A. kamarinense* by the shape, size and surface of the seeds. In fact, in *A. raphaelis* the seeds are reniform, flattened, pale-brown, dark dotted, slightly rugose, 1.5–2.0 mm long and 1.6–2.0 mm wide (Brullo *et al.* 2011: fig. 6-A1). In *A. stella* the seeds are quadrangular, not compressed, brown without dots, markedly rugose, 1.0–1.5 mm long, and 1.2–1.5 mm wide (Brullo *et al.* 2011: fig. 6-B1). Relevant differences may also be observed in the cellular arrangement of the seed testa. The seed epidermis in *A. raphaelis* is formed of isodiametric cells, 5.5–6.5  $\mu$ m wide, slightly rugose-colliculate, bordered by minute, slightly branched rays (Brullo *et al.* 2011: fig. 6-A2), while *A. stella* has elongated stellate cells, 4.5–5.5  $\mu$ m wide with long prominent irregular rays (Brullo *et al.* 2011: fig. 6-B2).

In order to highlight the taxonomical relationships of *A. kamarinense* with the other species of sect. *Sesamei*, a matrix based on morphological characters was processed. The matrix published by Brullo *et al.* (2011), which included all species belonging to the section (except *A. biovulatus*), was used. *Astragalus kamarinensis* and *A. castroviejoi*, the latter recently described by Talavera Lozano *et al.* (2010) from southern

**Table 1.** Main differential characters among *Astragalus stella*, *A. raphaelis*, *A. kamarinensis* and *A. tribuloides*.

Character	<i>A. stella</i>	<i>A. raphaelis</i>	<i>A. kamarinensis</i>	<i>A. tribuloides</i>
Stem	prostrate-ascending, 4–36(50) cm long, hairs 0.3–1.9 mm	ascending-erect, 5–20 cm long, hairs 0.3–1 mm	prostrate-ascending, 8–15 cm long, hairs 0.5–1 mm	prostrate-ascending, 5–40 cm long, hairs 0.2–1.5 mm
Stipules	3–6(7) mm long, green, triangular, hairs white and black	2–3 mm long, membranaceous, lanceolate, hairs white and black	2–3.5 mm long, membranaceous, lanceolate-ovate, hairs white	2–3 mm long, membranaceous, triangular, hairs white and black
Leaf	2–7.5(9) cm long	2.5–9 cm long	1.5–7 cm long	1.5–7(9) cm long
Leaflets	obtusely, 2.5–10(16) × 1.5–3.5(5) mm	rounded, 2.5–10 × 1–3.5 mm	obtusely, 2–7 × 1–2 mm	acute, 2.5–9(15) × 0.8–2(4) mm
Inflorescence peduncle	2–11.5 cm long, hairs white and black	1.5–4 cm long, hairs white	0.5–1.2 cm long, hairs white and black	0–2.5 cm long, hairs white
Bracts	1.5–3 mm long, lanceolate, acuminate, hairs white and black	3–4.5 mm long, lanceolate, acute, hairs white and black	1–2 mm long, cordate, acuminate, hairs white	1–2(3) mm long, triangular, acute, hairs white
Calyx	4.5–7 mm long, teeth 1.2–3(3.8) mm long, shorter than tube, hairs white and black, 0.5–1.5 mm long	6.5–7.5 mm long, teeth 3–4.5 mm long, longer than tube, hairs white and black, 0.4–1.2 mm long	4.5–5 mm long, teeth 1.3–1.5 mm long, shorter than tube, hairs white and black, 0.5–0.8 mm long	3–5 mm long, teeth 1–2 mm long, shorter than tube, hairs white and black, 0.5–1.5 mm long
Corolla	yellow to violet, much longer than calyx	pale blue, slightly longer than calyx	whitish, slightly longer than calyx	whitish to pale pink, much longer than calyx
Standard	elliptical, 7–10(11) × 2–4 mm	obovate-spathulate, 5.5–6.5 × 2.5–2.7 mm	spathulate, 4–4.5 × 2.2–2.5 mm	oblong, 8–10 × 1.2–2.5 mm
Wings	6–8 mm long, limb 3–4 mm long, claw 3–4 mm long	5.5–6 mm long, limb 3.5–3.7 mm long, claw 2–2.3 mm long	3.5–4.2 mm long, limb 2–2.2 mm long, claw 1.8–2 mm long	4–6 mm long, limb 1.5–2.8 mm long, claw 2–3 mm long
Keel	5–6 mm long, acute, limb 2.5–2.7 mm long, claw 2.5–3.5 mm long	4.5–5.5 mm long, obtusely, limb 2–2.2 mm long, claw 2.2–3 mm long	3–3.5 mm long, obtusely, limb 1.4–1.5 mm long, claw 1.4–1.8 mm long	3–5 mm long, obtusely, limb 1–2.5 mm long, claw 2–2.5 mm long
Legume	lanceolate, patent, 10–15 × 2.5–3 mm, apex long, curved, bigibbous at base, indumentum appressed to patent, short hairs 0.05–0.2 mm long, long hairs 0.5–2 mm long	oblong, erect, 9–12 × 3–4 mm, apex long, curved, rounded at base, indumentum patent, short hairs 0.1–0.2 mm long, long hairs 0.5–1.3 mm long	linear-lanceolate, patent, 7.5–8 × 2–2.3 mm, apex short, curved, bigibbous at base, indumentum appressed, short hairs 0.1–0.2 mm long, long hairs 0.4–1 mm long	oblong-triangular, patent, 4–9(12) × 1.5–4 mm, apex short, straight, bigibbous at base, indumentum appressed, short hairs 0.05–0.15 mm long, long hairs 0.5–1.5 mm long
Seed	quadrangular, 4–7 per locule, 1–1.5 × 1.2–1.5 mm, brown, smooth	reniform, 3–5 per locule, 1.5–2 × 1.6–2 mm, olivaceous, rugose	quadrangular, 3–5 per locule, 0.8–1.2 × 0.8–1.2 mm, pale yellow, rugose, pitted	reniform, 4–10(12) per locule, 1–2 × 1–1.5 mm, pale brown, leviter rugose

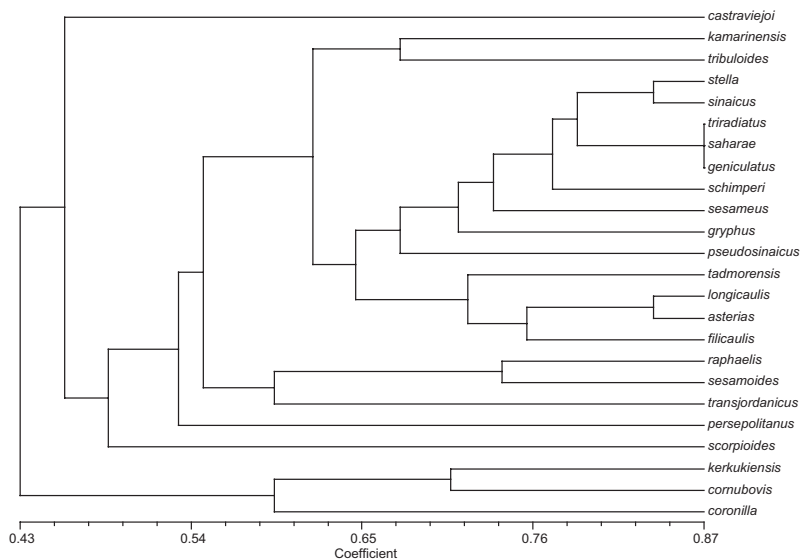


**Fig. 3.** SEM microphotographs of (A) *Astragalus kamarinensis* and (B) *A. tribuloides*. — 1: Seed. — 2: Testa. — 3: Pod coat.

Spain, were added to this matrix. This morphological dataset was processed by the NTSYSpc package (Rohlf 2000). The resulting phenetic tree (Fig. 4) places *A. kamarinense* and *A. stella* in two distinct and well separated clades. *Astragalus raphaelis* is placed in a clade even more distant from the clade containing *A. stella*. The phenogram suggests that the species most closely related to *A. kamarinensis* is *A. tribuloides*, both falling in a clade sister to *A. stella* clade.

*Astragalus kamarinensis* and *A. tribuloides* share several characters, but also differ in many macromorphological features (Table 1). Other differences are found the micromorphology of the seeds and pods (Fig. 3B1–B3). *Astragalus tribuloides* is characterized by the pod surface being more regularly polygonate, covered by longer and slenderer hairs, inserted on an inconspicuous tubercle, while the seed coat is formed of stellate cells with long irregular rays.

**Fig. 4.** UPGMA phenogram of the species belonging to *Astragalus* sect. *Sesamei*; see text for further explanation.



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