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Research Article

Allium kubeysdaghense, A New Species of *Allium* sect. *Codonoprasum* (Amaryllidaceae) From Eastern Anatolia, Türkiye

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Abstract: *Allium kubeysdaghense* Balos & Sonay, *Allium* sect. a new species from *Codonoprasum*, described from Elazığ Province, eastern Turkey. It is morphologically similar to *A. turcicum* and *A. turcicum* subsp. *fusciflorum* in general shape and presence of long spathe valves. But it differs in papyrus-like outer tunic; flexible, purple or green petioles on the upper part of the leaves; leaf sheaths covering up to 2/3 of the total length of the scape; crescent-shaped leaf cross-section; leaf margins with 3 to 6 scabrous teeth; verrucose leaf surface; non waxy, cream or white bell-shaped perigone; different structure and shape of inner and outer tepals; reticulate ovary surface. This study includes a detailed description of the new species, photographs of the species, habitat and ecological characteristics, conservation assessment, significant morphological differences with related species, and seed micromorphology (SEM).

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Keywords: Elazığ; Karakoçan; Kovancılar; New onion; Palu; Sultan Kubeys Mountain.

1. Introduction

The genus *Allium* L. is the largest monocotyledonous genera in the family Amaryllidaceae, with approximately 1078 species naturally distributed throughout the northern hemisphere in worldwide (Friesen et al., 2006; POWO, 2024), however some of the subgenera may not be monophyletic (Li et al., 2010). The main centers of biodiversity are the Southwest and Central Asia and the Mediterranean region (Friesen et al., 2006; Li et al., 2010; Chase et al., 2016). *Allium cepa* L., *A. sativum* L., *A. fistulosum* L., *A. ascalonicum* L, *A. ampeloprasum* and *A. porrum* L. are *Allium* species with high culinary and medicinal values. Many *Allium* species found in the wild in Turkey have ethnobotanical use and among the people, their leaves and bulbs are consumed as vegetables and spices; their water is drunk, added to cheese, pastry, rice and made into brine etc. and used for food purposes and earache treatment, appetite stimulant, blood pressure lowering, antiseptic purposes, strength booster, cold treatment, hemorrhoid treatment, parasite treatment, hair loss, stomach ache, inflamed wounds, worm reducer, boil treatment, asthma, cough suppressant and flu infection treatment, kidney stone reducer, earache, rheumatic pain, expectorant, blood pressure lowering, diabetes treatment (Baytop, 1999; Akan et al., 2005, 2008; Balos and Akan, 2007; Genç, 2010; Koçyiğit, 2010; Ekşi, 2012; Sargın et al., 2013; Akgül et al., 2018; Ekşi Bona, 2018; Yeşil and İnal, 2019; Yeşil et al., 2019; Balos et al., 2022; Demir and Ayaz, 2022; Sağıroğlu et al., 2023).

Türkiye an important center of *Allium* diversity in the Southwest Asia (Koyuncu et al., 2023; Balos et al., 2023; Balos and Sonay, 2024) with 234 species. In recent years, new species related to *Allium*, especially sect. *Codonoprasum*, have been published (Koyuncu et al., 2023; Koçyiğit et al., 2023a; Fırat, 2023; Koçyiğit et al., 2024; Eker, 2024; Yıldırım et al., 2024; Sonay et al., 2024; Çeçen et al., 2024).

Allium sect. *Codonoprasum* Reichb., contains 67 taxa (37 of which are endemic) (Koyuncu et al., 2023; Koçyiğit et al., 2023a; Sonay et al., 2024). With the new species in this study, the number of *Allium* species in Turkey increased to 232 and the number of sect. *Codonoprasum* species increased to 68.

The first specimens of the new species described here were collected in August 2023 during the floristic studies carried out in Sultan Kubeys Mountain (Elazığ, Türkiye) during the scientific field trip, which was the second author's master's thesis study. As a result of the examinations made on the collected specimens, it was determined that the species was an undescribed species, but due to the lack of specimens for a detailed description, a sufficient number of plant specimens were collected from the place where the plant was first collected the following year, in August 2024. As a result of detailed morphological studies on living materials, it was concluded that the plant was a new species and this article was written. The new species presented to your journal under the name *Allium kubeysdaghense* was compared in relation to the species *A. turcicum* and *A. turcicum* subsp. *fusciflorum*.

The eastern and south-eastern region of Türkiye region is a less studied region in terms of the *Allium* genus. In 4 years, new *Allium* species have been discovered from Türkiye (Armağan, 2021a, 2021b; Balos et al., 2021; Balos, 2022a, 2022b, 2022c; Balos et al., 2022a; Özdöl et al., 2022; Balos and Geçit, 2023a, 2023b; Balos et al., 2023; Koçyiğit et al., 2023a; Eker, 2023; Fırat, 2024; Koçyiğit et al., 2024; Eker, 2024; Yıldırım et al., 2024). Many new endemic species have been described in Elazığ (Türkiye) in the last two years (Balos, et al., 2022a; Balos, et al., 2023; Keskin, et al., 2023; Sonay, et al., 2024). This shows that the region is rich in plant diversity.

2. Materials and Methods

In this study, about 30 specimens were collected in this study from natural locality. For the identification of the collected specimens, the literature on *Allium* was reviewed. We consulted Kollmann (1984), Özhatay and Tzanoudakis (2000), and Koyuncu et al., (2023) that deal with the Turkish species. Floras of the neighbouring regions including Iran, Iraq, Syria and Palestine were also consulted (Boissier 1882; Feinbrun 1948; Wendelbo, 1971, 1985). Additional relevant publications include Brullo et al., (2013; 2014), Salmeri et al., (2015), Cowley et al., (1993), Özhatay et al., (2018), Bagheri et al., (2020), Ioannidis and Tzanoudakis (2022), Koçyiğit and Kaya (2020), Trigas and Barega (2020), Armağan (2021a), Pirhan (2022), Balos (2022a, 2022b), Balos et al., (2022a), Özdöl et al., (2022), Balos and Geçit (2023a, 2023b), Koçyiğit et al., (2023), Jang et al., (2024), Koçyiğit et al., (2024), Eker (2024), Sonay et al., (2024), and Yıldırım et al., (2024).

Morphological studies were carried out to describe and characterize of this *Allium* species in all *Allium* were examined on fresh material using with a stereo-binocular microscope. The collected specimens are kept in the herbarium of the Harran University Herbarium (HARRAN).

Electron micrographs (Scanning Electron Microscope, SEM) were obtained under a Zeiss EVO 50 SEM at an accelerating voltage of 10 kV, three seeds were mounted onto aluminium stubs with double adhesive carbon tape and coated with 5 nm thick gold prior to observation. Ornamentation descriptions (Table 1) on SEM ornamentation images of seeds (Figure 4) were made according to Neshati and Fritsch (2009), Choi and Cota-Sanchez (2010, 2012), Bednorz et al., (2011), Celep et al., (2012), Lin and Tan (2017), Baasanmunkh et al., (2020; 2021), Khorasani et al., (2020), Ariunzaya et al., (2022, 2023), Shin et al., (2022) and Yusupov et al., (2022).

3. Results and Discussion

Allium kubeysdaghense Balos & Sonay ***sp. nov.*** (Fig. 1 and 2)

Type: Türkiye, Elazığ Province, Kovancılar / Palu / Karakoçan district, Mt. Sultan Kubeys, steppe area, 2315 m., 15 July 2024, M. Balos 5670 & V. Sonay (holotype HARRAN, isotype FUH, HARRAN).

Paratype: Türkiye, Elazığ Province, Kovancılar / Palu / Karakoçan district, Mt. Sultan Kubeys, steppe area, 2310 m., 12 August 2023, M. Balos 5554 & V. Sonay (Paratype HARRAN).

Etymology: The new species takes its name from Sultan Kubeys, which gave its name to Sultan Kubeys Mountain and where his tomb is located. Sultan Kubeys Mountain is located between the Kovancilar, Palu and Karakoçan districts, close to the Elazığ-Bingöl border. The new scientific Turkish name suggested according to the guides of Menemen et al., (2016; 2021) is "Kubeys soğanı", named in honor of Sultan Kubeys.

Bulbous perennial, bulb ovoid, 1.5–2 × 1–1.5 cm diameter, no bulblets; outer tunics greyish, blackish, papyraceous, forming a 0.5–1 cm collar on the stem; inner tunics membranous, dirty white. Scape 16–33 × 1–2.5 mm; straight, upper part sometimes flexuous; purple or green; usually up to 2/3 of total long covered by scabrid leaf sheaths ± ribbed. Leaves (–2) 3–4 pieces, 7–15 × 2–3 mm; sometimes exceeding the inflorescence, crescent shaped, semi-cylindrical, canaliculate, scabrid teeth in groups of 3–6 at intervals; surface densely covered with white verrucose. Spathe persistent with two unequal valves, much longer than umbel; lower part of valves narrow triangular, upper part thin-pointed; short one 4–10 cm, longer one 7.5–14.5 cm long; fragile, easily falls off in herbarium specimens during fruiting period. Inflorescence lax, umbellate, sparsely flowering, slightly spreading, 3.5–6 cm in diam, with 20–60 flowers. Pedicels unequal, 1.5–2.5 cm, directed laterally and upwards, central pedicels elongating up to 3 cm at fruiting stage, waxy, bracteolate. Perigone 4–4.75 × 3–4 mm, campanulate, tepals unequal. Outer tepal 3.9–4.5 x 1.6–2 mm, wider than inner tepal, obovate, oblong-obovate or elliptic-obovate, retuse, truncate or rounded at apex, creamy, brownish, brownish-green, the tips and edges of the tepals have greenish or brownish stripes, with green or dark brown midvein, inner tepal 3.5–4.5 × 1.5–1.8 mm, narrower than outer tepal, oblong or narrowly obovate, truncate or retuse at apex, creamy, brownish, brownish-green, tepals. Stamens clearly exserted from perigone; filaments simple, upper part purplish, 5.5–7 mm long, below connate into an annulus 0.6–0.9 mm high, interstaminal teeth absent. Anthers yellow, oblong, 1.2–1.4 × 0.6–0.7 mm, retuse at apex. Ovary yellow, subglobose or globose, with deep longitudinal furrows, upper part narrowed, with reticulate surface, no papillose, 1.5–2.8 × 1.2–2 mm, with a 0.3–0.5 mm long stipe. Style 3.75–6 mm long, white, distinctly exerted from perigon. Capsule globose, tripartite, 4–4.5 × 4–4.2 mm, upper parts purplish; valves globose, emarginate, 4–4.5 × 3.5–4 mm; 3 carpel and trilocular, each loculus bearing 2 seed; seed oblong, semicircle, with a feebly rugose surface, 3.5–4 × 1.6–2 mm.

Distribution and Habitat: *Allium kubeysdaghense* is a endemic found Elazığ province, eastern Anatolia (Türkiye). It grows on the mountain top, in stony, steppe areas at 2200–2315 m a.s.l. (Fig. 1). Other plant species grooving nearby are *Acantholimon saxifragiform* Hausskn. & Sint. ex Bokhari*, Achillea millefolium* L. *Allium murat-sonayi* Balos, Sonay & C.Çeçen*, A. pseudoampeloprasum* Miscz. ex Grossh., *Astragalus acicularis* Bunge, *A. lagopoides* Lam. *Helichrysum arenarium* subsp. *aucheri* (Boiss.) P.H.Davis & Kupicha*, Hypericum linarioides* Bosse, *H. Scabrum* L.*, Jacobaea cilicia* (Boiss.) B.Nord., *Odontites aucheri* Boiss., *Prometheum sempervivoides* (Fisch. ex M.Bieb.) H.Ohba, *Tanacetum nitens* (Boiss. & Noë) Grierson.

Conservation status: As a result of the Geocat Program Analysis (GeoCAT, 2024), the distribution area of the plant species covers an area of occupancy (AOO) is 4000 km^2, extent of occupancy (EOO) is 0.012 km^2. It is estimated that there are less than 200–250 individuals in the only known location. Due to goat grazing and people's tourist activities, a decrease in the number of the species is expected in the near future. Therefore, according to the IUCN Red List categories and criteria (https://www.iucnredlist.org/), we assessed its conservation status as "Critically Endangered" (CR) [criterion B2ab [i, ii, iii] (IUCN, 2024).

Allium kubeysdaghense is morphologically similar to *A. turcicum* and *A. turcicum* subsp. *fusciflorum* in general shape and presence of long spathe valves. But it differs in papyrus-like outer tunic; flexible, purple or green petioles on the upper part of the leaves; leaf sheaths covering up to 2/3 of the total length of the scape; crescent-shaped leaf cross-section; leaf margins with 3 to 6 scabrous teeth; verrucose leaf surface; non waxy, cream or white bell-shaped perigone; different structure and shape of inner and outer tepals; reticulate ovary surface, different colour of capsule and ornemantasyon of seed surface (*see* Fig. 1–4 and Table 1).

Additional examined selected specimens: *Allium turcicum* (Endemic): Türkiye. Diyarbakır: Between Çermik and Çüngüş counties, near Sinek village, stony and rocky areas, 1125 m., 06 June 2023, M. Balos 5440 & C. Çeçen (HARRAN). *Allium turcicum* subsp. *fusciflorum* (Endemik): *Type*: Mardin Province, Artuklu District, Zınnar region, rocky areas, 1140 m., 09 June 2023, M. Balos 5482, C. Çeçen & M. Geçit (holotype HARRAN, isotype HARRAN).

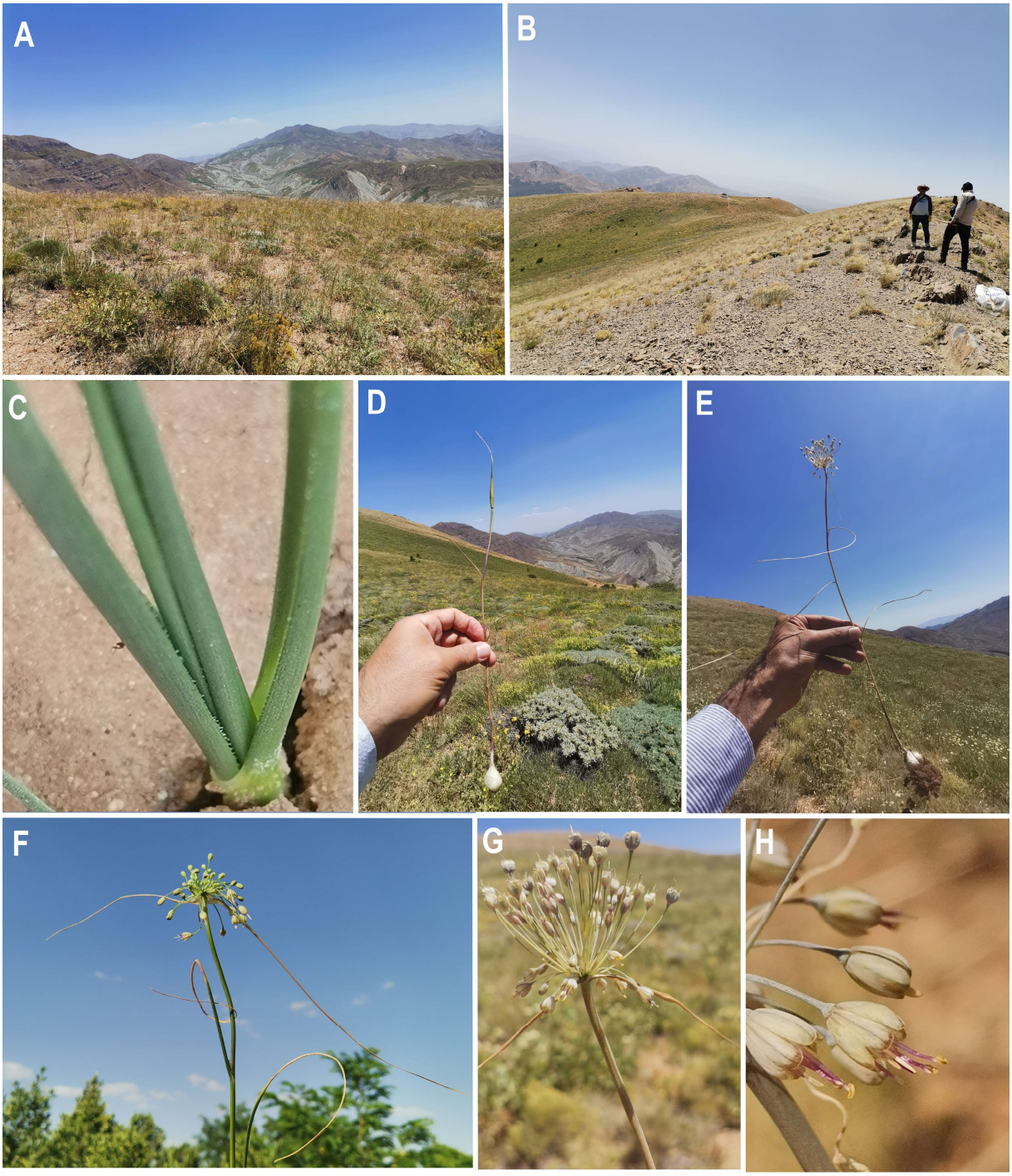

Figure 1. *Allium kubeysdaghense*. **A–B:** Habitat, **C:** Leaves, **D–E:** Habit at the holotype locality, **F:** Inflorescences, **G:** In fruit, **H:** Perigone.

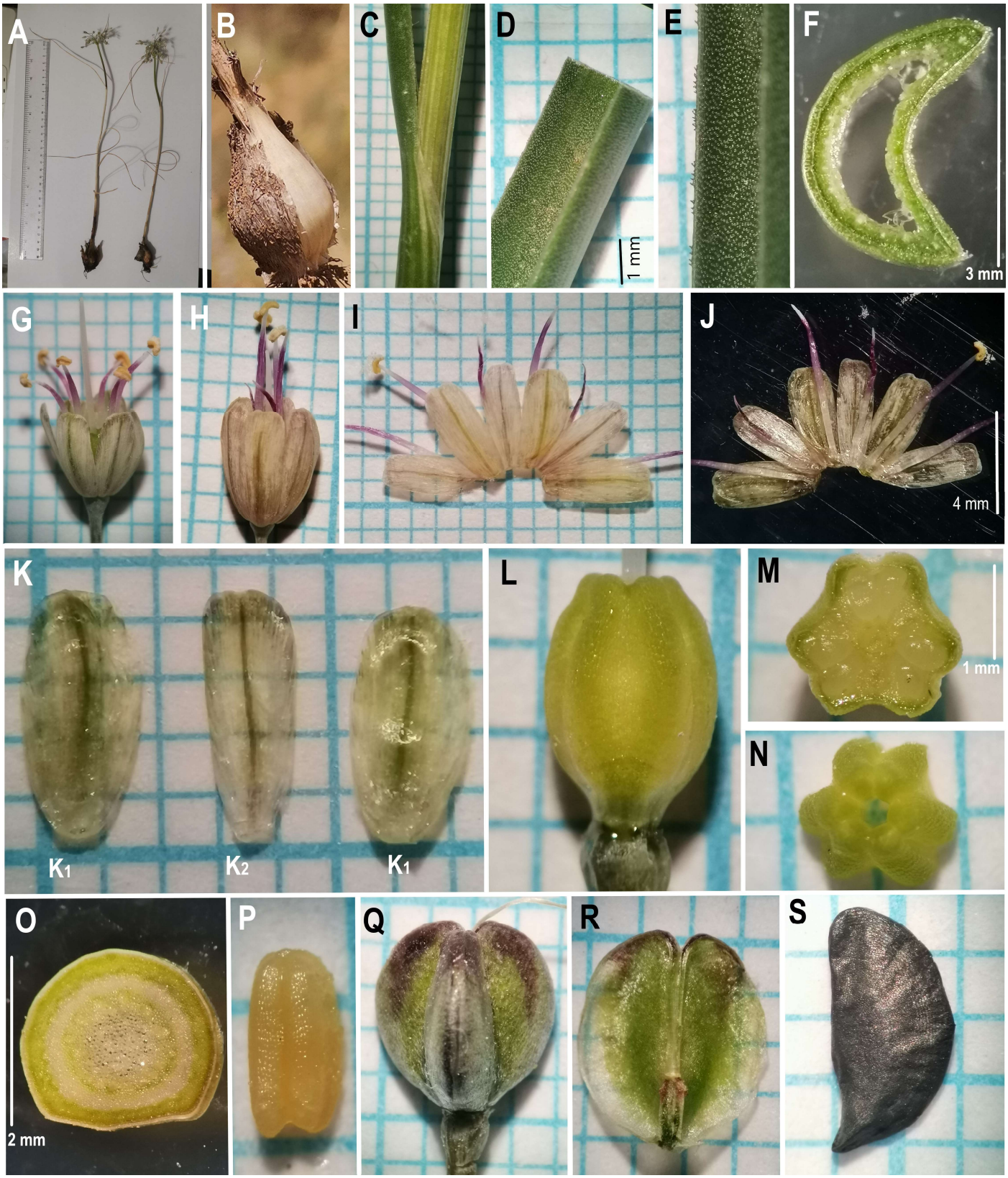

Figure 2. *Allium kubeysdaghense* (from holotype). **A:** Habit, **B:** Bulb, **C:** Leaf sheaths on stem, **D–E:** Leaf, **F:** Leaf cross-section, **G–H:** Perigon, **I:** Outer surface of open perigon, **J:** Inner surface of open perigon, **K:** Outer (K_1), inner (K_2) tepal, **L:** Ovary, **M:** Ovary cross-section (from lower part), **N:** Ovary cross-section (from upper part), **O:** Cross-section of the scape, **P:** Anther, **Q:** Capsule, **R:** Valve of capsule, **S:** Seed (from paratype, M. Balos 5554 & V. Sonay, for seed).

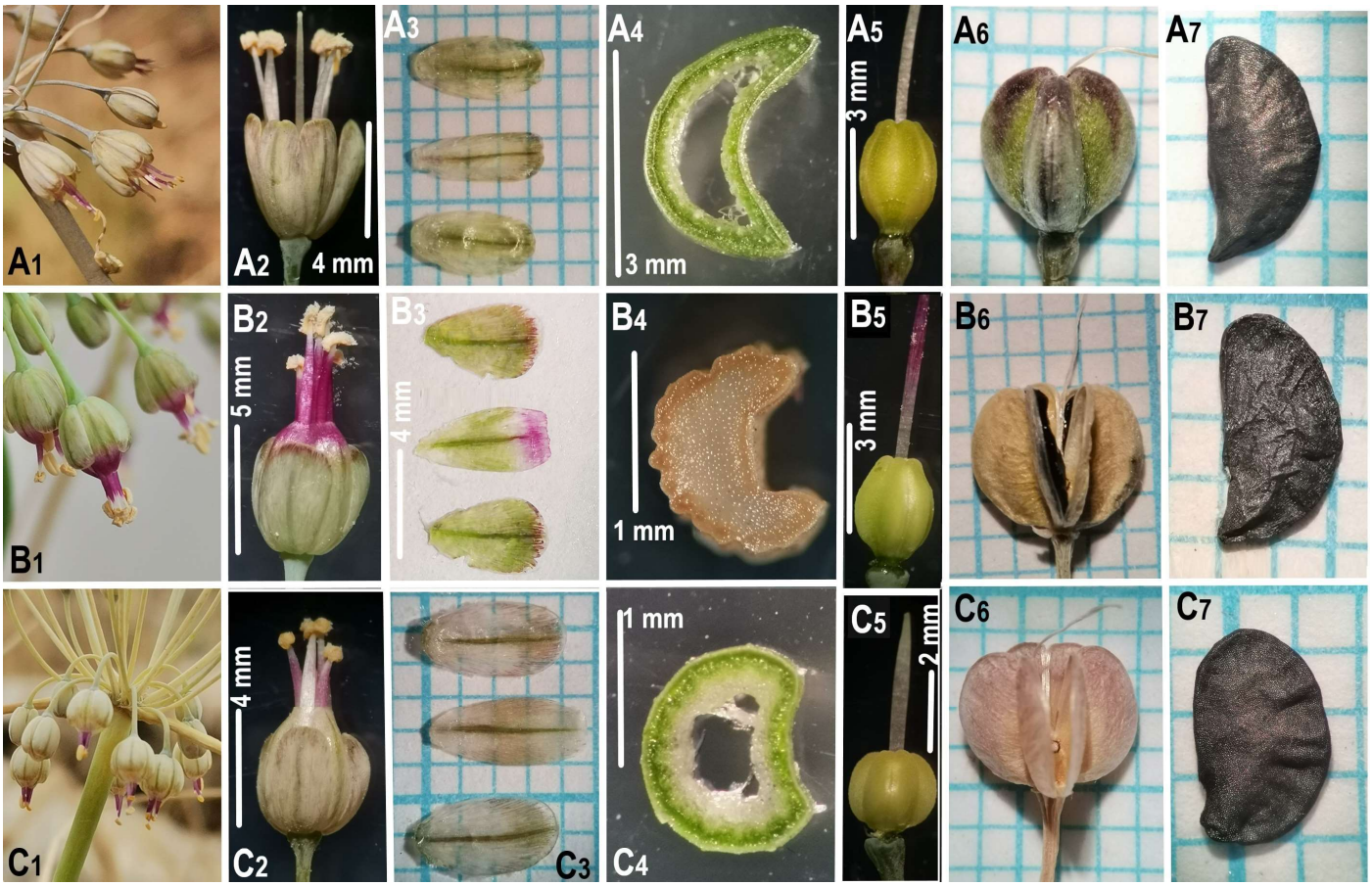

Figure 3. Comparison of some different morphological parts of *A. kubeysdaghense*, *A. turcicum* subsp. *turcicum*, and *A. turcicum* subsp. *fusciflorum*. **— *A. kubeysdaghense***: **A_1:** Inflorescences. **A_2:** Perigon, **A_3**. Outer–inner–outer tepals, **A_4:** Leaf cross-section, **A_5:** Ovary, **A_6:** Capsule, **A_7:** Seed; **— *A. turcicum* subsp. *turcicum*, B_1:** Inflorescences, **B_2:** Perigon, **B_3.** Outer–inner–outer tepals**, B_4:** Leaf cross-section, **B_5:** Ovary, **B_6:** Capsule, **B_7:** Seed; **— *A. turcicum* subsp. *fusciflorum***, **C_1:** Inflorescences, **C_2:** Perigon, **C_3.** Outer–inner–outer tepals, **C_4:** Leaf cross-section, **C_5:** Ovary, **C_6:** Capsule, **C_7**: Seed.

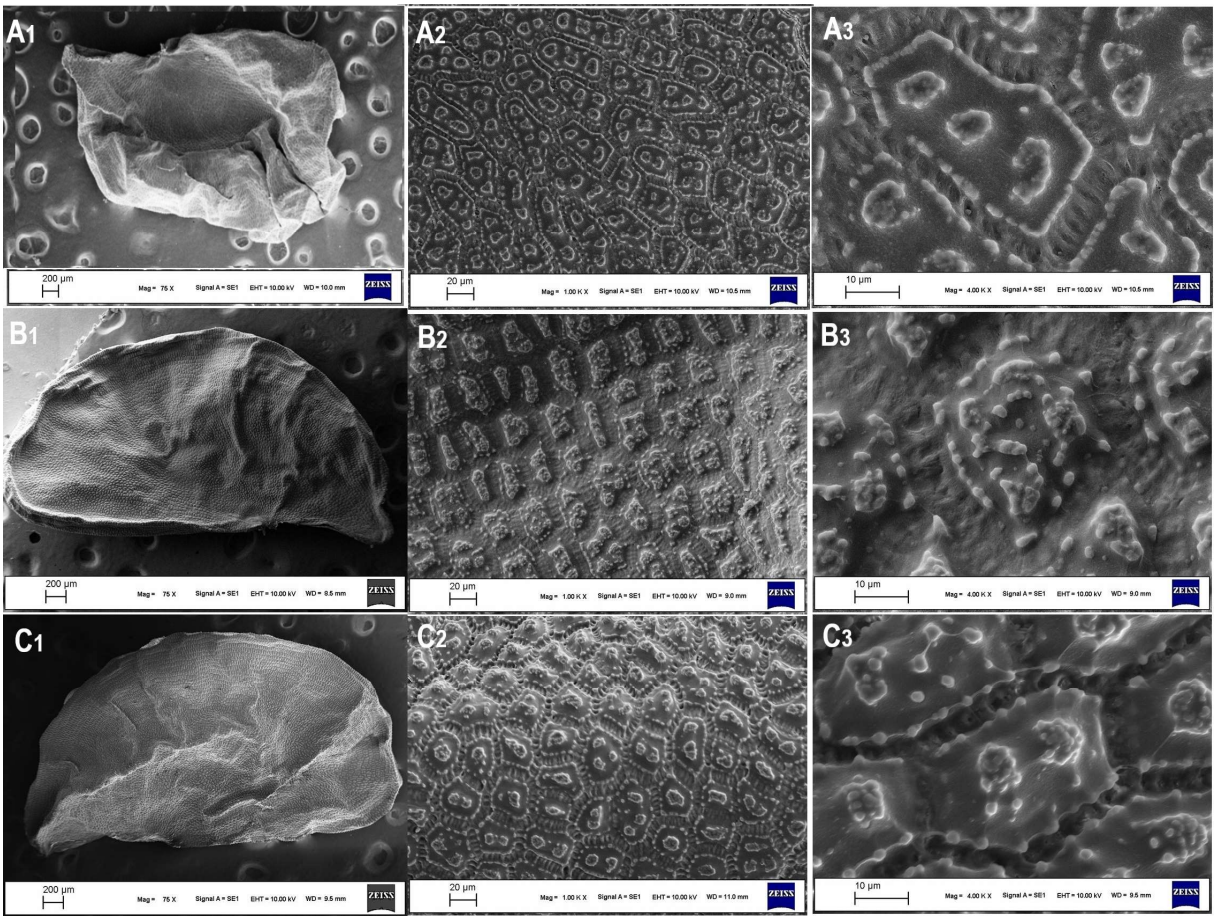

Figure 4. SEM micrographs of seed testa of the new species and its closest related taxa, (**A1**–**A3**): *Allium kubeysdaghense* (M. Balos 5670, HARRAN), (**B1**–**B3**): *A. turcicum* (M. Balos 5467, HARRAN), **C1**–**C3:** *A. turcicum* subsp. *fusciflorum* (M. Balos 5482, HARRAN).

Table 1. Distinguishing characters between *Allium kubeysdaghense, A. turcicum* and *A. turcicum* subsp. *fusciflorum*

Characters	*A. kubeysdaghense sp. nov.*	*A. turcicum* subsp. *turcicum*	*A. turcicum* subsp. *fusciflorum*
Bulb (length cm × width cm)	1.5–2 × 1–1.5, bulb single, a single scape emerging from a bulb	1.5–2 × 1–1.2, bulb single, a single scape emerging from a bulb	1–2 × 0.5–1.5, bulb single or double, a single or double scape emerging from a bulb
Outer tunic	papyraceous, greyish, blackish, intermediate tunic papery dirty yellowish, forming a 0.5–1 cm collar on the stem	coriaceous, brownish, intermediate tunic papery dirty yellowish, forming a 0.5–0.7 cm collar on the stem	coriaceous, brownish to blackish, intermediate tunic papery yellowish to orange, forming a 0.3–0.5 cm collar on the stem
Inner tunic	membranous, dirty white	membranous, white	membranous, white
Scape long (length cm × width mm)	16–33 × 1–2.5; straight, upper part sometimes flexuous; purple or green	15–30 × 2–2.5, erect or erect ascending, green	10–40 × 1.5–2, straight or slightly slanting, glabrous
Spathe valves	up to 2/3 of total length covered by scabrid leaf sheaths	up to 1/2 of scape length lower sheaths scabrid	more than 1/2 of total length covered by glabrous leaf sheaths
Leaves	(–2) 3–4, 7–15 cm long, 2–3 mm wide; crescent shaped, semi-cylindrical, canaliculate, scabrid teeth in groups of	3–4, 14–22 cm long, 1–1.2 mm broad, semi-cylindrical,	3–6, 1.5–2 mm broad, the lower part of the leaf that is connected to the stem and the upper parts are

	3–6 at intervals; surface densely covered with white verrucose	canaliculate, the lower part of the leaf is solid and the upper part is hollow, margins scabrid	hollow; sometimes there is a leaf with channels on both sides between the leaf and the leaf sheath, surface densely covered with white verrucose
Spathe valve	short one 4–10 cm, longer one 7.5–14.5 cm length, dirty yellow, easily falls off in herbarium specimens during fruiting period	short one 10–18 cm length, longer one 12–25 cm length, longitudinally fine densely veined, yellow, upper parts purplish, not falls off in herbarium specimens during fruiting period	short one 5.5–15 cm, longer one 9.5–22 cm length, margins entire;
Inflorescence	3.5–6 cm diam	2–4 cm diam	2–4.5 cm diam
Flowers	20–60	10–35	10–60
Pedicels	1.5–2.5 cm	1.5–2 cm length	0.5–2.5 cm length
Perigone (length mm × width mm)	4–4.75 × 3–4 mm width, campanulate, no waxy, tepals unequal, outher tepal wider than inner tepal	3.8–4.6 × 3.75–4, shortly campanulate, waxy, clearly unequal, inner longer than and narrower, tepals, covered with a waxy layer; green	3.5–4.3 × 3–4.2, globose, creamy to brownish, clearly unequal, inner longer than ones, covered with a waxy layer
Outer tepals (length mm × width mm)	3.9–4.5 × 1.6–2, wider than inner tepal, obovate, oblong-obovate or elliptic-obovate, retuse, truncate or rounded at apex, creamy, brownish, brownish-green, the tips and edges of the tepals have greenish or brownish stripes, with green or dark brown midvein	3.5–4.5 × 2.5–3, obovate, obtuse, no curved outwards, greenish with dark green midvein	3.5–4.1 × 2.1–2.5, elliptical, keeled, obtuse, broader than inner tepal, creamy to brownish, with green midvein, brown stripes on the sides and upwards
Inner tepals (length mm × width mm)	3.5–4.5 × 1.5–1.8, narrower than outer tepal, oblong or narrowly obovate, truncate or retuse at apex, creamy, brownish, brownish-green, the tips and edges of the tepals have greenish or brownish stripes, with green or dark brown midvein	4–5.5 × 2–2.5, obovate, no curved outwards, green with dark green midwein, purplish at apex (dark purplish when dry) with irregularly dentate, truncate-emerginate	3.75–4.75 × 1.75–2, narrowly elliptical, creamy to brownish, with green midrib, brown lines on sides and upwards, irregularly dentate at apex, truncate-truncate
Filaments	5.5–7 mm length, below connate into an annulus 0.6–0.9 mm high, white or upper part purple	6.5–8 mm length, below connate into an annulus 0.8–1 mm high, upper part purple	4.5–7 mm length, connected below into an annulus 0.5–1.0 mm long, upper part purple
Anther (length mm × width mm)	1.2–1.4 × 0.6–0.7, retuse at apex	1.25–1.5 × 0.6–0.9, truncate at apex	1.4–1.5 × 0.6–0.7, rounded at apex
Ovary (length mm × width mm)	1.5–2.8 × 1.2–2, with a 0.3–0.5 mm long stipe. subglobose or globose, with deep longitudinal furrows, upper	1.6–1.8 × 1.6–2, with a 0.2–0.3 mm stip, subglobose, with shallow	1.5–2.5 × 1.75–2, with a 0.25–0.5 mm long stipe. globose or

	part narrowed, with reticulate surface, no papillose	longitudinal furrows, surface papillose	subglobose, with deep longitudinal furrows, surface papillose
Style	3.75–6 mm length, white	4–4.5 mm length, the upper half is purple	2–5.8 mm length, white
Capsule (length mm × width mm)	4–4.5 × 4–4.2, upper parts purplish	3.5--4 × 4–5, dirty yellow	3.5–4 × 3.5–5.2 pinkish
Capsule valves (length mm × width mm)	4–4.5 × 3.5–4	3.75–4 × 3–4	3.5–4 × 3.5–4.5
Seed (length mm × width mm)	3.5–4 × 1.6–2	3.5–3.8 × 1.5–2	3–3.5 × 2–2.5
Seed testa cell	Irregularly polygonal (4–8 -edged), ellipsoid-oblongoid (43.95 µm long, 23.15 µm wide)	Irregularly polygonate (3–5), sub-isodiametric in some area, often have unclear boundaries. The length of the cells are approximately 2–3 times longer than their width (24–44.4 × 8–25.8 µm), with undulate borders	Irregularly polygonate testa cells (pentagonal to hexagonal), semi-isodiametric to elongated (24.4–38.8 × 15.6–24.00 µm), with distinct and sharply angled cell walls
Seed periclinal walls	± flat, granulose, with several irregularly shaped and sized verrucae, smaller verrucae in rows at the edges	slightly raised ± flat, with large and small verrucae and a few granular and irregular shaped verrucae at the edge	slightly elevated ± convex, with 1–3 large central papillate verrucae and smaller verrucae regularly arranged at the edges
Seed anticlinal walls	5.84 µm wide depressed, broad, ±straight, covered by strap-like sculptures	8–16.4 µm wide, depressed, more or less ± straight, covered with vaguely strap-like sculpture	4–10.8 µm wide, depressed, ± straight, covered by strap-like sculptures

Conflicts of Interests
Authors declare that there is no conflict of interests

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Statement contribution of the authors
This study's experimentation, analysis and writing, etc. all steps were made by the authors.

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