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What is *Allium achaium* Boiss. & Orph.? Disentangling the taxonomy of a Greek mountain species

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Abstract: *Allium oreohellenicum* Tzanoud., Tsakiri & Raus (*Amaryllidaceae*), endemic of the Greek mountains, is described and illustrated as a species new to science. Information regarding its cytology, geographical distribution and taxonomic relationships is also provided. Material belonging to *A. oreohellenicum* was formerly known/classified as *A. achaium* Boiss & Orph., a taxon described in 1882 based on a gathering by Orphanides from Mt Klokos (N Peloponnisos, Greece). A detailed study of the Orphanides gathering concerned revealed that it essentially belongs to *A. frigidum* Boiss. & Heldr., a taxon described 28 years earlier, and so the need for a new name.

Key words: *Allium*, *Allium achaium*, *Allium oreohellenicum*, *Amaryllidaceae*, chromosome numbers, Greece, mountain flora, new species

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Introduction

Allium L. (*Amaryllidaceae*) is one of the most species-rich genera of the Greek flora. Presently it is known to be represented in the country by 103 species with more than 50 % of them (54) endemics. Considering that continental Greece including some of the larger islands is characterized by dozens of mountain massifs approaching or exceeding 2000 m in altitude, it is worth noting that among the Greek *Allium* endemics only three are considered as "mountain species", i.e. adapted to and exclusively occurring in high-altitude habitats (>1600 m). These species are currently named *A. achaium* Boiss. & Orph., *A. frigidum* Boiss. & Heldr. and *A. parnassicum* (Boiss.) Halácsy (Strid & Tan 1991; Dimopoulos & al. 2013). They have some morphological characters in common, viz. an infundibular-campanulate to infundibular perianth, the perianth segments at least 6 mm long, the stamens included in the perianth, and the ovary much longer than wide.

Allium frigidum Boiss. & Heldr. was first published in Boissier (1854: 34) based on a gathering by Heldreich from Mt Taygetos (S Peloponnisos). *Allium achaium* Boiss. & Orph. was described 28 years later (Boissier 1882: 259) based on a gathering by Orphanides from Mt Klokos (NW Peloponnisos), distributed to Boissier (G, G-BOISS) and several other herbaria under *Orphanides, Fl. Gr. Exsicc. no. 427* ("In monte Clocos Achaia et prope Vostitza sito loco Pente Vryses dicto 4000 ped., 9/21. Jul. 1855"). Together with *A. achaium*, Boissier described slightly deviating plants from Mt Parnassos (Sterea Ellas) as *A. achaium* var. *parnassicum* Boiss. (Boissier 1882: 259). Halácsy (1904: 255) raised this variety to species rank (*A. parnassicum* (Boiss.) Halácsy), at the same time considering *A. achaium* Boiss. & Orph. to be a synonym of *A. frigidum*, stating: "Inter *A. frigidum* et *A. achaium* differentiam videre nequeo" and "*A. achaium* quo meo sensu ab *A. frigido* non diversum" (Halácsy 1904: 251, 255). Halácsy's concept of the *A. achaium* group was adopted by Hayek (1932: 47), Zahariadi (1975a, 1975b),

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Fig. 1. Inflorescences – A: *Allium oreohellenicum* from S Pindos (Mt Kakarditsa, 6 Aug 2017, photograph by I. Kofinas); B: *A. frigidum* from Peloponnisos (Mt Panachaikon, 24 Jul 2014, photograph by D. Tzanoudakis); C: *A. parnassicum* from Sterea Ellas (Mt Parnassos, 28 Jul 2015, photograph by P. Trigas); D: *A. flavum* subsp. *tauricum* from Peloponnisos (Mt Klokos, 11 Jul 2017, photograph by D. Tzanoudakis). – The last (D) erroneously considered by Bogdanović & al (2011) as the "true *A. achaium*".

Stearn (1978, 1980, 1981) and Kollmann (1984: 135). On the contrary, *A. achaium* has been subsequently reappraised as a distinct species of the Greek flora by Andersson (1991: 709), with the Orphanides gathering from Mt Klokos in G-BOISS as the holotype of the species and its total distribution range indicated from Peloponnisos to the mountains of Sterea Ellas and Southern and Northern Pindos (Thessalia/Ipiros).

Twenty years later, Bogdanović & al. (2011) completely changed the taxonomic treatment of *Allium achaium*. Indeed they continued to quote the voucher of *Orphanides, Fl. Gr. Exsicc. no. 427* (G-BOISS) as the holotype of *A. achaium*, but confusingly described and illustrated under this designation an *Allium* from Mt Klokos characterized by morphological characters that do not at all match either the specimens of the Orphanides gathering, mentioned above, or any other specimen belonging to the species group of *A. achaium* sensu Andersson (1991) and previous botanists, *A. frigidum* and *A. parnassicum* (Fig. 1). In fact, the characters given by Bogdanović & al. (2011), viz. exserted stamens, cup-shaped perianth and globose ovary, characterize the *A. flavum*/*A. stamineum* group, which is quite different from those groups in which *A. achaium*, *A. frigidum* and *A. parnassicum* belong (with the stamens included in an infundibular-campanulate to infundibular perianth

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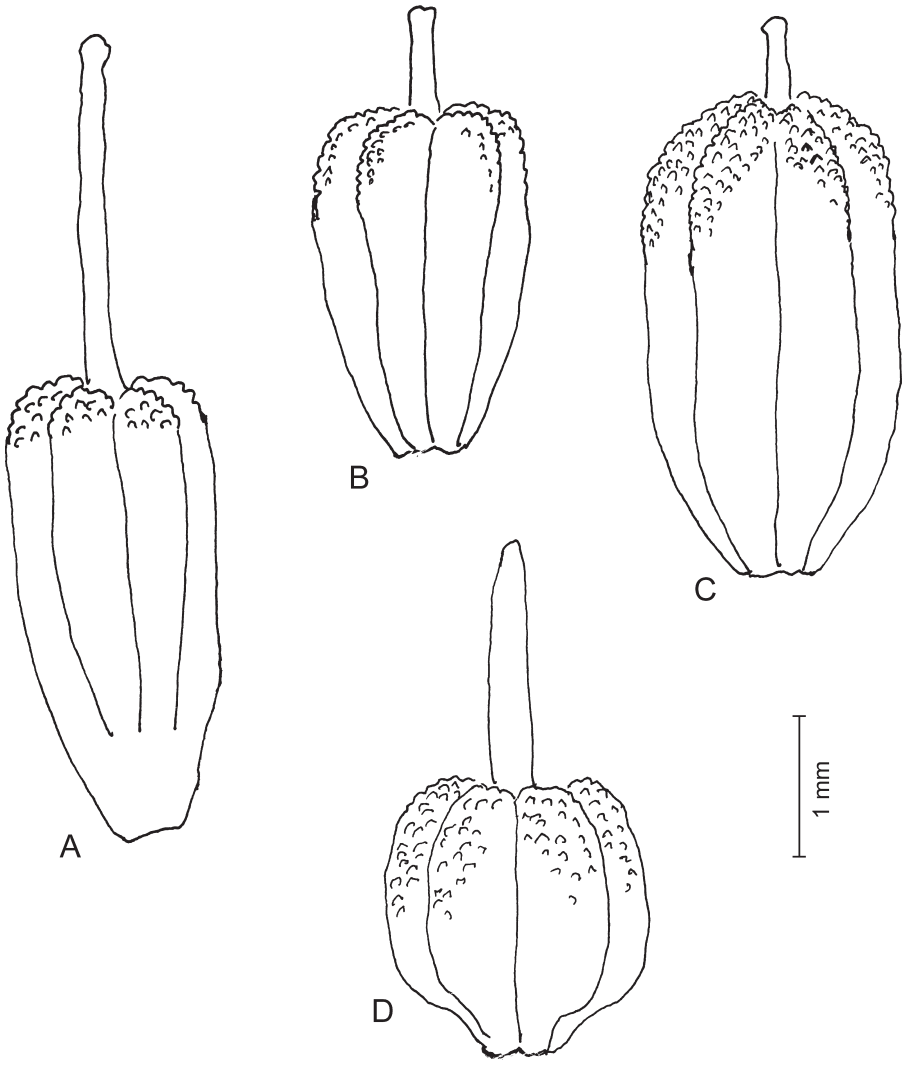


Fig. 2. Ovaries – A: *Allium oreohellenicum*, from *Tzanoudakis X653* (see Additional specimens examined); B: *A. parnassicum*, from Brullo & al. (2001); C: *A. frigidum*, from Brullo & al. (2001); D: "*A. achaium*" sensu Bogdanović & al., from Bogdanović & al. (2011). – Scale bars = 1mm.

and the ovary much longer than wide; Fig. 1 & 2). The present paper aims at disentangling these contradicting taxonomic points of view.

Material and methods

Mt Klokos, the locus classicus of *Allium achaium* Boiss. & Orph., had been visited and explored by the first author, accompanied by varying staff of the Botanical Institute of Patras, several times from 2013 to 2017 in the framework of monitoring regional "Natura 2000" sites, and all *Allium* taxa occurring in the area have been completely registered. In parallel, herbarium specimens of *A. achaium* sensu Andersson (1991), *A. frigidum* and *A. parnassicum* from all mountains of Peloponnisos, Sterea Ellas and the Pindos range, which are available in the Botanical Museum of the University of Patras (UPA), have been comparatively studied, among them an isotype sheet of the original gathering by Orphanides from Mt Klokos (*Orphanides, Fl. Gr. Exsicc. no. 427*), on which the description of *A. achaium* was based (Fig. 5). In addition, the type material of the three species *A. achaium*, *A. frigidum* and *A. parnassicum* deposited in the Geneva herbarium (G, G-BOISS) was investigated. Herbarium specimens of these three species examined by Andersson (1991) and deposited in the herbarium of Lund (LD) were also examined. No relevant historical exsiccata could be traced in the herbarium of Berlin (B), very likely destroyed there in 1943.

Results and Discussion

Mt Klokos (1774 m) is situated SW of the city of Egion (previously Vostitsa) and NNW of the much higher mountain massifs of Chelmos (2355 m) and Erimanthos (2224 m) in northern Peloponnisos. Based on the information given by local people, the locality "Pente Vryses" (i.e. five springs), which is given on the label of *Orphanides, Fl. Gr. Exsicc. no. 427*, is located a few kilometres SW of Pteri, a village on the NE-facing slope of the mountain at an altitude of c. 1300 m. The altitude given by Orphanides for this locality is almost the same (4000 ft). In the framework of our floristic exploration, we visited the slopes above the locality "Pente Vryses" as well as the opposite, SSE-facing slopes from an altitude of 1400 m up to the summit area. During our field work, three *Allium* species were found in the area:

(1) The first, and most common one, was a representative of *Allium* sect. *Codonoprasum* (Rchb.) Endl. characterized by spathe valves longer than pedicels, the perianth 4–5 mm long with evidently exserted stamens and a globose, more or less stipitate ovary (Fig. 1D & 2D). It was found on the slopes just above the locality "Pente Vryses" as well as on the opposite-facing slopes and in the summit area. Without any doubt this is the plant that Bogdanović & al. (2011) described and considered as the "true *A. achaium*", although none of the plants

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of the Orphanides gathering from Mt Klokos (G!, UPA!) has any of the characters provided by Bogdanović & al. (2011). However, plants with the mentioned characters do occur in the mountains of Greece, where they are more or less common and widespread; they represent *A. flavum* subsp. *tauricum* (Besser ex Rchb.) K. Richt.

(2) The second taxon met with on Mt Klokos was an *Allium* characterized by hairy sheaths and leaves, very long spathe valves and a pinkish brown perianth with included stamens. Because of these characters it belongs to *A. rhodopeum* Velen. subsp. *rhodopeum*, a taxon also known to occur at moderate altitudes on other mountains next to Mt Klokos in N Peloponnisos.

(3) The third representative of the genus on Mt Klokos was an *Allium* characterized by a pendulous inflorescence, spathe valves shorter than pedicels, white-pinkish to brownish perianth, included stamens and an ovoid to ellipsoid ovary. Only a few individuals were found, confined to the summit area. When comparing this plant with material of *A. frigidum* from other mountains of Peloponnisos as well as with the plants of the Orphanides gathering from Mt Klokos (G!, UPA!) designated as the type material of *A. achaium*, we found no differences. Hence Halácsy (1904) was completely correct in pointing out that there is no difference between these two taxa ("inter *A. frigidum* et *A. achaium* differentiam videre nequeo"). They are conspecific, and the name *A. frigidum* has priority over *A. achaium*, hence the latter is correctly treated as a synonym of the former by Halácsy (1904), Hayek (1932–1933), Zahariadi (1975a, 1975b), Stearn (1978, 1980, 1981) and Kollmann (1984).

There is no doubt that in high-altitude habitats of the mountains of N Peloponnisos one more taxon of the *Allium paniculatum* group is present, sometimes growing side by side with *A. frigidum*. It is characterized by having outer bulb tunics often longitudinally splitting into parallel fibres, inflorescence erect (versus pendulous in *A. frigidum*), spathe valves longer than the pedicels, perianth segments pinkish white in the living state, to 6(–6.5) mm long, stamens with white-yellowish anthers included in the perianth, and ovary much longer than wide, narrowed at the base and truncate at the apex (Fig. 1A, 2A & 4). Plants with a similar morphology have also been collected in the high mountains of Sterea Ellas and in the Pindos range of NW Greece (Thessalia/Ipiros) and were treated by Tzanoudakis & Vosa (1988) under the misnomer "*A. parnassicum*". These plants were erroneously classified by Andersson (1991) as *A. achaium*. We agree with Andersson, who recognized a third *Allium* species in the mountains of C and NW continental Greece in addition to *A. frigidum* and *A. parnassicum*. However, Andersson misapplied the name *A. achaium* and its type, chosen by him, to this third species, whereas in fact they belong taxonomically to *A. frigidum*. This third species therefore needs a new name, a new description and a new type, which are provided here.



Fig. 3. Metaphase plate of *Allium oreohellenicum* from the type locality, $2n = 3x = 24$.

Allium oreohellenicum Tzanoud., Tsakiri & Raus, **sp. nov.** – Fig. 1A, 2A, 3 & 4.

Holotype: Greece, Peloponnisos, Achaia, Mt Chelmos, near Pouliou Vrisi, 39°59'26"N, 22°11'13"E, c. 2020 m, grassland and rocky places, 11 Aug 2018, *Tzanoudakis 14682* (UPA [Fig. 4]).

Diagnosis — Species ad sectionem *Codonoprasum Allii* generis pertinens, ab *Allio parnassico* simili non modo caule robustiore, floribus compluribus, periantho roseo-albo ad 6(–6.5) mm tantum longo antherisque albo-flavidis, sed etiam chromosomatum numero plerumque triploideo ($2n = 3x = 24$) satis diversa.

Allium oreohellenicum is a species of the Greek mountain flora, a member of the *A. paniculatum* group in *A.* sect. *Codonoprasum*. It is similar to *A. parnassicum*, from which it chiefly differs by its more robust stem (slender in *A. parnassicum*), inflorescence with more flowers, perianth segments pinkish white, smaller, to 6(–6.5) mm long (versus purplish to brownish purple and to 7.5 mm long in *A. parnassicum*), anthers white-yellowish (versus purple in *A. parnassicum*) and mainly triploid chromosome number ($2n = 3x = 24$), rarely diploid ($2n = 16$) (versus only diploid in *A. parnassicum*).

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Fig. 4. Holotype of *Allium oreohellenicum* Tzanoud., Tsakiri & Raus, *Tzanoudakis 14682* (UPA).

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Fig. 5. Isotype of *Allium achaium* Boiss. & Orph. (in UPA), from the original gathering made by Orphanides in 1855 on Mt Klokos (Achaia, Peloponnisos, Greece). It belongs taxonomically to *A. frigidum* Boiss. & Heldr. Note the pendulous inflorescences.

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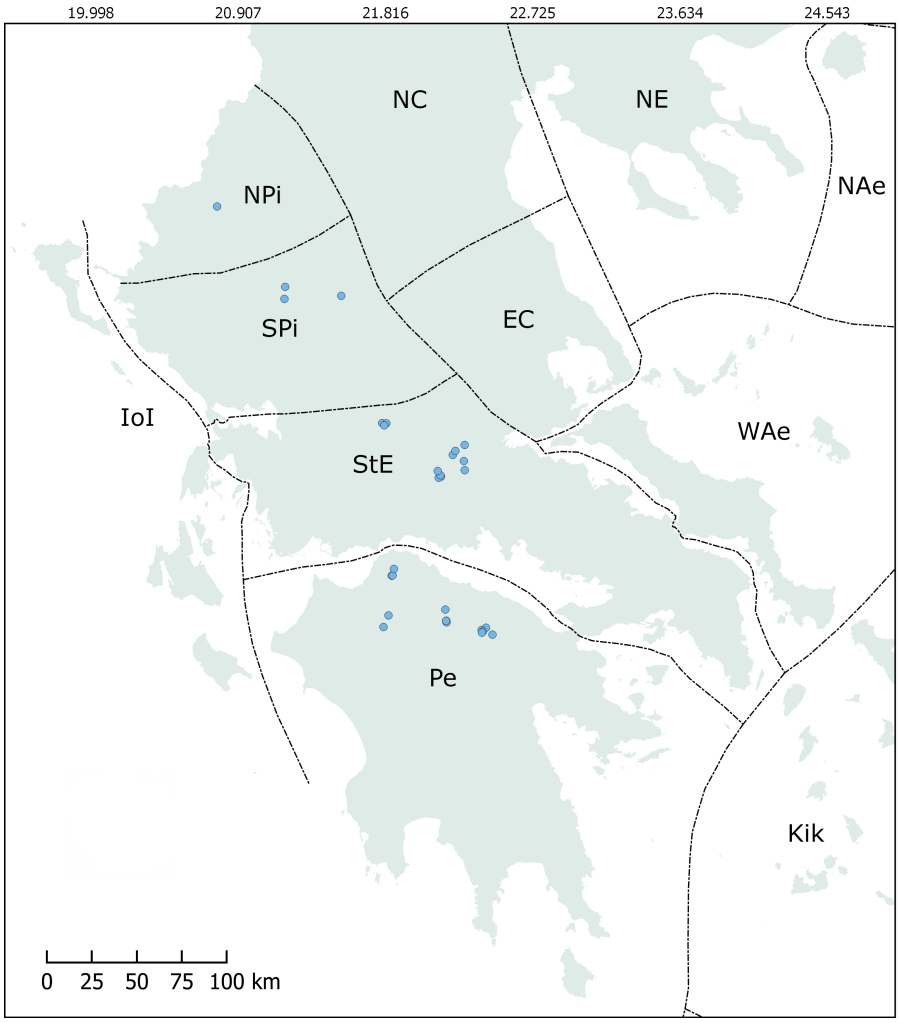


Fig. 6. Total known distribution of *Allium oreohellenicum*. – NPi = Northern Pindos; SPi = Southern Pindos; StE = Sterea Ellas; Pe = Peloponnisos (floristic regions and their abbreviations follow Dimopoulos & al. 2013: 22, fig. 1). – Drawing by M. Tsakiri.

Description — *Bulb* ovoid, 1–1.3(–1.8) cm in diam.; outer tunics brown to blackish brown, coriaceous, often longitudinally splitting into parallel fibres; inner tunics brownish to whitish brown, membranous. *Bulblets* 1 or 2, oblong-ovoid, 3–4 × 1–1.5 mm, apex acuminate, sometimes stalked on lower part of stem. *Stem* erect, (7–)10–20(–30) cm long, glabrous, covered by leaf sheaths for c. ½ of its length. *Leaves* 2 or 3(or 4), filiform, usually shorter than stem, glabrous, withered at flowering time. *Spathes* 2, opposite, unequal, 5- or 6-nerved, lanceolate at base and gradually attenuate into an appendage at apex, longer one 3–5(–8) cm long, shorter one 2–3(–4) cm long. *Inflorescence* usually lax with (7–)10–20(–35) flowers, marginal ones pendulous, central ones erect. *Pedicels* unequal, 1–1.5(–2.5) cm long. *Perianth* campanulate to funnel-shaped; perianth segments pinkish white in living state, sometimes becoming greenish brown when dry, elliptic to obovate, 5–6(–6.5) × 1–1.5(–2) mm. *Stamens* included; filaments ± similar, white, connate below into an annulus c. 1 mm long; anthers white-yellowish. *Ovary* cylindric to obovoid, longer than wide, c. 3 × 1.5–1.8 mm, narrowed at base, truncate and papillose at apex. *Style* white, 2–3 mm long.

Karyology — Material of *Allium oreohellenicum* from the mountains of Peloponnisos and Sterea Ellas was investigated cytologically by Tzanoudakis & Vosa (1988, under "*A. parnassicum*"). The triploid chromosome number $2n = 3x = 24$ was reported from all examined populations, but the diploid chromosome number, $2n = 2x = 16$, was additionally found in some individuals from Mts Iti and Velouchi in Sterea Ellas. The chromosome morphology and karyograms from the populations concerned were given by Tzanoudakis (1992: fig. 3 & 6), who pointed out that in both diploid and triploid plants the haploid complement consists mainly of metacentric and submetacentric chromosomes. The SAT-chromosomes observed (m^A, Sm^A) belong to the "*paniculatum*" type sensu Tzanoudakis (1983). In the present study, plants from the type gathering were also cytologically investigated and likewise turned out to be triploid ($2n = 3x = 24$, Fig. 3).

Distribution — The total range of *Allium oreohellenicum*, as presently known (Fig. 6), covers C and NW continental Greece from N Pindos (Mt Smolikas, see Andersson 1991: 709, under "*A. achaium*") to Sterea Ellas (Mt Vardousia), extending to N Peloponnisos (Mts Chelmos, Erimanthos, Killini and Panachaiko) where it co-occurs with *A. frigidum*.

Ecology — *Allium oreohellenicum* grows preferentially at 1800–2400 m in high-mountain meadows and rocky places, flowering from mid-July to August, depending on altitude and exposition. In the type locality, it is accompanied by several endemic and critical taxa such as *Allium frigidum* Boiss. & Heldr., *A. phthioticum* Boiss. & Heldr., *Campanula aizoides* Zaffran ex Greuter, *Cerastium candidissimum* Correns, *Festuca jeanpertii* (St.-Yves) Markgr., *Minuartia juniperina* (L.) Maire & Petitm., *Senecio rupestris* Waldst. & Kit., *Solenanthus stamineus* (Desf.) Wettst. and *Verbascum epixanthinum* Boiss. & Heldr.

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Etymology — The specific epithet is a compound of *oreo-* (mountain) and *hellenicum* (Greek), reflecting the ecological and chorological traits of the species, which is confined to high-mountain habitats of continental Greece. The taxon was hitherto concealed by misapplication of the name *Allium achaium* (Andersson 1991) or by misidentification of *A. flavum* subsp. *tauricum* (Bogdanović & al. 2011).

Additional specimens examined — **Northern Pindos:** Ioannina: Mt Timfi, near Drakolimni, 39°58.5259'N, 20°46.54'E, alt. 1880 m, 6 Aug 2017, *Kofinas* (UPA). — **Southern Pindos:** Ioannina: Mt Katarachias, 5.5 km ENE of Kalarites, alt. c. 2050 m, 25 Aug 1974, *Aldén 5339* (LD); Mts Athamanika, Kakarditsa, 39°32.0279'N, 21°11.3169'E, alt. 1940 m, 5 Aug 2017, *Kofinas* (UPA); Trikala: Mt Kotziakas, 6 km E of Pertoulion, alt. 1750–1850 m, 7 Aug 1974, *Aldén 4815* (LD). — **Sterea Ellas:** Evritania: Mt Velouchi, ad locum Seitan dictum, 38°56'N, 21°48'E, alt. c. 1800 m, 17 Aug 1981, *Tzanoudakis 6725* (UPA); ibid., in regione cacuminis, 38°57'N, 21°50'E, alt. c. 2100 m, 17 Aug 1981, *Tzanoudakis 6722* (UPA); ibid., 6 km ENE of Karpenision, alt. 1750–1850 m, 24 Jul 1970, *Gustavsson 364* (LD); Fokida: Mt Vardousia, 7 km W of Athanasios Diakos, alt. c. 1975 m, 9 Aug 1973, *Gustavsson 3595* (LD); ibid., prope refugium EOS, 13 Aug 1980, *Tzanoudakis & Georgiadis 6604* (UPA); ibid., in cacumine Korakas, 38°41'N, 22°08'E, alt. c. 2400 m, 13 Aug 1980 *Tzanoudakis & Georgiadis 6607* (UPA); ibid., 4 km W of Athanasios Diakos, alt 1750 m, 11 Aug 1973, *Gustavsson 3699* (LD); ibid., 5 km NNE of Dafnos, alt. c. 2000 m, *Gustavsson* (cultivated and dried 22 Jul 1974, LD); Fthiotida: Mt Iti, inter Pavliani et Katavothra, alt. 1500–1600 m, in sylvaticis, 3 Aug 1987, *Tzanoudakis s.n.* (UPA); ibid., inter Katavothra et Vrisi Kalogerou, 38°49'N, 22°16'E, alt. c. 1800 m, in pratis, 13 Aug 1980, *Tzanoudakis 6603* (UPA); ibid., in regione cacuminis, c. 2000 m, 12 Aug 1980, *Tzanoudakis & Georgiadis 6614* (UPA); ibid., near refugium EOS, alt. c. 1850 m, 12 Aug 1980, *Tzanoudakis & Georgiadis 6606* (UPA); ibid., 5 km E of Neochorion, alt. 1900–2000 m, 27 Aug 1973, *Gustavsson 4164* (LD); ibid., 7 km SSE of Ipati, alt. 1820–1850 m, 25 Jul 1972, *Gustavsson 1926* (LD). — **Peloponnisos:** Achaia: Mt Chelmos, Gaidourorachi, above Souvardiotoki Kria Vrisi, alt. c. 1500 m, 20 Jul 2003, *Tzanoudakis X653* (UPA); ibid., near refugium EOS, 37°59.414'N, 22°11.386'E, alt. 2080 m, 18 Jul 2012, *Tzanoudakis & al. X726* (UPA); ibid., forest road from Pouliou Vrisi to Aristarchos, 37°58.939'N, 22°11.494'E, alt. 2020 m, 18 Jul 2012, *Tzanoudakis & al. X759* (UPA); ibid., 37°59.391'N, 22°11.298'E, alt. 2100 m, 22 Aug 2012, *Tzanoudakis X787* (UPA); Mt Erimanthos, ad locum Mesa Gouvia dictum, 37°57'N, 21°47'E, alt. c. 1700 m, 20 Jun 1981, *Tzanoudakis 6979* (UPA); ibid., ad cacumen Neraidovouni, 38°01'N, 21°50'E, alt. c. 1700 m, 17 Jul 1973, *Tzanoudakis 318b* (UPA); Mt Panachaiko, supra pagum Balas, inter Kokkinovrisi et Prassoudi, prope Vrisi Despoti, alt. c. 1700 m, *Tzanoudakis 5945* (UPA); ibid., 38°12'35.8"N, 21°51'32.7"E, alt. 1670 m, *Kokkoris 2122* (UPA); Korinthia: Mt Ziria (Killini), pathway from refuge EOS (B) to summit, 37°57'N, 22°25'E, alt. 1650–1950 m, *Dimopoulos 2769* (UPA).

Photographs and field observations — **Peloponnisos:** Achaia: Mt Panachaiko, mountain plateau of Prassoudi, alt. c. 1800 m, grassland, 11 Aug 2015, *Tzanoudakis obs. & photos*; Korinthia: Mt Ziria (Killini), 37.55°N, 22.25°E, alt. 1750 m, 12 Aug 2010, *Polymenakos obs. & photos*; ibid., 37.55°N, 22.24°E, alt. 1950 m, 7 Aug 2009, *Kit Tan & al. obs.*; ibid., 37.55°N, 22.28°E, alt. 1946 m, *Zarkos obs.*; ibid., alt. 1500 m, dry meadow with rocky limestone outcrops, 37.57°N, 22.25°E, 27 Jul 2013, *Kit Tan, Vold & Zarkos obs.*

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