



Galatella malacitana (Asteraceae): a new species from the peridotitic mountains of southern Spain

GABRIEL BLANCA¹, ÓSCAR GAVIRA² & VÍCTOR N. SUÁREZ-SANTIAGO^{1,3}

¹ Departamento de Botánica, Facultad de Ciencias, Universidad de Granada, C/ Fuentenueva s/n, 28001 Granada, España; email: gblanca@ugr.es, vsuarez@ugr.es

² Camino de Castillejos 9, 1º D, 29010 Málaga, España; email: ogavira@hotmail.com

³ Author for correspondence

Abstract

A new species of the genus *Galatella* is described, illustrated, and compared with the other three Iberian taxa of the genus, *G. aragonensis*, *G. linosyris*, and *G. sedifolia* subsp. *sedifolia*, and the two morphologically most similar taxa, *G. sedifolia* subsp. *biflora* and *G. regelii*. The new species occurs on peridotitic soils, forming part of the open shrublands in the province of Málaga (southern Spain). In addition, a distribution map, illustrations, and a description of the habitat of the new species are presented. We also propose to use the presence or absence of hairs on the outer surface of the corolla as a diagnostic character in *Galatella*.

Key words: Astereae, Compositae, Iberian Peninsula, taxonomy

Introduction

The genus *Galatella* Cassini (1825: 463) includes between 30 and 45 species distributed mainly throughout Europe, Russia, Iran, and from India to western China (Tzvelev 1959, Ling *et al.* 1985, Nesom & Robinson 2007), its main centre of diversity being Eastern Europe and Russia.

The circumscription of this genus within the tribe Astereae and its relations with the genus *Aster* Linnaeus (1753: 872) are still insufficiently studied. Although main systematic studies of the tribe invariably argued for the independence of the genus *Galatella* with respect to the genus *Aster* (Tzvelev 1959, Ling *et al.* 1985, Nesom 1994a and 1994b, Nesom & Robinson 2007), this viewpoint has had little reception in most of the regional flora guides available in the Iberian Peninsula, which still include the species of *Galatella* in the genus *Aster* (Willkomm 1865, Coutinho 1939, Merxmüller *et al.* 1976, Franco 1984, Bolòs & Vigo 1996, Aedo 2014a). The most recent molecular studies suggest, on the one hand, its clear separation from the genus *Aster*, and, on the other hand, the inclusion of other closely related genera in *Galatella*, such as *Crinitaria* Cassini (1825: 475) [= *Linosyris* Cassini (1825: 460, 476), *nom. illeg.*], and *Tripolium* Nees (1832: 152) (Fiz *et al.* 2002, Brouillet *et al.* 2009, Li *et al.* 2012), this latter often being accepted as a separate genus.

The genus *Galatella* includes biennial to perennial species with stems erect; leaves alternate, linear, oblong to sometimes oblanceolate-spathulate, entire, 1–3-nerved, sessile or the lowermost petiolate; synflorescence corymbose, (1–)2–50(–70)-headed; involucre cylindrical to obconical, with phyllaries 2–9-seriate, herbaceous to subcoriaceous; ray flowers absent or up to 30, usually sterile, rarely pistillate, limbs pinkish or bluish-violet; disc flowers hermaphrodite, yellow or partly pink; anthers not appendiculated at the base; style appendages lanceolate or ovate-triangular; achenes obovate, fusiform to oblong, somewhat compressed, without obvious ribs, strigose-sericeous and gland-dotted; pappus bristles whitish to pinkish, (1–)2–3-seriate, basally somewhat connate, rarely caducous.

In Western Europe, and more specifically in the Iberian Peninsula, only 3 species of *Galatella* are found (Aedo 2014a, sub *Aster*): *G. aragonensis* (Asso 1779: 121) Nees (1832: 167), endemic to the Iberian Peninsula; *G. linosyris* (Linnaeus 1753: 841) Rehb. fil. in Reichenbach (1853: 8), widespread throughout Southern and Central Europe to Central Russia, Western Turkey, and the Caucasus, Algeria, and Morocco; and *G. sedifolia* (Linnaeus 1753: 874) Greuter

(2003: 47), distributed throughout Southern Europe, and from the Caucasus to Central Asia. *Galatella aragonensis* and *G. sedifolia* have ray flowers and have often been included in the genus *Aster*; *G. linoisyris* lacks ray flowers and has been included both in the genus *Aster* as well as in *Crinitaria*.

During a study of the flora of the peridotitic substrates of the province of Málaga (Andalusia, S Spain), we identified an undescribed species, which had been previously collected at least twice. Firstly, it was collected by Haenseler during the first half of the nineteenth century (GDA 4285); Willkomm (1865) cited the Haenseler's material as *Nolletia chrysocomoides* (Desfontaines 1799: 269) Lessing (1832: 187), while Aedo (2014b) recently identified it as *Aster sedifolius* Linnaeus (1753: 874) (= *G. sedifolia*), suggesting the exclusion of *Nolletia chrysocomoides* from the European flora. More recently it was collected and reported by López González (1975) as *Linoisyris vulgaris* Cass. ex Lessing (1832: 195).

The new species is characterized by the lack of ray flowers, a character shared with *G. linoisyris* and related taxa [subgen. *Linoisyris* (Cassini 1825: 460, 476) Rehb. fil. in Reichenbach (1853: 8)], *G. sedifolia* subsp. *biflora* (Linnaeus 1753: 841) Sennikov in Greuter & Raab-Straube (2006: 710) from Eastern Europe and Central Asia, and *G. regelii* Tzvelev (1959: 143) from Central Asia; however, the new species has vegetative characters that distinguish it from the others. This species is described and illustrated in the present paper, and its affinities, distribution and habitat are discussed.

Methods

The flowers and achenes were photographed using a variable-pressure LEO 1430 VP scanning electron microscope (SEM) in conventional mode, after gold-palladium coating (Thornill *et al.* 1965).

Chromosome numbers were counted at metaphase in root-tip meristems taken from germinating achenes. Roots were pretreated with 8-hydroxy-quinoline, fixed in ethyl alcohol-acetic acid (3:1), hydrolysed in 1 N HCl, stained in acetic orcein solution, and then flattened for light microscopy (Darlington & La Cour 1969).

Taxonomy

Galatella malacitana Blanca, Gavira & Suár.-Sant., **sp. nov.** (Figs. 1–3)

Leaves linear-lanceolate, the lowermost 3-nerved, the intermediate (2–)3–6 mm wide and one-nerved. Synflorescence laxly corymbose. Involucre 5–8 mm long, phyllaries 4–5-seriate. Ray flowers absent; disc flowers 17–23, hairy. Achenes 3.5–4.8 mm; pappus 3.5–5.5 mm.

Type:—SPAIN. Málaga: Coín, Sierra Alpujata, enebreal sobre peridotitas, elevation of 438 m, 14 Octubre 2013, *O. Gavira 61331* (holotype GDA!).

Perennial herb with nodose rhizome. Stems 1–3(–5), 35–55 cm, erect, floccose-tomentose, especially at the base. Leaves alternate, linear-lanceolate, entire, margins flat, gland-dotted and lanuginose on the lower side, the lowermost ones 50–120 × 3–7 mm, long-petiolate, 3-nerved, the intermediate ones 30–50 × (2)3–6 mm, sessile or subsessile, one-nerved, gradually decreasing in size upwards. Synflorescence corymbose, lax, 3–8-headed (or with up to 16 heads if abortive ones are included); branches simple, subpatent; peduncles 2.5–14(–16) cm. Involucre 5–8 mm long, cylindrical to obconical, decurrent in the peduncles; phyllaries 4–5-seriate, gradate, herbaceous, linear-subulate, one-nerved, glabrous, margins partly scarios. Receptacle slightly convex. Capitula discoid. Ray flowers absent. Disc flowers 17–23, 5–7 mm long, hermaphrodite, yellow, surface hairy (Fig. 3A); tubes slender, limbs narrowly campanulate, lobes 5, lanceolate; anthers 2.2–2.8 mm, not appendiculated at the base; style appendages lanceolate or ovate-triangular. Achenes 3.5–4.8 mm, obovate, somewhat compressed, without obvious ribs, strigose-sericeous and gland-dotted (Fig. 3B); pappus 3.5–5.5 mm, bristles scabrid, whitish to pinkish, (1–)2–3-seriate, basally somewhat connate. $2n=18$ (Fig. 4A, Table 1).

Etymology:—The specific epithet refers to the province of Málaga (Spain).

Distribution and habitat:—*Galatella malacitana* is a species endemic to the south of peninsular Spain, restricted to the province of Málaga. There are only three known localities: one in the municipality of Coín, specifically in Sierra

Alpujata, another in Sierra de Aguas, corresponding to the municipality of Carratraca, and another in Sierra Bermeja, municipality of Estepona (Fig. 5).

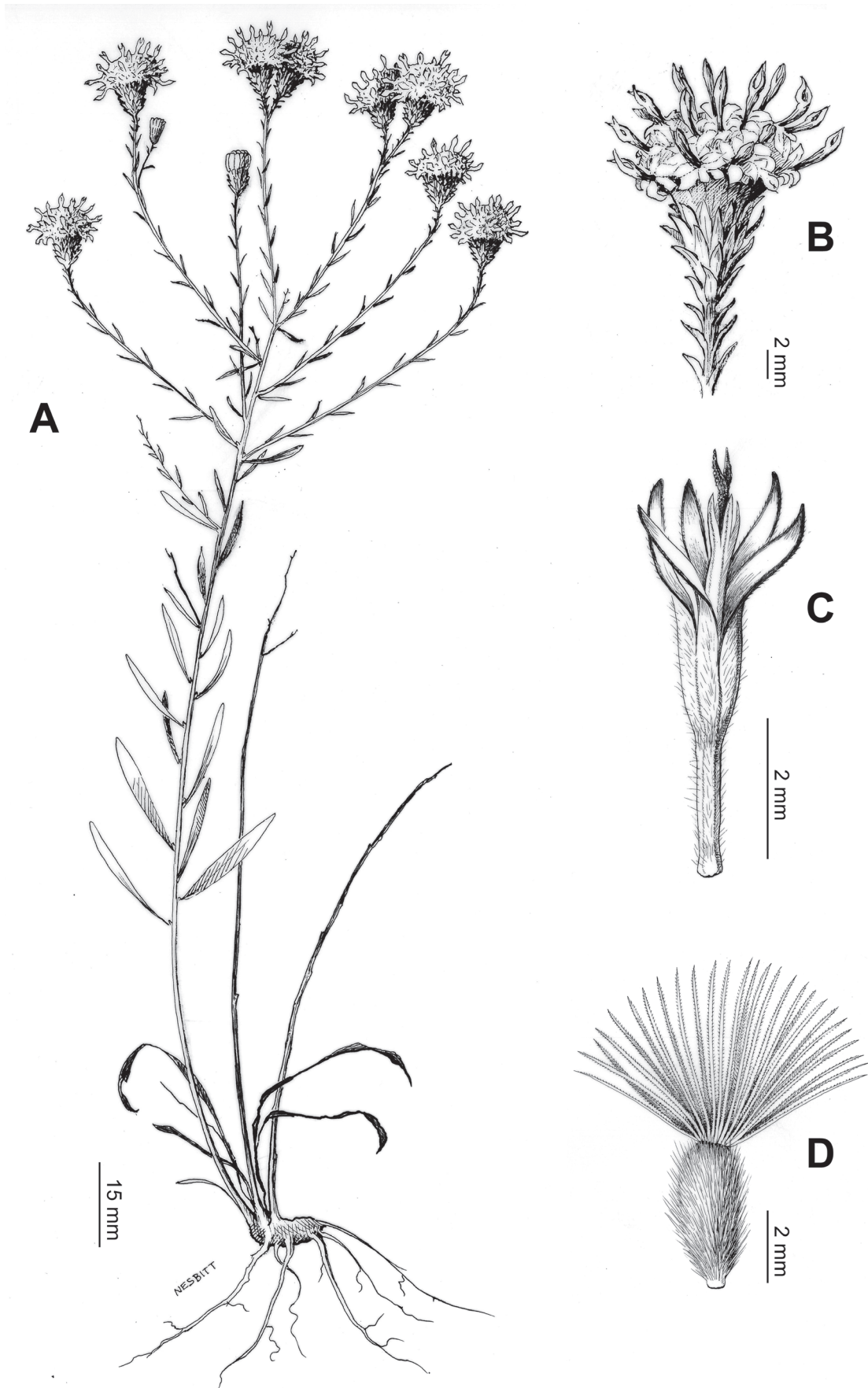


FIGURE 1. A–D *Galatella malacitana* (from the holotype). A, Habit; B, capitulum; C, detail of disc flower; D, achene and pappus.

TABLE 1. Comparison of *Galatella malacitana* with the other three Iberian taxa of the genus.

	<i>G. aragonensis</i>	<i>G. linoisyris</i>	<i>G. malacitana</i>	<i>G. sedifolia</i> subsp. <i>sedifolia</i>
Stem indumentum	floccose-tomentose, especially at the base and near the capitula	glabrous or papillose, especially towards the inflorescence	floccose-tomentose, abundant at the base and diminishing upwards	more or less scabrid
Basal leaves	spathulate 3-nerved	linear or acicular 1-nerved	linear-lanceolate 3-nerved	linear-lanceolate 3-nerved
Cauline leaves				
– width	0.5–0.9 mm	0.7–2 mm	(2–)3–6 mm	1.5–6 mm
– shape	linear or acicular, revolute	linear or acicular, revolute, rarely linear-lanceolate	linear-lanceolate, flat	linear or linear-lanceolate, flat
Synflorescence				
– aspect	lax (or solitary capitula)	compact	lax	compact
– branch	simple, ascendant or subpatent	ramose or sometimes simple, ascendant	simple, subpatent	ramose or sometimes simple, ascendant
– number of capitula	2–8	4–12	3–8(–16, abortive)	15–45
– peduncle length	1–6.5 cm	0.5–2.5(–3.5) cm	2.5–14(–16) cm	(0.5–)1–5.5 cm
Involucre				
– number of rows	7–9	4–5	4–5	4–6
– length	5.3–8.9 mm	3.5–5.5 mm	5–8 mm	4–6.3 mm
– indumentum	arachnoid	glabrous or papillose	glabrous	glabrous
Number of ligulate flowers	5–11	0	0	5–9
Floscules				
– length	5.3–7 mm	5–8 mm	5–7 mm	5.3–9.5 mm
– indumentum	present	absent	present	absent
Achenes				
– length	2.5–4.6 mm	2.4–4.5 mm	3.5–4.8 mm	3–5 mm
– shape	fusiform	obovoid	obovoid	obovoid
– pappus	4.6–6.7 mm	4.5–6.5 mm	3.5–5.5 mm	5.5–7.5 mm
Chromosome number (2n)	not known	18* ¹ , 36* ²	18 ³	18* ⁴ , 36* ⁵ , 36 ⁶
Substrate	limestone or siliceous	generally limestone	serpentine	generally limestone

* Counts made in material from outside the Iberian Peninsula

¹ Baksay (1958), Chuksanova *et al.* (1968), Hindáková (1970), Javůrková-Jarolímová (1992)

² Baksay (1958), Monti *et al.* (1978), Kovanda (1984)

³ Reported here (Málaga, Coín, Sierra Alpujata, GDA 61331; Málaga, Carratraca, Sierra de Aguas, GDA 61334, Fig. 4A)

⁴ Monti *et al.* (1978)

⁵ Negodi (1938), Garbari & Tornadore (1972), Krasnikov & Korolyuk (2011)

⁶ Reported here (Granada, Puebla de Don Fadrique, HUAL 25014; Jaén, Torredelcampo, cerro de los Morteros, JAEN 742348, Fig. 4B)

The new species grows exclusively on peridotitic soils, forming part of the open shrublands, in the thermomediterranean bioclimatic belt at elevations between 400–700 m a.s.l. and in a dry ombrotype climate.

Phenology:—*Galatella malacitana* flowers from October to November, and produces fruits from late November to December.

Additional specimens examined (paratypes):—SPAIN. Málaga: Carratraca, Sierra de Aguas, 5 October 1972, *G. López González 444948* (MA!); Carratraca, Sierra de Aguas, pinar con matorral sobre peridotitas, 650 m, 15 October 2013, *O. Gavira 61334* (GDA!); Coín, Sierra Alpujata, pinar con matorral sobre peridotitas, 600 m, 6 October 2012, *O. Gavira & P. Carrasco 61332* (GDA!); Coín, Sierra Alpujata, pinar con matorral sobre peridotitas, 600 m, 9 October 2012, *O. Gavira & P. Carrasco 61333* (GDA!); Sierra Bermeja, ad laterem maris, undated, *Haenseler 4285* (GDA!).



FIGURE 2. *Galatella malacitana* (GDA 61334). **A**, Detail of synflorescence; **B**, capitulum.

Comparison and discussion:—Table 1 lists the main differences between *Galatella malacitana* and the other three Iberian taxa. Besides morphology, it is distinguished from the other three by its ecological behaviour. While *G. aragonensis*, *G. linoisyris* and *G. sedifolia* subsp. *sedifolia* live on limestone or siliceous substrates, *G. malacitana* grows exclusively in Mediterranean thickets on peridotites, a type of substrate with nutrition imbalances for plants that harbour numerous endemic taxa (Rivas Goday & Esteve Chueca 1972; Rivas Goday 1973; Kruckerberg 1992; Stevanović *et al.* 2003; Reeves & Adigüzel 2004; Safford *et al.* 2005; Selvi 2007; García-Barriuso *et al.* 2012; Pérez-Latorre *et al.* 2013).

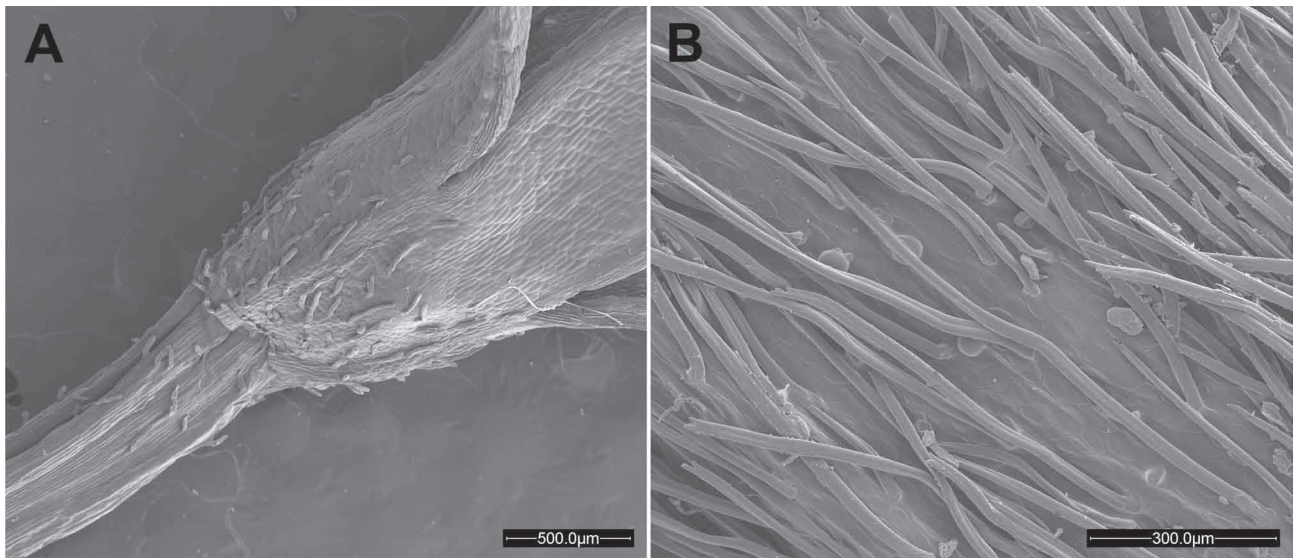


FIGURE 3. SEM micrographs of *Galatella malacitana* (from the holotype). **A**, Detail of disc flower showing surface hairs; **B**, detail of achene showing the strigose-sericeous indumentum and the short-stalked glands.

Galatella malacitana can be easily distinguished from *G. aragonensis* and *G. sedifolia* (except subsp. *biflora*) by its lack of ray flowers, a character that it shares with *G. linoisyris* and related species [subgen. *Linoisyris*]. It can be distinguished from this latter species by its stems floccose-tomentose, basal leaves 3-nerved, cauline leaves wider, linear-lanceolate, flat, and hairy disc flowers (Fig. 3A). The presence or absence of hairs on the outer surface of the corolla is an excellent taxonomic character that has not been taken into account previously; *G. malacitana* and *G. aragonensis* have hairy disc flowers, while those of *G. linoisyris* and *G. sedifolia* are constantly glabrous.

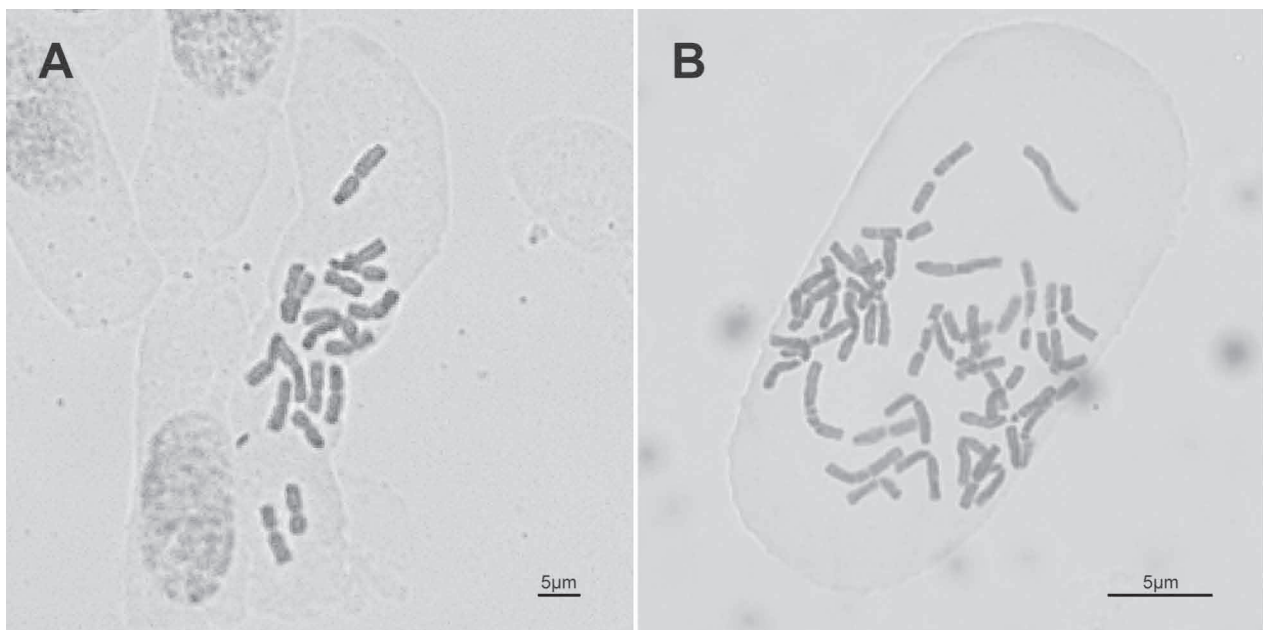


FIGURE 4. Metaphase plates: **A**, *Galatella malacitana* (GDA 61334); **B**, *Galatella sedifolia* (JAEN 742348).

Besides *G. malacitana*, only two taxa of *Galatella* outside *G.* subgen. *Linosyris* lack the ray flowers, namely *G. sedifolia* subsp. *biflora* and *G. regelii*. *Galatella malacitana* differs from *G. sedifolia* subsp. *biflora* by a combination of differences in morphological characters and chromosome number. The morphological characters distinguishing both taxa include: the venation of the cauline leaves (all one-nerved in *G. malacitana* vs. the lower ones 3-nerved in *G. sedifolia* subsp. *biflora*), the synflorescence (laxly corymbose in *G. malacitana* vs. rather compact in *G. sedifolia* subsp. *biflora*), the number of flowers in capitula (17–23 in *G. malacitana* vs. 5–20 in *G. sedifolia* subsp. *biflora*), the involucre length (5–8 mm in *G. malacitana* vs. 3–5 mm in *G. sedifolia* subsp. *biflora*), and the venation of the external phyllaries (one-nerved in *G. malacitana* vs. 3-nerved in *G. sedifolia* subsp. *biflora*). Moreover, *Galatella malacitana* is a diploid species ($2n=18$; Fig. 4A) while *G. sedifolia* subsp. *biflora* is tetraploid ($2n=36$; Krasnikov & Korolyuk 2011).

Galatella malacitana also shares some morphological characters with the Asian *G. regelii* (besides the lack of ray flowers), such as having only 3-nerved basal leaves, and lax corymbose synflorescence with few capitula. However, *G. regelii* is clearly distinguished by lacking a lanuginose indument and having rather numerous basally ascending stems, cauline leaves c. 2 mm wide, a smaller involucre (4–5 mm long) with 3-seriate phyllaries, a longer pappus (5–6 mm), and the ecological behaviour characteristic of salt-marsh meadows and grasslands (Tzvelev 1959).

Given that *Galatella malacitana* is a diploid species ($2n=18$; Fig. 4A) and it presents a very restricted distribution area, it is probably a relict species which has survived Pleistocene glaciations to be stranded in thermophilous areas on the Mediterranean slopes of Betic Sierras, which constituted plant refugia during the glaciations (Blanca 1993, 1997; García-Antón *et al.* 2007; Monserrat & Gavira 2014).

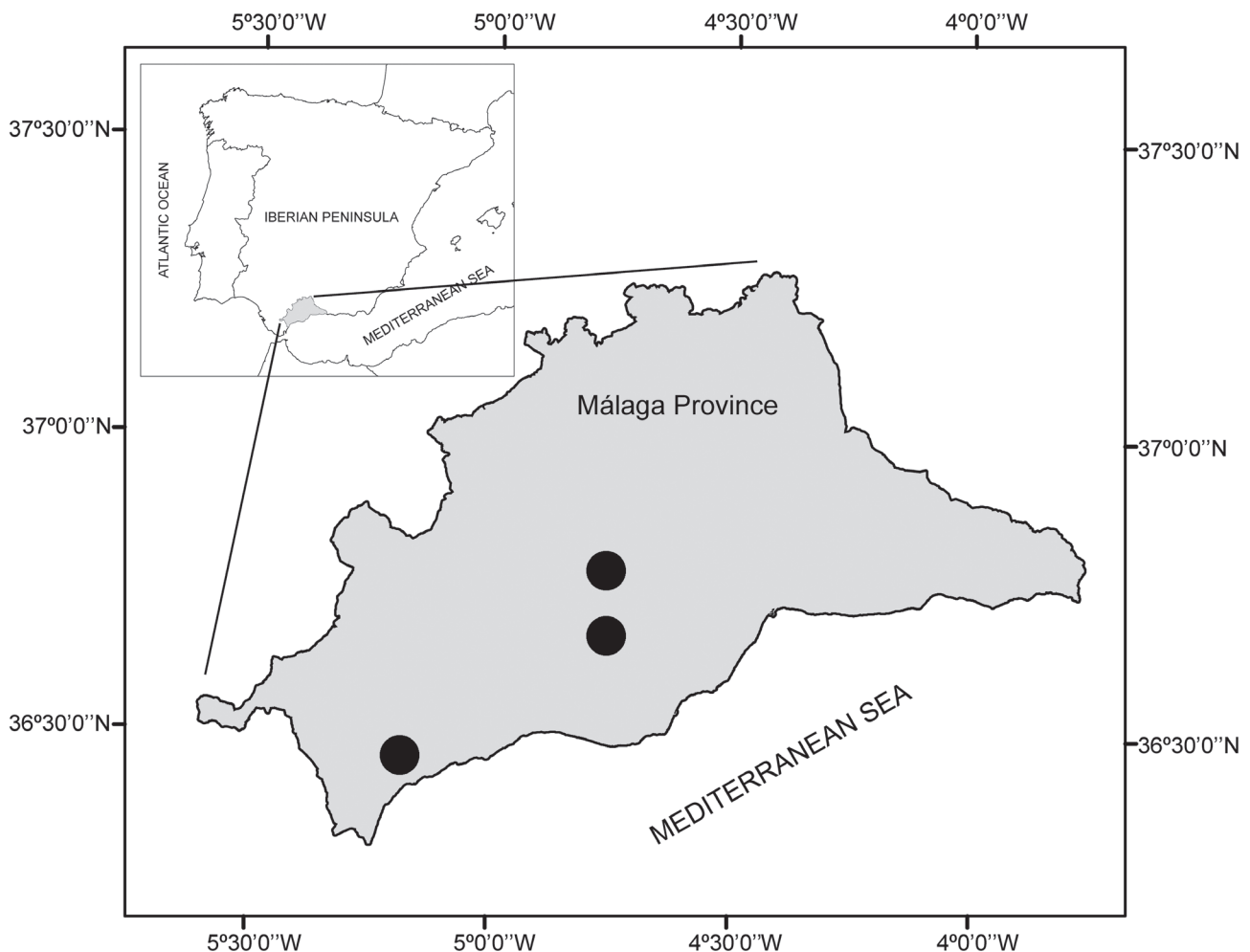


FIGURE 5. Map of the known populations of *Galatella malacitana* in the Iberian Peninsula.

Additional material studied:—*Galatella aragonensis*. SPAIN. Ávila: Navalenguilla, camino de los Veratos, 30TTK8657, brezales al borde del camino, 1300 m, 24 August 2003, A. González Canalejo 58054 (GDA!). Guadalajara: Sigüenza, en el rodano, 10 September 1949, Fernández Galiano & Rivas Goday (Flora Hispánica-Herbario Normal, Centuria VIII, Junio de 1954, núm. 787) 3732 (GDA!). La Rioja: Entre Robres et La Santa, cistetum laurifol., 1100

m, 4 September 1935, *F. Cámara* (Plantes d'Espagne.-F. Sennen, núm. 9967) 3730 (GDA!). Salamanca: Tejares, 30TTL7237, asomos de pizarras, 825 m, 22 September 1985, *Sánchez Rodríguez* 24046 (GDA!). Teruel: Entre Mora de Rubielos y Albentosa, en lugares arcillosos áridos, 950 m, 2 October 1946, *E. Sierra* (Flora Hispánica-Herbario Normal, Centuria VII, Abril de 1951, núm. 686) 3731 (GDA!); Santa Bárbara y Los Morenales, prope Orihuela del Tremedal, 21 August 1936, *P. Font i Quer* 46604, 46462 (GDA!). ***Galatella linosyris***. SPAIN. Álava: Vitoria-Gasteiz, Ullibarri-Arazua, bajo la fallida presa de Noreste, 30TWN3350, pastos y matorral de recuperación tras incendio de quejigal, margas, 16 September 2010, *P.M. Uribe-Echebarria* (Exsiccata de Flora Iberomacaronésica Selecta, Centuria XV, 2010, núm. 1541) 56784 (GDA!). Bizkaia: Getxo, de la playa de Arrigunaga a la Punta de la Galea, 30TVP9701, matorrales de *Genistion occidentalis* sobre margas, 60 m, 28 September 2004, *M. Herrera* (Exsiccata de Flora Iberomacaronésica Selecta, Centuria IX, 2004, núm. 904) 49932 (GDA!). Burgos: Junta de Traslaloma, Villaventín, cerca del camino de Valdecilla, herbazales en bordes de camino, 30TVN701636 (Datum ED-50), 755 m, 1 October 2011, *J.A. Alejandre & M.J. Escalante* (Exsiccata de Flora Iberomacaronésica Selecta, Centuria XVI, 2011, núm. 1712) 58635 (GDA!). Cantabria: Pradería de Tanarrio, Camaleño, 30TUN6197579285, prado de siega en contacto con encinar, 480 m, 15 October 2007, *S.L.G. Robinson* (Exsiccata de Flora Iberomacaronésica Selecta, Centuria XII, 2007, núm. 1228) 53542 (GDA!). Huesca: Berdún, 30TXN7618, pasto en los claros del carrascal, 630 m, 2 October 1969, *P. Montserrat* (Herbarium Jaca, Flora Iberica, núm. 726369) 19985 (GDA!); Jaca, camino entre Puente Colgante y Banaguás, 30TXN9816, pastos de lastón con toperas, 800 m, 8 October 2008, *D. Gómez & J. Azorín* (Exsiccata de Flora Iberomacaronésica Selecta, Centuria XIV, 2009, núm. 1469) 55595 (GDA!). Jaén: Cazorla, Sierra de Cazorla, Nava de las Correhuelas, sustrato calcáreo, October 1998, *A. Benavente* 44849 (GDA!). La Iruela, Arroyo Frío, Parque Natural de Cazorla, Segura y las Villas, arroyo La Teja, 30SWH0802, pastizales arcillosos húmedos, 750 m, 5 October 2013, *G. Blanca, J. Fuentes & M. Cueto* 60120 (GDA!). La Rioja: San Vicente de la Sonsierra, ladera W-NW del cerro Salviaza sobre río Ebro, 30TWN1811, matorral abierto y herbazal en ambiente de coscojares desmantelados, calcarenitas, 450-465 m, 26 September 1999, *J.A. Alejandre & M.J. Escalante* 42185 (GDA!). Navarra: Badostáin, Irigarai, 30TXN143396, matorral de *Aphyllanthion*, 520 m, 11 November 2003, *S. Fernández & R. Ibáñez* (Exsiccata de Flora Iberomacaronésica Selecta, Centuria IX, 2004, núm. 945) 49973 (GDA!). Salamanca: Entre Muñoz y Boadilla, pastizales eutrofos sobre suelos gleyzados, 21 September 1979 (Herbario de la Facultad de Biología, Universidad de Salamanca, Flora Española, Primera Centuria, núm 79) 12088 (GDA!). ***Galatella sedifolia***. Granada: Dílar, próximo a Ermita Vieja, claros del matorral heliófilo, sobre calizo-dolomías, piso mesomediterráneo subhúmedo, 12 October 2004, *F.B. Navarro & M.N. Jimenez* 50266 (GDA!); Guadix, Rambla Becerra, 30SVG9142, yesqueras y matorrales heliófilos, 950 m, 10 June 2000, *F. Navarro Reyes* 43200 (GDA!); Órgiva, Sierra de Lújar, cabecera del Barranco de las Cuevas, 30SVF6378, piornales y sotobosque de pinares calizos, 1650 m, 10 September 2013, *J. Fuentes & G. Blanca* 59944 (GDA!); Padul, Sierra Nevada, Silleta de Padul, 30SVF49, subrupícola en roquedo calcáreo, 1500 m, 23 July 1985, *Molero Mesa & Pérez Raya* 17702 (GDA!); Sierra de Alfácar, 20 August 1909, *Díez Tortosa* 3743, 3744 (GDA!); ibidem, pr. Cueva del Agua, calizas, October 1986, *J. Molero Mesa* 58837 (GDA!); Sierra Nevada, Güéjar Sierra, frente al Pulpito de Canales, suelos pedregosos, 19 October 1979, *M. Ladero, López Guadalupe & J. Molero Mesa* 9041 (GDA!). Jaén: Torredelcampo, cerro de los Morteros, 30SVG2579, calizas, 1100 m, 9 November 1974, *C. Fernández* 742348 (JAEN!). La Rioja: San Vicente de la Sonsierra, cerros cercanos a Los Corrales, ladera N-NW sobre el río Ebro, 30TWN2309, pastos en zonas de coscojares desmantelados, calcarenitas, 400 m, 23 September 1999, *J.A. Alejandre & M.J. Escalante* 42969 (GDA!). Teruel: Gea de Albarracín, 1 October 1967, *Rivas Goday & Borja* 7339 (GDA!). Valencia: Barig, October 1978, *Mansanet & Mateo* 16328 (GDAC!); Oliva, carrascales aclarados, 200 m, 23 November 1984, *G. Mateo & R. Figuerola* 27910 (GDAC!).

Acknowledgements

The authors would like to thank C. Aedo for valuable information and for allowing us to consult his manuscript on the genus *Aster* (in prep.) for Flora Iberica. We thank Dr. F. Alba-Sánchez for assistance with Fig. 1, and to David Nesbitt for providing the illustration of the new species and for the language editing. We thank two anonymous reviewers and Dr. Sennikov for their helpful suggestions. We are also grateful to the herbarium of the University of Granada.

References

- Aedo, C. (2014a) *Aster* L. In: Castroviejo, S. (Coord.) *Flora Iberica*. Vol. 16. Real Jardín Botánico, CSIC, Madrid. [in preparation]
- Aedo, C. (2014b) *Nolletia chrysocomoides* (Desf.) Less. (Compositae), especie a excluir de la Flora Europea. *Acta Botanica Malacitana* 39: 320–321.
- Asso, I.J. de (1779) *Synopsis stirpium indigenarum Aragoniae*. Massiliae, 198 pp.
- Baksay, L. (1958) The chromosome numbers of Ponto-Mediterranean plant species. *Annales Historico-Naturales Musei Nationalis Hungarici* 50: 121–125.
- Blanca, G. (1993) Origen de la Flora Andaluza. In: Valdés, B. (Ed.) *Introducción a la Flora Andaluza*. Junta de Andalucía, Sevilla, pp. 19–35.
- Blanca, G. (1997) Origen y Evolución de la Flora Andaluza. In: Rodríguez-Hiraldó, C. (Ed.) *Naturaleza de Andalucía*. Vol. 3. Ediciones Giralda, Sevilla, pp. 77–134.
- Bolòs, O. de & Vigo, J. (1996) *Flora dels Països Catalans*. Vol. 3. Barcino, Barcelona, 1230 pp.
- Brouillett, L., Lowrey, T.K., Urbatsch, L., Karaman-Castro, V., Sancho, G., Wagstaff, S. & Semple, J.C. (2009) Astereae. In: Funk, V.A., Susanna, A., Stuessy, T.F. & Bayer, R.J. (Eds.) *Systematics, Evolution, and Biogeography of Compositae*. IAPT, Vienna, pp. 589–629.
- Cassini, A.H.G. de (1825) Paquerolle, *Bellium*. In: Cuvier, F. (Ed.) *Dictionnaire des sciences naturelles*. Vol. 37. Le Normant, Paris, pp. 454–495.
- Chuksanova, N.A., Svechnikova, L.I. & Alexandrova, T.V. (1968) Data on karyology of the family Compositae Giseke. *Citologija (Moskva & Leningrad)* 10: 198–206.
- Coutinho, A.X.P. (1939) *Flora de Portugal (plantas vasculares)*. 2ª edição. Bertrand, Lisboa, 938 pp.
- Darlington, C.D. & La Cour, L.F. (1969) *The handling of chromosomes*. Allen & Unwin, London, 272 pp.
- Desfontaines, R.L. (1799) *Flora atlantica*. Vol. 2(7–9). L.G. Desgranges, Paris, pp. 161–458.
- Fiz, O., Valcárcel, V. & Vargas, P. (2002) Phylogenetic position of Mediterranean Astereae and character evolution of daisies (*Bellis*, Asteraceae) inferred from nrDNA ITS sequences. *Molecular Phylogenetics and Evolution* 25: 157–171.
[http://dx.doi.org/10.1016/S1055-7903\(02\)00228-2](http://dx.doi.org/10.1016/S1055-7903(02)00228-2)
- Franco, J. do A. (1984) *Nova flora de Portugal (Continente e Açores)*. Vol. 2. Edição do autor, Lisboa, 659 pp.
- Garbari, F. & Tornadore, N. (1972) Numeri cromosomici per la flora italiana: 108–123. *Informatore Botanico Italiano* 4: 60–66.
- García-Antón, M., Gil Romera, G. & Carrión, J.S. (2007) Historia de la vegetación. In: Blanca, G. & Valle, F. (Eds.) *Proyecto Andalucía Naturaleza, XXIV, Botánica V*. Publicaciones Comunitarias, Sevilla, pp. 343–378.
- García-Barruso, M., Fernández-Castellano, C., Rocha, J., Bernardos, S. & Amich, F. (2012) Conservation study of endemic plants in serpentine landscapes: *Antirrhinum rothmaleri* (Plantaginaceae), a serpentinophyte with a restricted geographic distribution. *Plant Biosystems* 146: 291–301.
<http://dx.doi.org/10.1080/11263504.2011.607194>
- Greuter, W. (2003) The Euro+Med treatment of Astereae (Compositae) – generic concepts and required new names. *Willdenowia* 33: 45–47.
<http://dx.doi.org/10.3372/wi.33.33103>
- Greuter, W. & Raab-Straube, E. von (Eds.) (2006) Euro+Med Notulae, 2. *Willdenowia* 36: 707–717.
<http://dx.doi.org/10.3372/wi.36.36206>
- Hindáková, M. (1970) Index of chromosome numbers of Slovakian Flora (Part 1). *Acta Facultatis Rerum Naturalium Universitatis Comenianae, Botanica* 16: 1–26.
- Javůrková-Jarolímová, V. (1992) *Aster linosyris* (L.) Benth. In: Měsíček, J. & Javůrková-Jarolímová, V. (Eds.) *List of chromosome numbers of the Czech vascular plants*. Academia, Praha, pp. 106–119.
- Kovanda, M. (1984) Chromosome number in selected Angiosperms. 2. *Preslia* 56 (4): 289–301.
- Krasnikov, A.A. & Korolyuk, E.A. (2011) Asteraceae. In: Marhold, K. (Ed.), IAPT/IOPB chromosome data 11. *Taxon* 60 (4): 1220–1223.
- Kruckerberg, A.R. (1992) Plant life of western north American ultramafics. In: Roberts, B.A. & Proctor, J. (Eds.) *The ecology of areas with serpentinized rocks: a world overview*. Kluwer, Dordrecht, The Netherlands, pp. 31–73.
http://dx.doi.org/10.1007/978-94-011-3722-5_3
- Lessing, Ch.F. (1832) *Synopsis generum Compositarum*. Duncker et Humblot, Berlin, 473 pp.
- Li, W.-P., Yang, F.-S., Jivkova, T. & Yin, G.-S. (2012) Phylogenetic relationships and generic delimitation of Eurasian *Aster* (Asteraceae: Astereae) inferred from ITS, ETS and trnL-F sequence data. *Annals of Botany* 109: 1341–1357.
<http://dx.doi.org/10.1093/aob/mcs054>
- Linnaeus, C. (1753) *Species plantarum*. L. Salvius, Stockholm, 1200 pp.

- Ling, R., Chen, Y.L. & Shi, Z. (1985) Astereae. In: Ling, R., Chen, Y.L. & Shi, Z. (Eds.) *Flora Reipublicae Popularis Sinicae. Vol. 74*. Science Press, Beijing, pp. 70–353.
- López González, G. (1975) Contribución al estudio florístico y fitosociológico de Sierra de Aguas. *Acta Botanica Malacitana* 1: 81–205.
- Merxmüller, H., Schreiber, A. & Yeo, P.F. (1976) *Aster* L. In: Tutin, T.G., Heywood, V.H., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (Eds.) *Flora Europaea. Vol. 4*. Cambridge University Press, Cambridge, pp. 112–116.
- Monserrat, V.J. & Gavira, O. (2014) A new European species of *Nevrorthus* in the Iberian Peninsula (Insecta, Neuropterida). *Zootaxa* 3796 (2): 349–360.
<http://dx.doi.org/10.11646/zootaxa.3796.2.7>
- Monti, G., Pagni, A.M. & Viegi, L. (1978) Numeri cromosomici per la Flora Italiana: 416–422. *Informatore Botanico Italiano* 10 (1): 101–110.
- Nees von Esenbeck, C.G.D. (1832) *Genera et Species Asterearum*. I.D. Gruson, Vratislaviae, 310 pp.
- Negodi, G. (1938) Cariologia del genere *Aster* L. (Compositae). I. Contributo. *Archivio Botanico (Forlì)* 14: 185–216.
- Nesom, G. (1994a) Subtribal classification of the Astereae (Asteraceae). *Phytologia* 76: 193–274.
- Nesom, G. (1994b) Review of the taxonomy of *Aster* sensu lato (Asteraceae: Astereae), emphasizing the New World species. *Phytologia* 77: 141–297.
- Nesom, G. & Robinson, H. (2007) Tribe Astereae Cass. In: Kadereit, J.W. & Jeffrey, C. (Eds.) *The Families and Genera of Vascular Plants. Vol. 8*. Springer, Leipzig, pp. 284–342.
- Pérez-Latorre, A.V., Hidalgo-Triana, N. & Cabezudo, B. (2013) Composition, ecology and conservation of the south-Iberian serpentine flora in the context of the Mediterranean basin. *Anales del Jardín Botánico de Madrid* 70: 62–71.
<http://dx.doi.org/10.3989/ajbm.2334>
- Reeves, R. & Adigüzel, N. (2004) Rare plants and nickel accumulators from Turkish serpentine soils, with special reference to *Centaurea* species. *Turkish Journal of Botany* 28: 147–153.
- Reichenbach, H.G.L. (1853–1854) *Icones Florae Germanicae et Helveticae. Vol. 16*. Ambrosii Abel, Lipsiae, 86 pp., 150 pl.
- Rivas Goday, S. (1973) Plantas serpentínicas y dolomíticas del sur de España. *Boletim da Sociedade Broteriana, 2a Series 47* (Supplement): 161–178.
- Rivas Goday, S. & Esteve Chueca, F. (1972). Flora serpentínica española. *Anales de la Real Academia de Farmacia* 38: 409–462.
- Safford, H.D., Viers, J.H. & Harrison, S.P. (2005) Serpentine endemism in the California flora: a database of serpentine affinity. *Madroño* 52: 222–257.
[http://dx.doi.org/10.3120/0024-9637\(2005\)52\[222:SEITCF\]2.0.CO;2](http://dx.doi.org/10.3120/0024-9637(2005)52[222:SEITCF]2.0.CO;2)
- Selvi, F. (2007) Diversity, geographic variation and conservation of the serpentine flora of Tuscany (Italy). *Biodiversity and Conservation* 16: 1423–1439.
<http://dx.doi.org/10.1007/s10531-006-6931-x>
- Stevanovič, V., Tan, K. & Iatrou, G. (2003) Distribution of endemic Balkan flora on serpentine. I. Obligate serpentine endemics. *Plant Systematics and Evolution* 242: 149–170.
<http://dx.doi.org/10.1007/s00606-003-0044-8>
- Thornill, J.W., Matta, R.K. & Wood, W.H. (1965) Examining three-dimensional microstructures with the scanning electron microscope. *Grana Palynologica* 6: 3–6.
<http://dx.doi.org/10.1080/00173136509429136>
- Tzvelev, N.N. (1959) *Galatella* Cass. In: Schischkin, B.K. (Ed.) *Flora of the USSR. Vol. 25*. Akademiya Nauk SSSR Publishers, Moscow & Leningrad, pp. 138–172. [English translation: Smithsonian Institution Libraries, Washington D.C., 1999, pp. 128–161]
- Willkomm, M. (1865) Compositae L. In: Willkomm, M. & Lange, J. (Eds.) *Prodromus Florae Hispanicae. Vol. 2*. E. Schweizerbart, Stuttgartiae, pp. 24–273.