

Typification of *Linaria badalii* (*Plantaginaceae*, *Antirrhineae*), and the problem of the original material used to describe the species

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Abstract. The typification of the name *Linaria badalii* (*Plantaginaceae*, *Antirrhineae*), is discussed. The designation of the nomenclatural type is based on an assessment of Loscos's original material, collected by Antonio Badal in Las Parras de Martín (Teruel, Spain). The name is lectotypified using a specimen from Loscos's herbarium preserved at The Royal Aragonese Economic Society of Friends of the Country (RAESFC) in Zaragoza, Spain. However, the lectotype lacks seeds, and the seeds have relevant diagnostic characters that are considered useful for taxonomy. Therefore, a specimen preserved in the Herbarium of the Royal Botanic Garden of Madrid (MA), also collected by Badal in the same locality as the original material used by Loscos to describe his species, is designated as the epitype of *L. badalii* to avoid any ambiguity in the interpretation of the lectotype.

Keywords: Antonio Badal, Francisco Loscos, epitype, lectotype, nomenclature, *Scrophulariaceae*, Teruel, Willkomm.

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Introduction

Linaria Miller is the largest genus (ca. 150 species) within the tribe *Antirrhineae* Dumortier (*Scrophulariaceae*, or *Plantaginaceae* sensu APG IV, 2016). It is distributed throughout the northern hemisphere, with its center of distribution in the Mediterranean Basin (Hong, 1983).

Linaria sect. *Supinae* (Bentham) Wettstein is a monophyletic taxon (Blanco-Pastor *et al.*, 2012) and highly diversified in the Mediterranean basin (Sutton, 1988). It is the most complex taxonomic section of the genus forming groups of closely related taxa that are difficult to separate due to their variable vegetative characters. The Iberian Peninsula is considered the center of diversity of this section, with 44 species (Sutton, 1988). This section includes hermaphroditic annual and perennial plants, with corolla size, seed shape, and life form being considered diagnostic characters for winged-seeded *Linaria* species (Valdés, 1970, 1987; Segarra & Mateu, 2001a, 2001b; Sáez & Bernal, 2009; Blanco-Pastor *et al.*, 2012; Juan *et al.*, 2018).

Within *L.* sect *Supinae*, the species *L. badalii* Willk. ex Loscos is an annual plant, characterized by leaves on fertile stems grouped in whorls of 3–5 up to half the stem length, and a relatively narrow corolla tube with a white, whitish-pinkish, or yellowish corolla, purple veins, and a yellow to orange palate. It is a very critical species, frequently confused with *L. propinqua* Boiss. & Reut., *L. glauca* (L.) Chaz., *L. supina* (L.) Chaz., *L. argillicola* Juan *et al.*, and *L. accitensis* L. Sáez *et al.* (Valdés, 1970; Chater *et al.* 1972; Sutton, 1988; Pérez Dacosta, 1998; Sáez & Bernal, 2009; Juan *et al.*, 2018). These taxa are very difficult to separate from each other, as they differ in only a few characters, and some of them are sympatric. The species is distributed in calcareous, siliceous, marly, and gypsiferous soils in the north, northeast, and east of Spain (Vicioso, 1911; Montserrat, 1975; Bolòs & Vigo, 1996; Mateu *et al.*, 2000; Segarra & Mateu, 2001a; Mateo *et al.*, 2011; Sáez & Bernal, 2009; Sáez & Sainz, 2011; <http://www.anthos.es/>).

Several classical and modern works, as well as current international databases, consider Heinrich

Moritz Willkomm to be the author of the effective and valid description of this species (see e.g., Vicioso, 1911; Valdés, 1970; Sutton, 1988; Pérez Dacosta, 1998; Marhold, 2011+; IPNI, 2024; POWO, 2024; among other). However, although Willkomm published '*Linaria badalii* Willk.' (Willkomm, 1886 [December]: tab. 110; 1887 [August]: 33), this species had already been validly published by Loscos (1885), perhaps inadvertently (see below). As mentioned in the results section of this paper, although Loscos was the author of the valid description, the epithet "*badalii*" (as "*Badali*") was attributed to Willkomm by Loscos himself (see Loscos, 1885). Thus, the name is cited as either *L. badalii* Willk. ex Loscos or *L. badalii* Loscos.

From the nomenclatural point of view, Valdés (1970: 168) was unable to locate any relevant specimens of *L. badalii* in the Herbarium Willkomm at Coimbra (Portugal) and published a hypothesis on Willkomm's material, which was sent by Badal, as follows: "*Tipificación. Entre el material de herbario de Willkomm (COI), no se encuentra ningún ejemplar que pertenezca a esta especie. Badal envió a Willkomm unos ejemplares vivos que utilizó para preparar la descripción y el icon (l. c.), y probablemente no los conservaría*" [*Typification. Among Willkomm's herbarium material (COI), there are no specimens belonging to this species. Badal sent Willkomm some live specimens that he used to prepare the description and the icon (l. c.), and he probably did not keep them*].

On the other hand, Sutton (1988) indicated: "Type: Spain: (not located (cf. Valdés, 1970a: 168) COI?)", and mentioned that it may be necessary to select a neotype for *L. badalii*. However, this does not constitute any concrete and effective typification for the name.

In conclusion, the name *Linaria badalii* has apparently not yet been typified (Valdés, 1970; Sutton, 1988; Sáez & Bernal, 2009). In this paper, we aim to fix the application of the name *Linaria badalii* through typification. This nomenclatural act is highly recommended because this species is a very critical and polymorphic taxon (Sutton, 1988; Sáez & Bernal, 2009), highly variable with respect to vegetative morphological traits, even within populations. Furthermore, the name includes several accepted synonyms (see e.g., *L. guarensis* Losa; *L. odoratissima* var. *pau* C. Vicioso & Sennen; *L. proxima* Coincy, *L. supina* var. *glaberrima* Freyn).

Material and Methods

This work was undertaken based on the study of the protologue of *Linaria badalii* (Loscos, 1884, 1885). The designation of type is based on the consultation of original material, specifically a relevant specimen cited in the protologue. This original material used to describe the species has been carefully evaluated to determine the precise taxonomic application of the name. Acronyms of the herbaria consulted are listed according to Thiers (2024 [continuously updated]). However, the Herbarium of Francisco Loscos y Bernal, which has been studied and cited in this paper, is preserved at The Royal Aragonese Economic Society of Friends of the Country (RAESFC) in Zaragoza, Spain. The RAESFC was founded in

Zaragoza in 1776 and opened its establishment in the year 1876 at 5 Reyno Square. It is currently located at 8 San Jorge St. (Zaragoza).

We have investigated the epistolary correspondence between Loscos and Willkomm to find clues related to the history of the description of this species. Likewise, to locate original material used by Loscos for the description of this plant, it was necessary to examine the information contained in the correspondence between these two authors. The epistolary collection of Loscos has been studied based on the transcriptions and edition published by Gotor & Martínez (2001) from the "Joaquín Loscos collection" (see González Bueno & Muñoz Garmendia, 2001a, 2011b).

Features of gross morphology were studied using a binocular microscope, Olympus SZX12, with a DFPL-1X-PF objective and an incorporated micrometer.

For scanning electron microscopy (SEM), seeds samples were glued to aluminum stubs, coated with a 50 nm gold film, and examined with an EVO ZEISS Scanning Electron Microscope at 10kV at the "Servei de Microscopia, Universitat Autònoma de Barcelona". The terminology of seed-coat surface sculpturing follows Barthlott (1981), Sutton (1988), and Sáez & Crespo (2005).

Results and Discussion

Historical background of the name and material of *Linaria badalii*

In the early 1860s, due to the difficulties encountered in publishing their botanical work, Francisco Loscos and José Pardo began their correspondence with the Saxon botanist Heinrich Moritz Willkomm, an expert in Iberian flora. It was he who had to summarize, correct, translate into Latin, and edit the *Series inconfecta plantarum indigenarum Aragoniae praecipue meridionalis* [...] (Loscos & Pardo, 1863); from then on, a fluid professional relationship was established with H. M. Willkomm, which was maintained until the death of Loscos.

The protologue of *Linaria badalii* (Loscos, 1885) includes a comment mentioning the species name, with the epithet '*badali*', and with reference to a work by Willkomm that had not yet been published (see below). The protologue also includes a direct reference to a previously published description of this plant by Loscos: "Para la entrega XII [of the *Illustrationes Florae Hispanicae*... of Willkomm] se halla designada la *Linaria* de flor blanca (Suplemento 6°, pág. 27) bajo el nombre *Linaria Badali*, reconocida como especie nueva" (Loscos, 1885: 58). Loscos clearly refers to Willkomm in his commentary "Para la entrega XII", referring to volume 2(12) of Willkomm's *Illustrationes Florae Hispanicae* (1886).

Therefore, the name *Linaria badalii* can be cited as "Willk. ex Loscos" (see ICN Art. 46.5, Turland *et al.*, 2018). In this regard, there is a letter from Badal to Loscos (Las Parrás de Martín, 20 June 1884) in which he mentions: "Mi estimado Sr. Loscos. He recibido las dos cartas de V., la 1ª con letra del Sr. Willkomm; siento que no llegaron bien las flores de la *Linaria* de flor blanca. Ahora estoy cogiendo

semillas y las remitiré juntamente con un ejemplar seco; de este modo podrá verla y estudiarla [...]” [My dear Mr. Loscos. I have received the two letters from you, the first in Mr. Willkomm’s handwriting; I am sorry that the flowers of the white-flowered *Linaria* did not arrive properly. I am now collecting seeds and will send them along with a dry specimen; in this way, you will be able to see it and study it [...]].

Badal certainly sent material of *L. badalii* to Willkomm. In a letter dated 3 July 1884 (n. 132 in the epistolary, Joaquín Loscos collection), Badal told Loscos that he would send seeds to Willkomm: “Estos días remitiré al Sr. Willkomm semillas de la *Linaria* de flor blanca. No he recibido carta de dicho Sr.” [I will send seeds of the white-flowered *Linaria* to Mr. Willkomm these days. I have not received a letter from Mr. Willkomm].

Loscos also cultivated this species in 1885. In the manuscript of Loscos “Datos sobre la siembra en el jardín de Francisco Loscos y Bernal. 1885” [Planting data in the garden of Francisco Loscos y Bernal. 1885] (n. 139 in the epistolary, Joaquín Loscos collection), it is noted: “[...] Corral, Onopordon humile en el cuadro 1.º junto a los *Thalictros* y á la *Linaria* flor blanca. 8 Octubre [1885] [Corral, Onopordon humile in the 1st plot next to the *Thalictros* and the white-flowered *Linaria*. October 8th].

In July 1885, Willkomm had not yet described his ‘*Linaria Badali*’. In a letter sent to Loscos on July 17, 1885 (n. 143 in the epistolary, Joaquín Loscos collection), Willkomm mentioned that he had the plant grown in a pot and in bloom at that time: “Sñr. D. Francisco Loscos. [...] Para la entrega 11.ª [Illustrationes...], en la cual entran 4 plantas aragonesas, a saber *Allium Pardoii*, *Artemisia Assoana*, *Aster aragonensis* y *A. Willkommii*, necesito nada. La 12.ª contendrá especies de *Linaria* y *Antirrhinum*, entre ellas la *Linaria* de Aragón con flor blanca, supuesto que verdaderamente es especie nueva, pues hasta ahora no he podido ocuparme con ella, á pesar que la tengo viva en maceta y que está ahora mismo en flor. Sin embargo, celebraré mucho si V. quiere remitirme (¡a su tiempo!) ejemplares vivos de esta planta, pero por ahora no las quiero, porque me marchó pasado mañana y no volveré á fines de año que viene [...]” [Mr. Francisco Loscos. [...] For the 11th installment [Illustrationes...], which includes 4 Aragonese plants, namely *Allium Pardoii*, *Artemisia Assoana*, *Aster aragonensis* and *A. Willkommii*, I need nothing. The 12th will contain species of *Linaria* and *Antirrhinum*, among them the white-flowered *Linaria* of Aragón, which is, of course, truly a new species, since until now I have not been able to deal with it, even though I have it alive in a pot and it is right now in bloom. However, I will be very happy if you want to send me (in due time!) live specimens of this plant, but for now I don’t want them, because I’m leaving the day after tomorrow and I won’t be back until the end of next year...].

In a postcard sent by Willkomm to Loscos on October 21, 1885 (n. 152 in the epistolary, Joaquín Loscos collection), it is mentioned: “... le ruego á V. de remitirme planta viva ninguna, porque tenemos un frío de 4-12° bajo cero; pero tendré mucho gusto de recibir la raíz de la *Linaria*...” [...] I beg you to send me no live plant, because we have a cold of 4-12° below zero; but I will be happy to receive the root of *Linaria*]. Most likely, it is *Linaria badalii*.

On April 17, 1886, Willkomm sent a letter to Loscos (n. 155 in the epistolary, Joaquín Loscos collection) and mentioned that he had several specimens of this species before April 1886: “Muy Sñr. mío y estimado amigo: es en mi poder su carta de V. con fecha 7 del corriente, en cuya contestación le ruego me remita ahora las plantas que me ofrece, sobre todo la *Linaria* Badali, que voy a dibujar pronto. Tengo, si, bastantes ejemplares de esta especie con flor y fruto, pero quisiera pintarla al vivo, sobre todo las flores, habiendo descuidado, cuando la tuvo viva bien en flor, dibujarla” [Dear Sir and friend: I have in my possession your letter dated the 7th of this month, in whose reply I ask you to send me now the plants that you offer me, especially the *Linaria* Badali, which I will draw soon. I have, yes, quite a few specimens of this species with flower and fruit, but I would like to paint it live, especially the flowers, as I neglected to draw it when I had it alive and in full bloom]. Unfortunately, however, we have not been able to locate the material mentioned by Willkomm in this letter in the COI herbarium.

One month later, Willkomm sent a letter to Loscos (May 14, 1886) in which he discussed some aspects of the samples of *Linaria badalii*, its cultivation, and different material in his possession (n. 158 in the epistolary, Joaquín Loscos collection): “Muy Sñr. mío y estimado amigo: están en mi poder sus dos cartas de V. con fecha de 26 de Abril y 8 de Mayo, también los cañutos con plantas vivas de *Arenaria minutiflora* y *serpyllifolia*, *Erodium aragonense* y *malacoides*, *Linaria* Badali, *Onopordon humile*, *Ranunculus Aleae* y *Artemisia Assoana*, pero las plantas no han llegado en estado bueno [...]. Los ejemplares de *Onopordon*, *Ranunculus Aleae*, *Linaria* Badali y *Artemisia Assoana*, los he puesto al instante en macetas, pero exceptuando la *Artemisia* que vegeta bien, parece que perecerán. [...] Desearía ejemplares florecientes de la *Linaria* Badali, las semillas tengo ya. Hay también en el jardín plantas jóvenes de esta *Linaria* nacidas de las semillas recibidas el año pasado, pero apenas florecerán.” [Dear Sir and friend: I have in my possession your two letters from you dated April 26 and May 8, as well as the canes with live plants of *Arenaria minutiflora* and *serpyllifolia*, *Erodium aragonense* and *malacoides*, *Linaria* Badali, *Onopordon humile*, *Ranunculus Aleae* and *Artemisia Assoana*, but the plants have not arrived in good condition [...]. The specimens of *Onopordon*, *Ranunculus Aleae*, *Linaria* Badali and *Artemisia Assoana* were immediately placed in pots, but except for the *Artemisia*, which is growing well, it seems that they will perish. [...] I would like to have flowering specimens of *Linaria* Badali, I already have the seeds. There are also young plants of this *Linaria* in the garden, born from the seeds received last year, but they will hardly bloom].

In summary, it seems that Willkomm had material (even abundant material, see below) of *L. badalii* that was sent by Badal himself and by Loscos in several shipments. Willkomm had in his possession seeds as well as live specimens, either through shipments or through plant cultivation, whose material he used to draw the species he would later publish in his vol. 2(12) of the *Illustrationes...* published in 1886 (Figure 1).

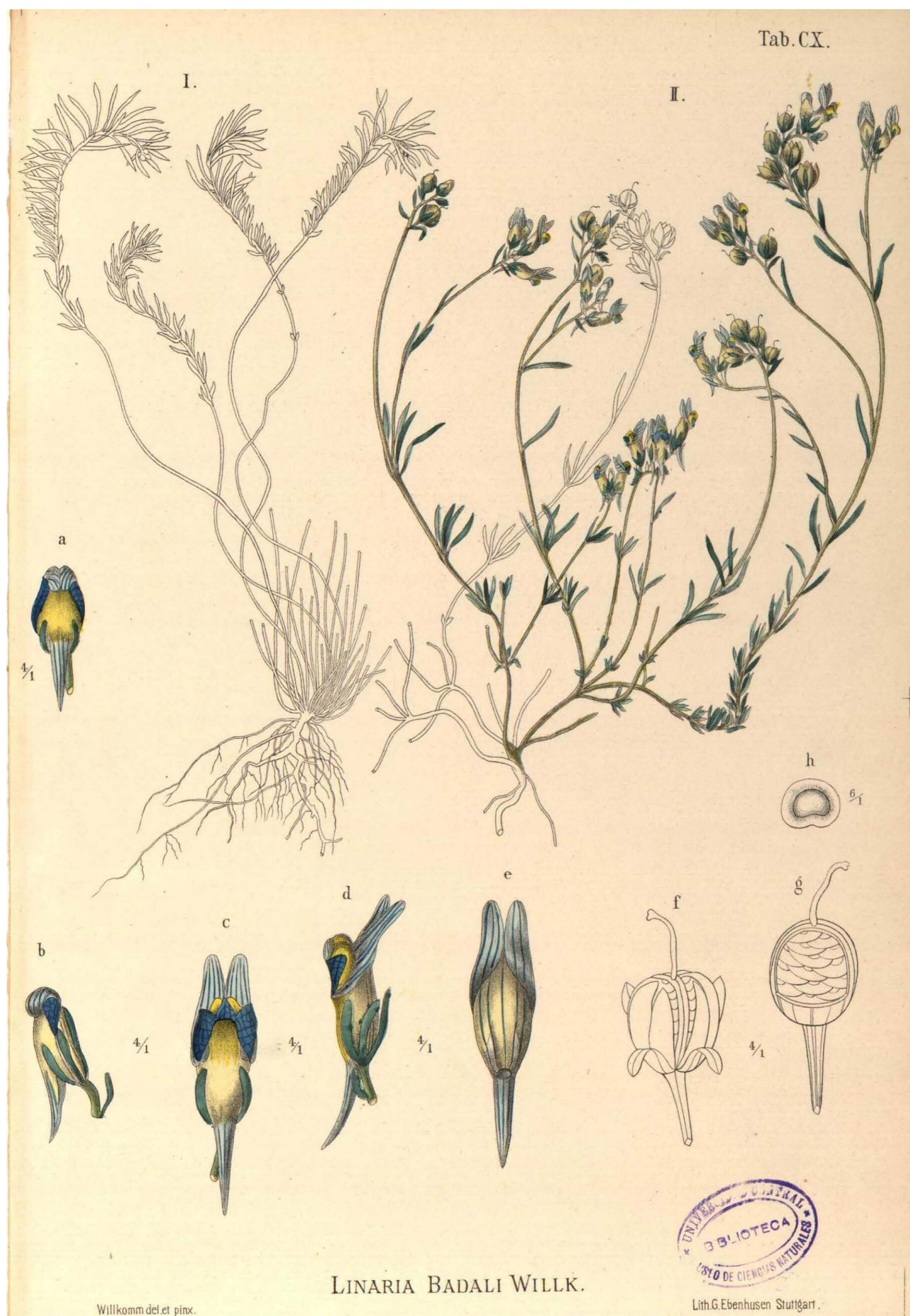


Figure 1. Illustration of *Linaria badali* published by Willkomm in volume 2 of his *Illustrationes Florae Hispaniae insularumque Balearum* (1887).

However, we have not been able to locate this material in the COI herbarium (see below). According to the correspondence between Willkomm and Loscos, the material of *L. badalii* in Willkomm's possession was abundant, but it is not entirely certain that it ended up in herbarium sheets. Perhaps Loscos' attempts to send live material so that Willkomm could draw the plant well failed to result in good specimens for herbarium sheets. Alternatively, Willkomm might have been unable to successfully grow the plants. Willkomm repeatedly insisted to Loscos that he needed living, flowering plants, and at one point in the correspondence commented that the plants he grew did not seem likely to bloom ("Desearía ejemplares florecientes de la Linaria Badali, las semillas tengo ya. Hay también en el jardín plantas jóvenes de esta Linaria nacidas de las semillas recibidas el año pasado, pero apenas floreceran") [I would like flowering specimens of Linaria Badali, I already have the seeds. There is also a young plant of this Linaria from seeds received last year, but they will hardly bloom].

On the description of the species and the typification of the name

The validly published description of *L. badalii* was made by Loscos in 1884 and was directly cited a year later by the author (Loscos, 1885) alongside with the binomial name, as discussed above. The work published in 1884 by Loscos ("Supplement 6", p. 27), cited in 1885 (see Loscos, 1885: 58), includes a complete description of this species: "2.692 [the number of the plant in the herbarium of Loscos, in the Herbarium of Aragón]. *Linaria* núm. 1 = de flor blanca. / Pertenece exactamente á la misma Sección que el núm. 2 por sus tallos numerosos desparramados ascendentes; semillas (lustrosas, totalmente negras) lenticulares-comprimidas (convexas), rodeadas de ala ancha, entera y muy delgada en los bordes, con la parte central lisa (arriñonada). / Planta *glauca muy lampiña*, con tallos de un decímetro filiformes, largamente ramosos. / Hojas lineares angostadas inferiormente, así como los segmentos del cáliz, aplanadas ó algo convexas por encima, deprimidas por debajo; las inferiores verticiladas por 3-4, así como las de ramos estériles que son más cortas; las superiores esparcidas, de 8-12 milím. de longitud sobre 1-1/2 de anchura. / Brácteas *rectas*, una mitad al menos *más largas* que el pedúnculo, que es poco más corto que las divisiones del cáliz, las cuales son *más cortas* que el tubo de la corola y más cortas ó apenas tan largas como la caja. / Corola blanca bañada de púrpura, sin puntos, larga de 18 milímetros, con espolón *encorvado* de 8 milím., esto es, *más corto* que la restante corola, con labio superior provisto de estrías purpúreas y formado de dos lóbulos obtusos y divergentes; el inferior amarillo por encima con tres lóbulos reticulados-estriados, *redoblados y plegados* por los lados" (Loscos, 1884: 27) [*Linaria* no. 1 = white-flowered. / It belongs exactly to the same section as number 2 due to its numerous, spreading, ascending stems; seeds (shiny, completely black) lens-shaped, compressed (convex), surrounded

by a wide, entire, and very thin wing at the edges, with a smooth central part (kidney-shaped). / A glaucous, very smooth plant, with filiform stems about a decimeter long, extensively branched. / Linear leaves, narrower at the base, as well as the calyx segments, flattened or slightly convex on top, depressed on the underside; the lower leaves in whorls of 3-4, as are the sterile stem leaves, which are shorter; the upper leaves scattered, 8-12 mm long and 1-1.5 mm wide. / Straight bracts, at least half longer than the peduncle, which is slightly shorter than the calyx lobes, which are shorter than the tube of the corolla and either shorter or only just as long as the capsule. / White corolla tinged with purple, without spots, 18 mm long, with a curved spur of 8 mm, shorter than the rest of the corolla, with an upper lip marked with purple ridges, formed by two obtuse and divergent lobes; the lower lip is yellow on top with three lobes, reticulated and striated, doubled and folded on the sides].

This detailed description is followed by the information on the geographical provenance, the collector of the specimen (Antonio Badal), and a diagnosis: "Habita en cercanías de Las Parras de Martín, de donde ha sido remitida á esta Agencia en 1883-1884 por D. Antonio Badal: May. - Jun./ Es por su porte y estatura muy semejante al núm. 2, del cual en el acto se diferencia por el colorido y muy particularmente por la dirección y mayor longitud constante de las brácteas, por la forma de la corola y por el color y brillo diferente de sus semillas. / Es también muy semejante á la *L. glauca* Willd., especie que no he visto, pero de ella difiere al menos por el color de la corola y semillas y por la curvatura constante del espolón" (Loscos, 1884: 27) [It grows in the vicinity of Las Parras de Martín, from where it was sent to this Agency in 1883-1884 by Mr. Antonio Badal: May-June. / It is very similar in size and stature to number 2, from which it immediately differs by its coloration and, very particularly, by the direction and greater, constant length of the bracts, the shape of the corolla, and the color and shine of its seeds. / It is also very similar to *L. glauca* Willd., a species I have not seen, but it differs from it at least in the color of the corolla and seeds, and by the constant curvature of the spur].

Among the preserved material of *L. badalii* that we have located from the locality of "Las Parras de Martín" (Teruel) and collected by Antonio Badal, we have found a very relevant specimen that is part of the original material used by Loscos to describe his species (Figure 2). The specimen is preserved in the Herbarium of Loscos at The Royal Aragonese Economic Society of Friends of the Country (RAESFC) in Zaragoza, Spain. The herbarium of Loscos at RAESFC is distributed in 36 hard cardboard boxes (see Ferrer & Muñoz Garmendia, 2001). It contains 3,378 herbarium sheets. According to Fernández Galiano (1961), the herbarium originally consisted of "3,363 plants" was in 20 cardboard boxes, which were later replaced by 36. Herbarium sheets of plants from the family *Scrophulariaceae*, including *Linaria*, are housed in box number 18 (Ferrer & Muñoz Garmendia, 2001). The sheet containing the original specimen of *Linaria badalii* is numbered "1921" (Ferrer & Díez, 2001).



Figure 2. Lectotype of *Linaria badalii*; Herb. Loscos n. 1921 (Box n. 18) preserved at The Royal Aragonese Economic Society of Friends of the Country (RAESFC) in Zaragoza. Image reproduced with permission from the herbarium RAESFC.

This specimen (no. 1921) consists of a single plant with leaves, flowers, and immature fruits. It is accompanied by two handwritten labels, which are annotated as follows: 1) “763 *Linaria* pequeña de flor blanca / (27) Rara en Parras de Martín / sobre el Molino Bajo: Parras en / los Cascajares sobre el Molino Bajo / en la Carbonera frente al Corral / 29 Mayo / Badal”; and 2) “n. 86 / *Linaria* Badali Willk. in litt. / Esp. nueva todavía no descrita. / Vease Supl. 6.º pag. 27 / *Linaria* n.1 = de flor blanca / Badal” (Figure 2).

Antonio Badal (1834-1911), born in Linares de Mora (Teruel), was the priest of Las Parras de Martín (Teruel). He corresponded and exchanged materials with Loscos and Carlos Pau, with some specimens reaching Willkomm via Loscos. Badal's name first appears among Loscos's correspondents at the end of 1882. Loscos published a “Herbario de D. Antonio Badal, remitido á la Agencia de Castelserás en 1883” [Herbarium of D. Antonio Badal, sent to the Castelserás Agency in 1883], containing collections dated between June 1882 and October 1883 (Loscos, 1884, 1986: 528-535). In this publication, under number 2692 “*Linaria* núm. 1 = de flor blanca” (see Loscos, 1884: 528).

Subsequently, Loscos refers again to Badal in supplements 5, 6, and especially 7, which likely include plant names collected by Badal and sent to the Castelserás Agency, under Loscos's direction. These collections were made in July and August 1884 (Loscos, 1884: 51, 1986: 553). Badal also contributed to Supplement 7 (1885) to the *Tratado de Plantas de Aragón* (Loscos, 1885: 57, 1986: 559), where “Plantas nuevas ó raras para la Flora de Aragón por D. Antonio Badal”, primarily collected in summer 1884, were published (Loscos, 1885, 1986: 555-556). This was followed by “Plantas nuevas ó raras para la Flora de Teruel y localidades nuevas en que habitan, por D. Antonio Badal”, also dated summer 1884 (Loscos, 1885, 1986: 556-558).

The Botanical Agency of Castelserás, founded by Francisco Loscos and José Pardo, facilitated the exchange and identification of Aragonese botanical material among local naturalists and, particularly, between Francisco Loscos and foreign botanists with whom he maintained correspondence (Loscos & Pardo, 1863; Fernández Galiano, 1961). Willkomm published a detailed description of *L. badalii*, also citing it as “*Linaria* Badali Willk. in litt. ad cl. Loscos – *Linaria* con flor blanca Losc. in suplem. 6 ad Tratado de plantas de Aragon (1884), p. 27”. Willkomm also referenced the same locality and collector indicated in Loscos's protologue (1884: 27), stating: “Hab. in Aragonia australi (provincial Turdetana), ubi in regione montana provenit, sed hucusque non nisi prope Las Parras de Martín, ubi eam cl. Badal detexit, observata est. – Floret Majo, Junio”. Willkomm includes an excellent illustration of this specimen along with several comments (see Willkomm, 1887). However, according to information from the COI herbarium, no material identified as *L. badalii* is preserved currently at COI (Filipe Covelo, pers. comm.).

We have found a specimen at COI, with barcode “COI00042538”, which is labeled as “*Linaria*

melanantha Boiss. R. / *Aragonia australis* / Leg. Loscos.” handwritten by Willkomm (Figure 3). The name *Linaria melanantha* Boiss. & Reut. is currently considered a synonym of *L. aeruginea* (Gouan) Cav. subsp. *aeruginea*. However, this specimen “COI00042538”, does not appear to fit *L. aeruginea* and may instead represent *L. badalii*. Unfortunately, it lacks a collection date and specific provenance, so it cannot be considered original material for the name *L. badalii*.

There are also two specimens of *L. badalii* collected by Badal in Las Parras de Martín (Teruel) and preserved in the Royal Botanical Garden of Madrid (MA). The sheet barcoded “MA109894” contains two plants and several stems, with leaves, flowers, fruits, and seeds (Figure 4). The sheet bears three labels: 1) a handwritten label by Badal: “*Linaria* Badali Losc. / Frecuente en cascajales calizos / desde La Rambla hasta Palomar, / en Las Parras de Martín y Utri- / llas en la umbría de las Coronillas / 14 de Julio de 1885 / Badal”; 2) another label handwritten by Badal: “*Linaria* Badali con flores todo / el verano. Frecuente en cascajales / calizos de Las Parras de Martín, / La Rambla y Utrillas a 900 y 1200 / m! de altura 2 de agosto de 1888 / Badal”; and 3) a printed label: “Herbarium Horti Botanici Matritensis / *Linaria badali* Losc. / Frecuente en cascajales calizos desde / La Rambla hasta Palomar en las Parras / de Martín y Utrillas en la umbría de / las coronillas / (Teruel) / 14-VII-1885 / leg. et det. Badal” (Figure 4).

This collection was mentioned by Loscos (1886: 100) as “*Linaria* Badali: frecuente en el cascajo calizo desde La Rambla hasta Palomar, Parras de Martín, Utrillas en la Umbrías de las Coronillas, 15 Jul. 1885”. However, in the original label handwritten by Badal is annotated two collection dates “July 15, 1885, and August 2, 1888”.

Unfortunately, the material on “MA109894” presents a complication: the date August 2, 1888 is post-protologue, i.e., after the publication of the name (VIII or IX 1885) (Loscos, 1885: 58) and the original description (after VII, before 13-VIII 1884) (see Loscos, 1884: 27) (see González Bueno *et al.*, 2001). However, the date 14 of July, 1885, predates the publication of the name (VIII or IX 1885) and could be considered as original material. Nevertheless, the material on this sheet is mixed, and it is impossible to assign specific fragments to each of the dates indicated on the labels. Therefore, while the sheet may contain original material, this material is not suitable for the lectotype.

On the other hand, the sheet with barcode “MA109895” also contains material of *L. badalii*. This sheet includes a plant and several stems with leaves, flowers, fruits, and seeds, accompanied by a label handwritten by Carlos Pau, which reads: “Caroli Pau Herbarium hispanicum [printed] / *Linaria* Badali Willk. / In Aragonia austr. “Las Parras de / Martín. / 2 Aug. 1888. / vio Illustr. Willkomm / Leg. Badal” (Figure 5). This material can be considered a duplicate of the 1888 collection preserved at “MA109894”. Therefore, specimen “MA109895” cannot be treated as original material used by Loscos for the description of his species.

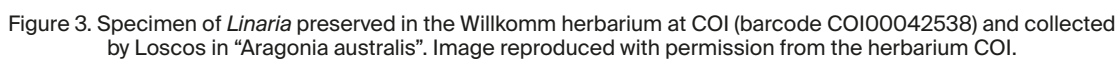




Figure 4. Specimen of *Linaria badalii* collected by Badal in "Las Parras de Martín" (Teruel), MA109894. Image reproduced with permission from the herbarium MA.

In conclusion, we propose the well-preserved specimen kept at The Royal Aragonese Economic Society of Friends of the Country (RAESFC) in Zaragoza (Figure 2) as the lectotype of the name *Linaria badalii*. The specimen shows diagnostic characters of this

species, such as: numerous fertile stems, decumbent to ascending, simple or branched, sterile stems 2–12 cm; leaves of fertile stems 3–16(–22) × 0.5–1.5(–2) mm, linear to linear-oblongate, flat, obtuse or subacute, arranged in whorls of 3–5 on the middle of the stems,



Figure 5. Epitype of *Linaria badalii*; MA109895. Image reproduced with permission from the herbarium MA.

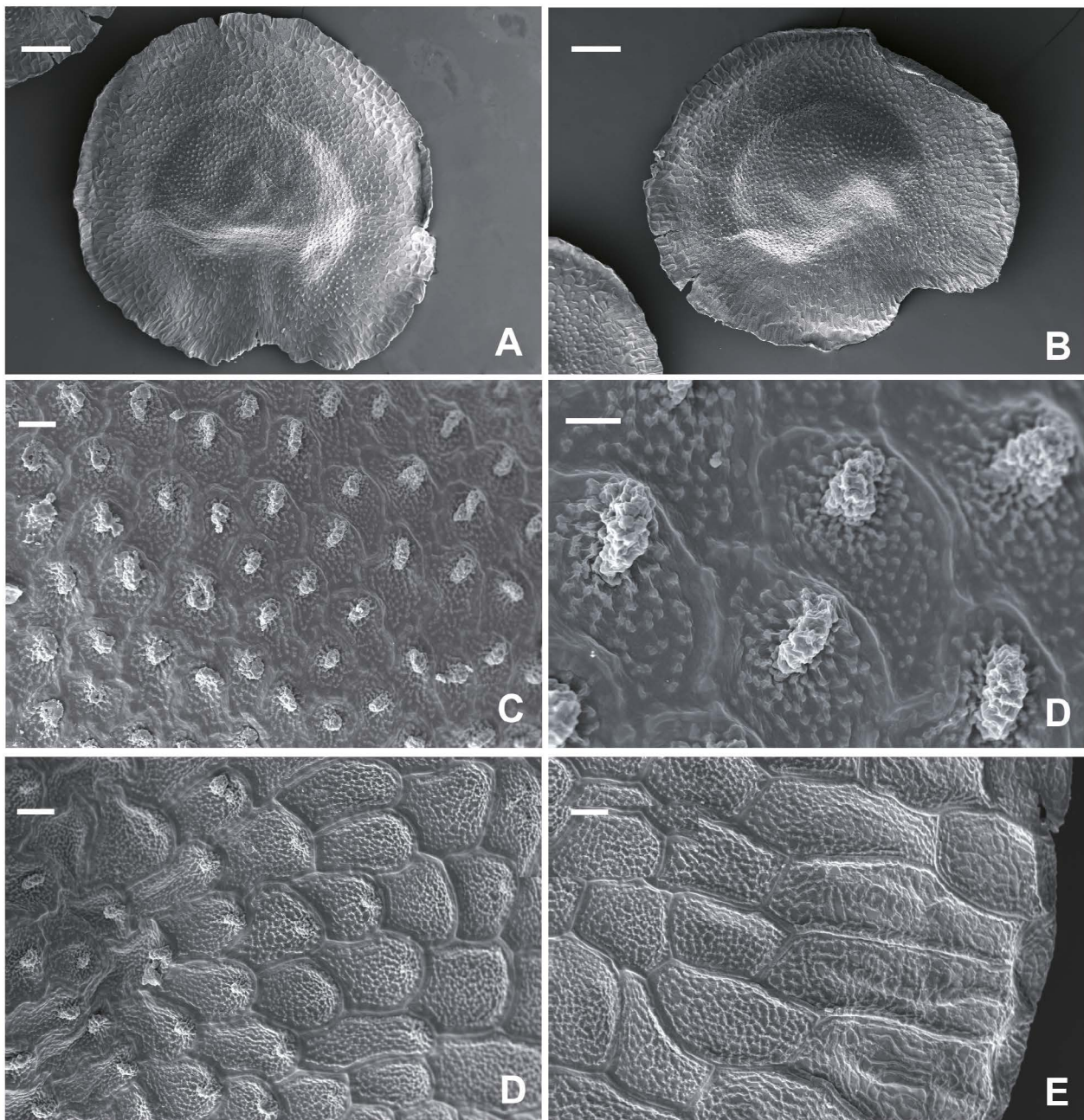


Figure 6. Scanning electron micrographs of seeds from the epitype of *Linaria badalii* (MA109895). A, B: Convex face of seeds. C, D: Testa cells from the disc showing papillae. E: Testa cells from the wing showing papillae in the cells closest to the disc. E: Testa cells from the outer wing showing densely reticulate, not papillate periclinal walls: Scale bars: A, B: 300 micrometers; C, E, F: 20 micrometers; D: 10 micrometers.

alternate above; leaves of sterile stems 3–11 × 0.5–1 mm, linear, flat, obtuse or subacute, in whorls of 3–5; inflorescence with 2–12 flowers, dense in flower and lax in fruit; bracts 2–8 × 0.4–1 mm, linear, acute; pedicels 0.5–2.5 mm in flower, and 0.5–4 mm in fruit, suberect; calyx-lobes subequal, 2.5–6 × 0.5–0.9 mm in flower, and 3–6.5 × 0.5–1 mm in fruit, linear; corolla 12–20 mm, white or pale yellow with purple veins; tube slender, straight or curved, shorter than the rest of the corolla [immature capsule ca. 3 × 3 mm, subglobose, glabrous; seeds absent] (see Figure 2).

Unfortunately, the lectotype lacks seeds, which are crucial for the critical identification and differentiation of this species from closely related taxa, such as *L. glauca*, *L. supina*, *L. argillicola*, and *L. accitensis*. Seed characteristics have been recognized as important for

the taxonomy of the tribe *Antirrhineae* (Elisens & Tomb, 1983; Elisens, 1985; Sutton, 1988), and particularly for *Linaria* species, as shown by Viano (1978a, 1978b, 1979) for non-winged seeded species, and Valdés (1970) for winged seeded ones (see Sutton, 1988). Studies by Juan *et al.* (1999), Segarra & Mateu (2001a, 2001b), and Juan *et al.* (2018) among others, have demonstrated the importance of seed-coat features, including sculpturing, in distinguishing different *Linaria* taxa. In this genus, seed morphology varies, but two main groups can be distinguished based on the presence or absence of a marginal encircling wing (Segarra & Mateu, 2001a).

Because the lectotype lacks the critical seed characters, which are essential for distinguishing *L. badalii* from related species, it is proposed that an

epitype be designated in accordance with Art. 9.9 of the *Shenzhen Code* (Turland *et al.*, 2018). This will resolve any ambiguity surrounding the interpretation of the lectotype and contribute to a more solid taxonomy of this group. We propose the specimen collected by Badal in “Las Parras de Martín” (Teruel) and preserved at MA (barcode MA109895) as the epitype (Figure 5).

The selected epitype shows diagnostic seed characters: 1.5–2.4 × 1.5–2.3 mm, suborbicular, discoid, flat or slightly concave-convex, membranous, opaque; wing 0.3–0.6 mm broad, with both the disc and wing being the same colour. The wing is broad, and both the disc and the inner part of the wing are covered by papillae (Figure 6C, D), with tubercles absent. The seed coat consists of more or less polygonal cells with flat anticlinal walls and densely reticulate periclinal walls. Papillae are in the center of the periclinal walls on the disc, and laterally on the wing, rounded to subcylindrical (Figure 6). This seed morphology matches the “Type IV” and “subtype I” described by Segarra & Mateu (2001a), which is found exclusively in *L. badalii*. Furthermore, this epitype fits the concept of this taxon and clearly represents the traditional and current application of the name (e.g., Willkomm, 1886, 1887; Valdés, 1970; Chater *et al.*, 1972; Sutton, 1988; Bolòs & Vigo, 1996; Pérez Dacosta, 1998; Mateu *et al.*, 2000; Segarra & Mateu, 2001a; Mateo *et al.*, 2011; Sáez & Bernal, 2009; Sáez & Sainz, 2011; Juan *et al.*, 2018).

Linaria badalii Willk. ex Loscos, Tratado Pl. Aragón Supl. 7: 58. 1885 (VIII or IX) [*“Badali”*] [description and geographical provenance in Loscos, Tratado Pl. Aragón Supl. 6: 27. 1884 (after VII, before 13–VIII)]

Lectotype (designated here): [Spain] Teruel, Utrillas, Las Parras de Martín, “Rara en Parras de Martín, sobre el Molino Bajo: Parras en los Cascajares sobre el Molino Bajo en la Carbonera frente al Corral, 29 May [1883 (see Loscos, 1884: 528)], Antonio Badal s.n., Herb. Loscos n. 1921 (Box n. 18) preserved in The Royal Aragonese Economic Society of Friends of the Country (RAESFC) in Zaragoza (Figure 2).

Epitype (designated here): [Spain] Teruel, “In Aragonia austr. [alis]”, Las Parras de, 2 August 1888, Antonio Badal s.n., MA barcode MA109895 [part of the material in the sheet barcoded MA109894 can be duplicated, and therefore isoepitype] (Figure 5).

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Authorship contribution

PPFG: Design and Writing; PPFG and LSG: Analysis of the original elements and their interpretation, Analysis of the seeds and image 6, Literature and Text review.

Conflict of interest

None.

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