

# Bulbous plants in the Iberian Peninsula. The collection of the Royal Botanical Garden Madrid

## Abstract

168 species of bulbous from Liliaceae, Amaryllidaceae and Iridaceae families are found in the Iberian Peninsula and the Balearic Islands, 16 of them are introduced, numerous endemic and subendemic (also from the other side of the Pyrenees in France). The living bulb collection at the Royal Botanic Garden Madrid conserves and manages most of the species growing in the wild in the Iberian Peninsula.

**Keywords:** bulbous, living collection, iberian peninsula, liliaceae, amaryllidaceae, iridaceae

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## Introduction

The geophytes in the sense of Raunkiaer are herbaceous perennial plants with its perennating buds below the ground. They can be rhizomes, tubers, bulbs and corms, these last solid bulbs almost without cataphylls.<sup>1</sup> These types of plants are very important in the Mediterranean region, because their biological cycle is well adapted to the Mediterranean climate conditions. Most of the species included in the botanical families Liliaceae, Amaryllidaceae and Iridaceae in the Mediterranean area are geophytes. Volume XX of *Flora iberica*<sup>2</sup> includes these three families; although there are other families in the Iberian Peninsula with rhizomatous, tuberous and bulbous species not included in this volume, only the bulbous plants from these three families are considered in this article. 168 species are living in the geographical area of *Flora iberica*, the Iberian Peninsula and the Balearic Islands. All the genera are included in Table 1. The most important genera is *Allium*, with 35 species, 8 of them endemic, and *Narcissus*, with 25 species, 8 endemic and 4 subendemic (also from the other side of the Pyrenees in France), and 8 endemic subspecies. The genus *Iris* has been split after a molecular study in 7 different genera: *Iris* s.str, *Juno*, *Limniris*, *Chamaeiris*, *Xiphion*, *Hermodactylus* and *Gynandriris*. In this article it will be considered as a whole genus, *Iris*. Only *Juno* (*Iris planifolia*), *Xiphion* with 5 species, and *Gynandriris* (*Iris sysirinchium*) are bulbous. Some South African species from the

Iridaceae family have recently established themselves in the wild, like *Ixia paniculata*, *Watsonia meriana*, *Freesia refracta*, *Freesia alba* and *Crocospmia × crocosmiflora*. *Sisyrinchium*, with 2 species living in the Iberian Peninsula, has been introduced from North America and occurs in a few localities in Spain. All the bulbous plants species of the three families are included in Table 2. In the case of endemic (e) and subendemic (s), subspecies are also included. The size of the bulbs and tepals are given.

The color of the flowers is an important feature. Some species within the same genera have the same color: *Gagea* yellow, *Colchicum* pink, *Scilla* blue, *Ornithogalum* white.

The flowerings months in Roman numerals in Table 2 indicate a greater variation. Some species flower in autumn (4 species of *Colchicum*, *Merendera filifolia*, 3 species of *Scilla*, *Sternbergia*, 3 species of *Crocus*) and in winter (*Gagea bohémica*, *Gagea mauritanica*, *Gagea foliosa*, *Colchicum triphyllum*, *Allium chamaemoly*, *Allium triquetrum*, *Galanthus nivalis*, *Narcissus papyraceus*, *Narcissus pachybolbus*, *Narcissus scaberulus*, *Narcissus cyclamineus*, *Narcissus pseudonarcissus* subsp. *munozii-garmendiae*, *Romulea ramiflora*). The majority of the species bloom in spring, but *Lilium martagon*, 16 species of *Allium* and *Pancratium maritimum* flower in summer (Figure 1– Figure 8).



**Figure 1** *Allium melananthum*. Carlos Aedo & *Allium pyrenaicum*. Carlos Aedo.

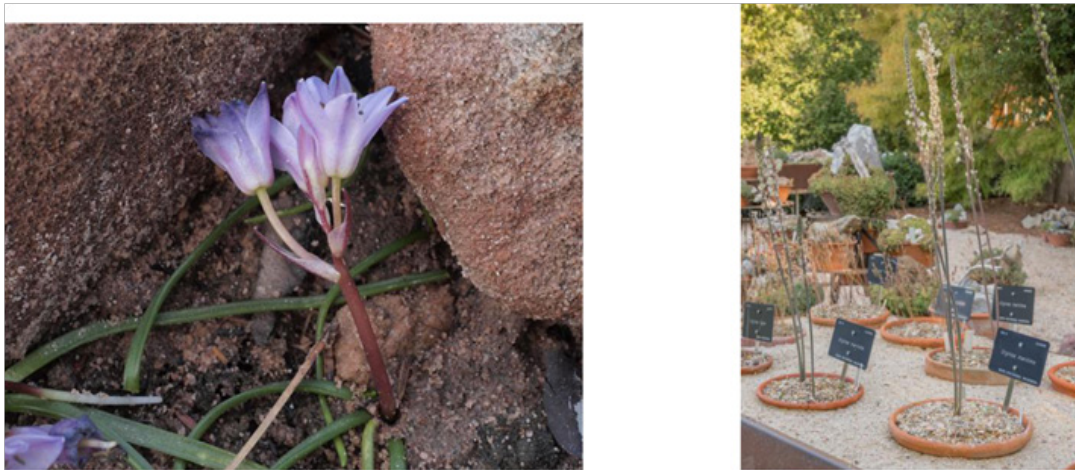


Figure 2 *Brimeura fastigiata*. Carlos Aedo & Collections in the RBG Madrid. Marisa Esteban.



Figure 3 *Iris planifolia* JL. Castillo, *Flora iberica* XX:4182 & *Iris planifolia*. Carlos Aedo.

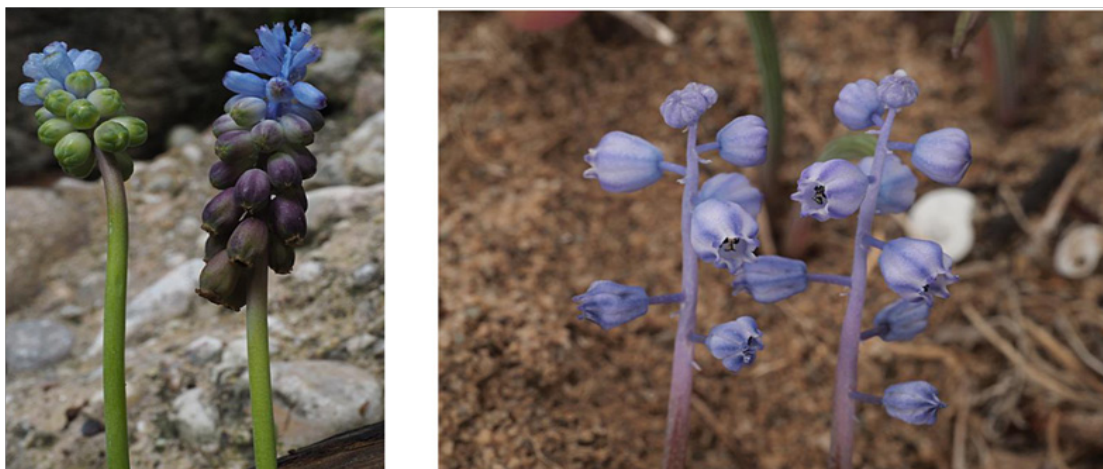


Figure 4 *Muscari cazorlanum* Carlos Aedo & *Muscari parviflorum* Carlos Aedo.





Figure 5 *Narcissus elegans*. Collections in the RBG Madrid. Marisa Esteban.

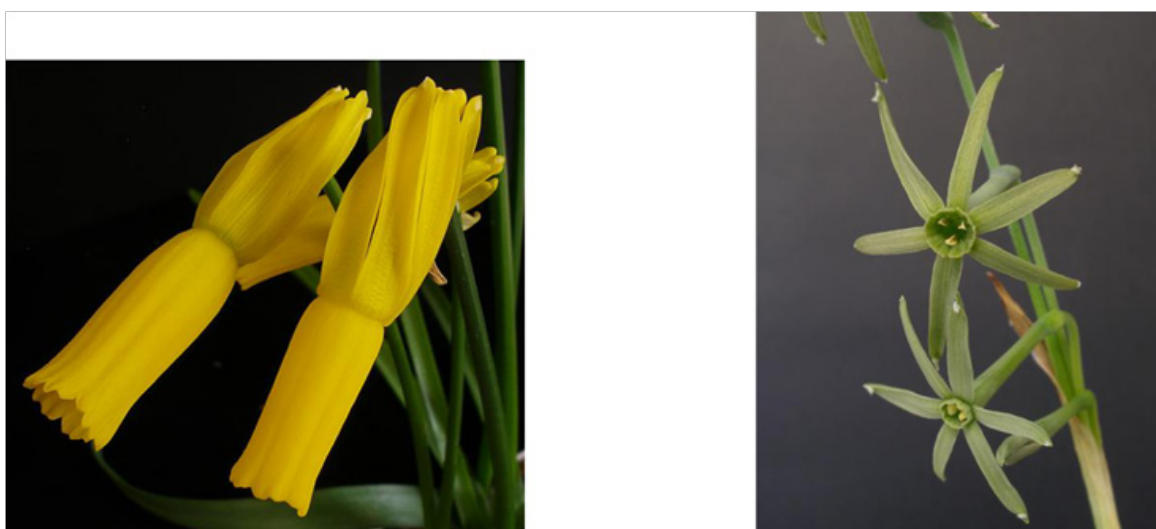


Figure 6 *Narcissus cyclamineus*. Carlos Aedo & *Narcissus viridiflorus*. Carlos Aedo.



Figure 7 *Ornithogalum reverchonii*. Carlos Aedo.



**Figure 8** *Romulea clusiana*. Carlos Aedo.

**Table 1** List of bulbous genera of Liliaceae, amaryllidaceae and iridaceae from the Iberian Peninsula and Balearic Islands. Ordered like *Flora Iberica*. introduced genera (i)

Families and genera	N. of species	N. of endemic	N. of subendemic
LILIACEAE	106 (105)	21	6
Lilium	3		1
Fritillaria	5	3	1
Gagea	12		
Tulipa	1		
Erythronium	1		
Colchicum	5	1	
Bulbocodium	1		
Merendera	3	1	1
Androcymbium	1		
Scilla	8 (?)		1
Hyacinthoides	5	3	
Brimeura	3	1	1
Muscari	8	2	
Bellevalia	1	1	
Ornithogalum	9	1	
Dipcadi	1		
Urginea	3		
Allium	35	8	1
Nothoscordum (i)	1		
AMARYLLIDACEAE	34	9	4

Table Continued

Families and genera	N. of species	N. of endemic	N. of subendemic
Sternbergia	2		
Leucojum	4	1	
Galanthus	1		
Lapiedra	1		
Narcissus	25	8	4
Pancratium	1		
IRIDACEAE	28	6	0
Iris s.l.	15, only 7 bulbous	3	
Ferraria (i)	1		
Sisyrinchium (i)	2		
Crocus	7	3	
Romulea	4		
Ixia (i)	1		
Watsonia (i)	1		
Freesia (i)	2		
Crocsmia (i)	1		
Gladiolus	2		
TOTAL	168	36	10

### The living bulb collection

The living bulb collection at the Royal Botanic Garden Madrid (hereafter RBG Madrid) is located<sup>3</sup> 40°24'43.97"N 3°41'27.76"W and an altitude of 632 m, and is outside all year round in full sun.

The collection has been created over the last 10 years in collaboration with scientists of the *Flora Iberica* project, horticulturist technicians from the living collection unit and staff from other botanical gardens and institutions. Currently 127 different taxa from the Iberian Peninsula are grown in clay pots, with 470 accession numbers of bulbs from wild collected bulbs and seed origin.

Since the beginning, the main purpose of the collection has been for taxonomic research, conservation, education, and to display the diversity of the geophytes in the Iberian Peninsula and Balearic Islands flora.

### Cultivation

All accession numbers are cultivated individually in different sized of clay pots and pot depths, on tables and sand benches in full sun, without any structure to provide shade.

They are repotted every two to three years after flowering and the foliage has died back. It usually starts<sup>4</sup> in July and August with the

early winter flowering genera like *Iris*, *Narcissus*, *Gagea*, *Galanthus*, *Romulea* and continues with the rest of the genera until December-January with species of the genera *Lilium*, *Allium*, *Pancratium*. This allows the removal of any seed contamination from others species.

The growing medium used is comprised of % grit, % humus, % silica sand and % coconut coir, the percentages vary depending on

their individual requirements but a free-drainage substrate is always provided.

The pots are first filled with growing media and the bulbs are placed at a third of the pot depth on a sand layer without touching each other, and then are covered with growing media and top dressed with a layer of grit to reduce weeds and conserve moisture.

**Table 2** List of bulbous species and subspecies from the the iberian peninsula and balearic islands, excluding recently introduced species<sup>2</sup>; endemic (e), subendemic (s), old introduced (i). subspecies indicated when endemic

Species, subspecies	Bulbs size (cm)	Tepals size (cm)	Tepals colour	Flowering months	N° of accessions in the living collection
<i>Allium ampeloprasum</i>	1,3-4,3x1,1-4,5	0,4-0,5	whitish	V-VI	1
<i>Allium baeticum</i>	2,4-5,1x2-3,7	0,4-0,5	whitish	V-VII	
<i>Allium chamaemoly</i>	0,8-2,1x0,4-2,1	0,6-1	white	XII-II	
<i>Allium commutatum</i>	2,8-4,8x2,3-4,8	0,3-0,4	whitish	VII	1
<i>Allium cupanii</i>	1,4-2,2x0,7-1,6	0,5-0,6	white	VI-IX	
<i>Allium ebusitanum</i>	1,9-4,4x1,4-3,6	0,4-0,5	pink	VI-VII	1
<i>Allium ericetorum</i>	1,8-4,3x0,6-1,7	0,3-0,5	white	VIII-XI	3
<i>Allium grosii</i> (e)	1,3-2,4x0,9-1,6	0,5-0,6	pink	VII-VIII	1
<i>Allium guttatum</i>	1,4-2,3x1,1-2	0,2-0,3	white	VI-VII	3
<i>Allium lusitanicum</i>	0,9-3,7x0,7-1,9	0,3-0,6	pink	VII-X	2
<i>Allium massaesylum</i>	1-1,9x1-1,6	1-1,2	white	IV-V	
<i>Allium melananthum</i> (e)	1,3-2,4x0,8-2	0,2-0,3	purple	V-VI	2
<i>Allium moly</i> (s)	0,8-2,7x0,7-2,7	0,8-1,1	yellow	V-VII	3
<i>Allium moschatum</i>	1,7-2,5x0,9-1,8	0,5-0,6	pink	VIII-X	
<i>Allium neapolitanum</i>	1,1-2,3 x 0,9-2,8	0,9-1,2	white	II-VI	
<i>Allium nigrum</i>	3,1-5 x 2,9-4,1	0,7-1,1	white	III-V	2
<i>Allium oleraceum</i>	1,3-2,1x1-2	0,5-0,7	pink	VII-IX	2
<i>Allium palentinum</i> (e)	1,8-5 x0,8-1,9	0,3-0,5	pink	VII-VIII	1
<i>Allium paniculatum</i>	1,5-2,6x1,1-1,9	0,4-0,6	pink	VI-VIII	5
<i>Allium pruinatum</i> (e)	0,8-1,6x0,6-1,3	0,3-0,4	purple	VI-VIII	1
<i>Allium pyrenaicum</i> (e)	1,6-4,2x1,7-4,1	0,7-0,8	whitish	VI-VII	1
<i>Allium roseum</i>	1,2-2,3x1,2-3,6	1,1-1,3	pink	III-VI	3
<i>Allium rouyi</i> (e)	1,3-2,7x0,8-1,8	0,4-0,6	yellowish	VI-VII	
<i>Allium schmitzii</i> (e)	1,9-3,4x1-1,9	0,5-0,6	white	V-VII	2
<i>Allium schoenoprasum</i>	1,5-4,3x0,8-1,4	0,8-1,2	purple	VI-VIII	7
<i>Allium scorodoprasum</i>	1,7-3,3x1,7-2,9	0,5-0,8	pink	VI-VII	
<i>Allium scorzonifolium</i>	0,6-2,6x0,9-2,4	0,7-1	yellow	IV-VII	
<i>Allium sphaerocephalon</i>	1-2,5x0,6-1,9	0,3-0,6	pink	V-VIII	7
<i>Allium stearnii</i> (e)	1,6-2,5x1,1-1,9	0,3-0,4	whitish	VI-VII	
<i>Allium subhirsutum</i>	1,1-1,8x0,9-1,9	0,5-0,7	white	IV-VI	
<i>Allium subvillosum</i>	1-2,1x1,1-1,8	0,4-0,7	white	II-V	
<i>Allium triquetrum</i>	1,3-2,8x1,1-3,6	0,9-1,4	white	I-V	
<i>Allium ursinum</i>	1,3-4,1x0,5-1,2	0,7-1	yellow	III-VI	
<i>Allium victorialis</i>	5,1-11,2x1,2-2,8	0,4-0,6	yellow	V-VII	3
<i>Allium vineale</i>	1,6-2,9x1,4-3	0,2-0,4	white	VI-VII	3

Table Continued

Species, subspecies	Bulbs size (cm)	Tepals size (cm)	Tepals colour	Flowering months	N° of accessions in the living collection
<i>Androcymbium europaeum</i>	1,5-3x1-2	2,2-3,5	white	XI-III	2
<i>Bellevalia dubia</i> subsp. <i>hackelii</i> (e)	1,7-2,3x1,3-3	0,5-0,8	blue-violet	III-IV	1
<i>Brimeura amethystina</i> (s)	x1-3,5	0,7-1,3	blue	V-VII	1
<i>Brimeura duvigneaudii</i> (e)	0,4-3,1x0,3-2,5	0,7-1,2	white, pink	IV-VI	
<i>Brimeura fastigiata</i>	x1-3,5	0,4-0,9	violet	IV-VII	1
<i>Bulbocodium vernum</i>	1,5-2,5x1,5-2	3-4,8	pink	III-VI	2
<i>Colchicum autumnale</i>	2,5-4x2,5-3,5	03-May	pink	IX-X	2
<i>Colchicum longifolium</i>	2-3,5x1,5-2,5	2,6-3	pink-purple	IX	
<i>Colchicum lusitanicum</i>	3-5x3-4,5	4-7,5	pink	IX-XI	3
<i>Colchicum multiflorum</i> (e)	2,5-3,5x2-3,5	3-5,5	pink	IX-XI	4
<i>Colchicum triphyllum</i>	1-2x1-1,5	1,5-2,5	pink	I-IV	
<i>Crocus cambessedesii</i> (e)	1-1,5x1,1-2,1	1,41,8	white, lila	IX-III	2
<i>Crocus carpetanus</i> (e)	0,8-1,8 x 1-2	02-Jun	pale lila	III-V	3
<i>Crocus clusii</i> (e)	1,4-3 x 1,2-3	2,3-6	lila	IX-XI	6
<i>Crocus nevadensis</i>	1,8-2,2x1,2-2	02-Apr	cream, white	II-IV	5
<i>Crocus nudiflorus</i>	0,8-1,5x0,6-1,7	03-Jun	purple	IX-X	4
<i>Crocus serotinus</i>	0,8-1,5x0,6-1,5	2,3-6	lila	IX-XII	17
<i>Crocus vernus</i>	0,8-3,5x0,9-2	1,5-5,5	purple, white	III-VI	4
<i>Dipcadi serotinum</i>	x 1,5-3	1-1,5	pink, yellowish	II-VII	9
<i>Erythronium dens-canis</i>	2-5,5x0,7-1,5	1,8-4	violet, pink	III-V	2
<i>Fritillaria caballeri</i> (e)	0,7-1,8x1-2	2,3-4,2	dark grey-purple	IV-VII	
<i>Fritillaria legionensis</i> (e)	1-1,9x1,4-3	2,4-4,6	purple	V-VII	
<i>Fritillaria lusitanica</i>	0,5-1,6x0,6-2,9	1,5-5,2	purple	III-VII	4
<i>Fritillaria pyrenaica</i>	0,7-1,4x1-2	2-4,1	dark grey-purple	IV-VIII	2
<i>Fritillaria stenophylla</i> (e)	0,5-1,2x0,6-2,4	1,6-4,3	purple	II-IV	
<i>Gagea bohemia</i>	0,4-0,8x0,3-0,6	0,9-1,4	yellow	I-V	3
<i>Gagea dubia</i>	1-1,6x0,7-1,2	1,2-1,6	yellow	IV-V	
<i>Gagea foliosa</i>	0,4-1,2x0,3-0,7	0,6-1,3	yellow	I-VIII	3
<i>Gagea lacaitae</i>	0,7-1,5x0,5-1,2	0,9-1,5	yellow	III-VI	
<i>Gagea liotardii</i>	0,5-1x0,5-1	1-1,4	yellow	IV-VII	
<i>Gagea lutea</i>	1-1,5x0,6-0,8	0,9-1,4	yellow	III-VI	
<i>Gagea mauritanica</i>	1-1,4x0,8-1	1-1,5	yellow	II-III	
<i>Gagea pratensis</i>	1-1,5x0,5-0,7	0,9-1,6	yellow	III-V	1
<i>Gagea reverchonii</i>	0,8-1,5x0,6-0,8	0,7-1	yellow	III-VI	1
<i>Gagea soleirolii</i>	0,3-0,6x0,3-0,5	0,6-1,2	yellow	IV-VII	2
<i>Gagea villosa</i>	0,8-1x0,6-0,8	1-1,4	yellow	III-IV	2
<i>Gagea wilczekii</i>	0,8-1,8x0,6-1,5	0,8-1,4	yellow	III-IV	
<i>Galanthus nivalis</i>	1,4-2,8x1,4-2,8	1,4-2,4	white	I-III	1
<i>Gladiolus communis</i>	x1-3	2,3-3,5	purple	III-VI	5
<i>Gladiolus italicus</i>	x1-3	03-May	read-violet	IV-V	1
<i>Hyacinthoides hispanica</i> (e)	1,5-3x1-2,5	1,2-1,4	bluish	II-VI	6

Table Continued

Species, subspecies	Bulbs size (cm)	Tepals size (cm)	Tepals colour	Flowering months	N° of accessions in the living collection
<i>Hyacinthoides mauritanica</i>	1-2,5x1-2,5	0,6-1	bluish	II-V	2
<i>Hyacinthoides non-scripta</i>	2-3,5x2-3	1,2-1,8	bluish	III-VI	
<i>Hyacinthoides paivae</i> (e)	1,7-3x1,3-3	1-1,2	bluish	III-VI	
<i>Hyacinthoides reverchonii</i> (e)	1,8-2,6x1,1-1,8	0,7-1	blue malva	III-V	1
<i>Iris boissieri</i> (e)	1,5-4,4x1-4	03-May	violet-bluish	V-VI	
<i>Iris filifolia</i> (e)	1,2-3,8x1,5-4	04-Aug	violet-reddish	IV-V	
<i>Iris latifolia</i>	2-7x1,5-6	05-Aug	blue-violet	VI-VIII	
<i>Iris planifolia</i>	1,5-8x2-4	4,5-7,5	bluish	XI-IV	3
<i>Iris serotinum</i> (e)	2-4x1-3,5	2,6-4	blue violet	VII-VIII	2
<i>Iris sisyrinchium</i>	1,5-2,5x2-2,5	2,4-4	blue	II-III	
<i>Iris xiphium</i>	2-5x2-3	3,4-8,6	bluish, yellow	III-VI	4
<i>Lapiedra martinezii</i>	2,6-6,5x2,4-6,7	0,8-1,2	white	VIII-IX	3
<i>Leucojum aestivum</i>	2,3-4,3x2,2-4,1	1,1-1,3	white	II-IV	3
<i>Leucojum autumnale</i>	1,4-2,2x1-2	0,7-1,1	white	VII-XI	6
<i>Leucojum trichophyllum</i>	1,1-1,9x1,1-1,8	1,3-1,8	white	III-IV	1
<i>Leucojum valentinum</i> (e)	2,4-3,6x2,1-3,6	1,1-1,3	white	VIII-IX	2
<i>Lilium candidum</i> (i)	x7-10	4,5-8	white	V-VII	
<i>Lilium martagon</i> (e)	x3-5	2,5-4	pink, violet	VI-VIII	1
<i>Lilium pyrenaicum</i> (s)	x3-8	2,5-4	yellow	V-VII	1
<i>Merendera androcymbioides</i> (e)	1-2x1-3	1,4-4	pale lila	XII-III	2
<i>Merendera filifolia</i>	1-2x1-1,8	2,5-4,5	pink	X-XII	6
<i>Merendera montana</i> (s)	23x1,5-2	04-Jul	pink	VII-XI	17
<i>Muscari atlanticum</i>	1,5-3,5x1,5-2,4	0,5-0,7	blue purple	III-VI	1
<i>Muscari baeticum</i>	1,7-2,5x1,3-2,4	0,5-0,7	blue purple	III-VI	5
<i>Muscari cazorlanum</i> (e)	2-3,5x1,4-3	0,5-0,7	greenish	IV-VI	
<i>Muscari comosum</i>	2-4,5x2-3,5	0,6	dark violet	III-VI	11
<i>Muscari matritensis</i> (e)	2,5-4x2-4	0,6-1	blue-violet	V-VII	1
<i>Muscari neglectum</i>	2-2,7x1,4-2	0,4-0,6	blue violet	II-V	9
<i>Muscari olivetarum</i>	2,3-3,5x1,7-2,5	0,5-0,8	violet	III-IV	2
<i>Muscari parviflorum</i>	1,5-2x1-1,5	0,3-0,4	blue violet	IX-XI	1
<i>Narcissus assoanus</i> (s)	1,5-3,1x1-2,7	0,7-1	yellow	II-IV	12
<i>Narcissus bicolor</i> (s)	2,2-4,4x2-4,2	2,8-3,7	whitish, yellow	V-VI	2
<i>Narcissus bulbocodium</i>	1,2-2,8x1,1-3,1	0,7-1,8	yellow	II-V	18
<i>Narcissus cantabricus</i>	1,1-2,1x0,8-1,9	0,7-1,6	white	I-IV	4
<i>Narcissus cavanillesii</i>	0,7-1,8x0,7-1,6	0,7-1,3	yellow	X-XI	3
<i>Narcissus cuatrecasasii</i>	1,8-2,6x1,3-2,9	0,8-1,3	yellow	III-V	2
<i>Narcissus cyclamineus</i> (e)	1,1-2,2x1-2,2	1,4-2,5	yellow	I-III	1
<i>Narcissus dubius</i> (s)	2-3,9x2-3,7	0,4-0,9	white	II-IV	4
<i>Narcissus elegans</i>	1,7-3x1,4-2,8	1,1-2	white	IX-XI	4
<i>Narcissus gaditanus</i> (e)	1,1-2,2x0,8-2,1	0,5-0,6	yellow	II-IV	3
<i>N. hedraeanthus</i> subsp. <i>hedraeanthus</i> (e)	1,2-2,6x1-2,5	0,8-1,4	yellow	III-IV	2



Table Continued

Species, subspecies	Bulbs size (cm)	Tepals size (cm)	Tepals colour	Flowering months	N° of accessions in the living collection
<i>N. hedraeanthus</i> subsp. <i>luteolentus</i> (e)	1,2-2,6x1-2,5	0,9-1,4	yellow	II-IV	
<i>Narcissus jonquilla</i> (e)	1,4-2,9x1,5-2,5	0,8-1,5	yellow	III-IV	2
<i>Narcissus minor</i> (s)	1,2-2,6x0,9-2,3	1-1,3	yellow	II-VI	1
<i>Narcissus minor</i> subsp. <i>asturiensis</i> (e)	1,2-2,6x0,9-2,3	1-1,3	yellow	III-V	5
<i>Narcissus moschatus</i> subsp. <i>moleri</i> (e)	1,4-3x1,3-3,1	2,7-2,9	light yellow	IV-V	
<i>Narcissus moschatus</i> subsp. <i>moschatus</i> (e)	1,4-3x1,3-3,1	2,1-2,7	white	IV-V	1
<i>Narcissus obsoletus</i>	1,1-2,9x1-3	1-1,8	white	IX-XI	10
<i>Narcissus pachybolbus</i>	3,3-5,7x3,5-4,5	0,6-0,8	white	I-III	1
<i>Narcissus papyraceus</i>	3,1-5,3x2,7-5,2	1,1-1,5	white	XII-III	5
<i>Narcissus poeticus</i>	2,6-3,7x1,9-3,3	2,2-3,8	white	IV-VI	1
<i>N. pseudonarcissus</i> subsp. <i>pseudonarcissus</i>	1,6-4,6x1,2-4,6	2,5-3,4	whitish, yellow	III-VI	14
<i>N. p.</i> subsp. <i>munozii-garmendiae</i> (e)	1,6-4,6x1,2-4,6	1,4-1,6	whitish, yellow	II-III	1
<i>N. pseudonarcissus</i> subsp. <i>nevadensis</i> (e)	1,6-4,6x1,2-4,6	1,9-2,4	whitish, yellow	II-V	4
<i>N. pseudonarcissus</i> subsp. <i>portensis</i> (e)	1,6-4,6x1,2-4,6	1,8-2,4	whitish, yellow	II-IV	1
<i>Narcissus rupicola</i> (e)	1,6-2,7x1,3-2,9	0,7-1,4	yellow	III-VI	10
<i>Narcissus scaberulus</i> subsp. <i>calcicola</i> (e)	1,5-2,8x1,5-2,7	0,6-0,8	yellow	I-IV	1
<i>Narcissus scaberulus</i> subsp. <i>scaberulus</i> (e)	1,5-2,8x1,5-2,7	0,4-0,5	yellow	II-III	1
<i>Narcissus serotinus</i>	1-2,5x0,9-2,7	1-2,1	white	IX-X	6
<i>Narcissus tazetta</i>	2-5,1x2,1-4,7	0,9-1,6	cream	XII-V	3
<i>Narcissus triandrus</i> subsp. <i>pallidulus</i> (e)	1,1-2,6x1-2,6	1,2-1,5	yellow	II-V	8
<i>Narcissus triandrus</i> subsp. <i>triandrus</i> (s)	1,1-2,6x1-2,6	1,7-2,1	yellow	III-V	4
<i>Narcissus viridiflorus</i>	1,8-3,7x1,9-3,1	0,7-1,4	green	X-XI	2
<i>Ornithogalum arabicum</i> (i)	3,5-5,5x3-5,5	2,3-2,6	white	IV-V	
<i>Ornithogalum baeticum</i>	2-3x1,4-2,5	1,7-2,5	white	III-VI	3
<i>Ornithogalum bourgaeum</i>	1,4-3,7x1-3	1,2-2,4	white	II-VI	12
<i>Ornithogalum broteri</i>	1,5-2,1x1,1-1,5	1,3-1,8	white	II-VI	1
<i>Ornithogalum concinnum</i> (e)	1,6-2,5x1,3-2,5	1,3-1,6	white	III-VII	1
<i>Ornithogalum divergens</i>	1,5-3x1,5-2,8	2,3-3	white	III-V	
<i>Ornithogalum narbonense</i>	5-7x3-5	1,3-1,5	white	IV-VI	10
<i>Ornithogalum pyrenaicum</i>	3,4-5x2,6-3,6	0,7-1,1	yellow	V-VII	3
<i>Ornithogalum reverchonii</i>	5-6x2,5-4	2,1-2,4	white	III-VI	
<i>Pancratium maritimum</i>	4,2-7,6x4,2-7,2	4,6-6,8	white	VI-IX	6
<i>Romulea bulbocodium</i>	x0,6-1,5	1,3-2,8	violet	II-V	6
<i>Romulea clusiana</i>	x0,7-1,3	3-4,6	white, violet	II-IV	1
<i>Romulea columnae</i>	x0,6-1,2	0,8-1,3	blue, white	III-V	3
<i>Romulea ramiflora</i>	x0,8-1,5	1,4-3,1	bluish	I-III	
<i>Scilla autumnalis</i>	x1-3	0,3-0,5	lila, violet	IX-X	5
<i>Scilla lilio-hyacinthus</i> (s)	x3-3,5	0,9-1,1	blue	IV-V	2
<i>Scilla monophyllos</i>	x1,2-1,8	0,6-0,9	blue	III-V	5
<i>Scilla numidica</i>	x1,2-4	0,1-0,3	purple	IX-XI	1
<i>Scilla obtusifolia</i>	x1-3	0,4-0,6	violet	IX-X	6



Table Continued

Species, subspecies	Bulbs size (cm)	Tepals size (cm)	Tepals colour	Flowering months	N° of accessions in the living collection
<i>Scilla peruviana</i>	×3,5-6	0,9-1,2	blue	III-V	4
<i>Scilla verna</i>	×1-2,6	0,5-1,2	blue	III-VI	7
<i>Sternbergia colchiciflora</i>	1,7-2,7×1,4-2,8	02-Apr	yellow	IX-XI	
<i>Sternbergia lutea</i> (i)	3,7-5,2×2,5-6,9	3,3-5,1	yellow	IX-X	1
<i>Tulipa sylvestris</i>	1,4-4,5×0,6-2	2,8-5,5	yellow, orange	III-VI	3
<i>Urginea fugax</i>	×1,8-2,5	0,9-1,2	white	VIII-IX	3
<i>Urginea maritima</i>	×6-15	0,8-1,1	white	VIII-X	9
<i>Urginea undulata</i>	×1,7-3,5	0,9-1,2	light pink	VIII-IX	2

Watering is done by hand, the main watering months are from April to early June, it is usually done three times a week, early in the morning because most of the bulbs in the living collections flower during these months. July and August watering is reduced to none, (or once every fifteen days for the small pot sizes because they dry out easily), as a way to provide a summer rest for the bulbs. In September watering is increased to once a week to help autumn flowering. During the winter months, depending on the year, they are not usually watered at all, in fact, because of the lack of a sheltered area; water can become a problem because the pots get too wet from precipitation causing bulbs to rot in some genera.

Seed germination work is carried out outdoors in September and March with a high germination percentage in species like *Narcissus assoanus*, *Narcissus jonquilla*, *Scilla verna* or *Lilium martagon* and *Lilium pyrenaicum*.

After 10 years of bulbs cultivation at the RBG Madrid, some of the mature bulbs depending on the species have not bulked up, the flowers are smaller and the scape shorter, in these cases they will be vegetatively propagated from lateral buds<sup>5</sup> or replaced with a view to conserve the collection.

## Discussion

Living collections in botanic gardens are extremely important and they can be very useful in different disciplines to understand plant diversity. Although in recent years public engagement with botanic gardens in general has been overwhelmed<sup>6</sup> by aesthetic-orchid festivals, light shows and music events, they conserve at least 41%<sup>7</sup> of known threatened species in their living collections and seeds banks.

The living bulb collection at the RBG Madrid conserves and manages at least 74,21% of the total bulbous species and subspecies from Liliaceae, Amaryllidaceae and Iridaceae families found in the Iberian Peninsula and the Balearic Islands, excluding introduced species (by 2020 the collection will be completed). It is the most complete *ex situ* living collection of geophytes in the Iberian Peninsula, providing information about growing conditions, pest and disease control, data in changes in plant phenology and supporting taxonomic research and future projects in climate change.

It is well known that bulbs are storage organs developed to carry a plant through dormancy during seasons of adverse weather conditions, usually of drought combined with extremes of heat or cold.<sup>8</sup> One of the main problems to conserve and maintain living collections of bulbs is (a) to cultivate plants over a longtime period because some of the mature bulbs, depending on the species, are difficult to bulk up and

lose reserves and finally die, (b) to guarantee the accession number and the label name are correct and there has not been contamination from seed germination or label exchanged from other taxa (especially during the dormancy period) and (c) to keep the database updated.

In order to avoid these problems, the living bulb collection at the RBG Madrid is repotted at least every two to three years according to the genera and any seed or bulb contamination from others accessions numbers is removed. It is conserved and managed by specialist horticulturists with knowledge of the plant's habitat and origin, to provide similar cultivation conditions and their knowledge of plant taxonomy enables them to recognize if there is contamination from other species. Finally, the constant collaboration of taxonomists at RBG Madrid is extremely important in plant identification and verification of the collection.

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## Conflicts of interest

Authors declare no conflict of interest exists.

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