

Extremely rare *Cistus ladanifer* var. *supermaculatus* var. nov. (Cistaceae)

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## ARTICLE INFO

## Article History:

Received 29 May 2023

Revised 6 September 2023

Accepted 6 September 2023

Available online 12 September 2023

Edited by Prof G.V. Cron

## Keywords:

Cistaceae

*Cistus ladanifer*

Floral morphology

Ornamental species

## ABSTRACT

*Cistus ladanifer* L. is a shrub which presents a typical flower consisting in five white petals provided or not with a basal deep purple blotch, covering less than 10% of the petal's surface. The new variety here proposed is characterized by the large dark dots that cover often an 80% of the petal's surface, hence the epithet adopted "*supermaculatus*". Because the dot is superb in dimensions and is visible both on the adaxial, but also on the abaxial faces of the petal. *Cistus ladanifer* var. *supermaculatus* var. nov. is endemic to the Ciudad Real Province of Spain.

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*Cistus* (Cistaceae) is one of the most characteristic genera of the Mediterranean flora. The highest species diversity therefore occurs in the western Mediterranean, where 14 species are distributed in the Iberian Peninsula and northwestern Africa (Martín-Bolaños and Guinea, 1949; Demoly and Montserrat, 1993; GBIF, 2023). The taxonomy of *Cistus* has traditionally been based on vegetative (nerve number, shape, and hairiness of leaves) and reproductive characters (sepal number, petal color, style length, and number of fruit valves). Plants are predominantly self-incompatible (Dunal, 1824; Bosch, 1992; Talavera et al., 1993) promoting crossing between individuals of the same and different species.

*Cistus ladanifer* L. (Cistaceae) is a dwarf to medium, ornamental shrub, 100–250 cm in height, endemic to Western Mediterranean countries and Macaronesia (Porto Santo, Gran Canaria and Tenerife islands) (see Santos-Guerra et al., 2013), which has been reported as invasive in South Africa (Du Plessis et al., 2018) and introduced in Cyprus (Schönfelder and Schönfelder, 2017), Great Britain, New Zealand, USA (California) and Australia (Randall, 2014). This species

inhabits acid and dry soils in warm open areas. Flowering phenology spans from March to June, and each plant produces generally white flowers, often exhibiting dark-colored spots at their bases (see Fig. 2). The flowers of this species are the largest in the family and are homogamous, polliniferous, and self-incompatible, secrete some nectar (Herrera, 1992; Talavera et al., 1993) and are mainly pollinated by bees, beetles, and flies (Talavera et al., 1993).

According to Guzmán and Vargas (2005), the three subspecies of *C. ladanifer*, as circumscribed by Demoly and Montserrat (1993) (subsp. *ladanifer*, subsp. *sulcatus*, and subsp. *africanus*), receives strong support as a lineage. However, the Guzmán and Vargas's phylogenetic hypothesis does not resolve relationships among these subspecies and our data are unable to determine whether populations from southern Portugal should be recognized as *C. ladanifer* subsp. *sulcatus* or as a distinct species (*C. palhinhae* N.D.Ingram).

Here we describe a new *Cistus ladanifer* variety which particularly differs from the type of the species for its peculiar flowers, where dark red to purple blotches predominate covering almost an eighty percent of the petals surface. This new variety not only differs from the type of the species but also from the rest of *Cistus* species and hybrids known.

**Table 1**

Comparison of the plant characteristics of *Cistus ladanifer* var. *supermaculatus*, the recently described *C. ladanifer* var. *sanguineus*, the subsp. *sulcatus*, and the type *C. ladanifer* var. *ladanifer*.

Traits <sup>2</sup>	<i>C. ladanifer</i> var. <i>supermaculatus</i>	<i>C. ladanifer</i> var. <i>sanguineus</i> <sup>*</sup>	<i>C. ladanifer</i> subsp. <i>sulcatus</i> (Demoly) P.Monts. <sup>*</sup>	<i>C. ladanifer</i> var. <i>ladanifer</i> (incl. <i>maculatus</i> )
Plant height	40–90 cm	100–150 cm	40–60 cm	80–200 cm
Leaf length	(6)7–10 (12) cm	5–9 cm	3–4 cm	(5)8–10 cm
Leaf width	(0.8)1–1.4(1.6) cm	0.7–1.5 cm	1–1.8 cm	(0.6)1–1.5(2) cm
Leaf length/width	5–7	6–7	2.2–3	5–9
Nerves on the adaxial side of leaves	not visible	not visible	visible	not visible
Corolla diameter	7–9 cm	8–9 cm	4–6 cm	5–8(9) cm
Flower color	White with large purple to dark red blotch	Purple with small dark red blotch	White	White, pure, or with small purple blotch
Flower period	15 Apr.–1 May	25 Apr.–12 May	1 Apr.–15 May	1 Apr.–15 May

(\*) Note data of *C. ladanifer* var. *sanguineus* from Tejerina and Vázquez (2021), for subsp. *sulcatus* from Demoly and Montserrat (1993).

The standard flower type of *Cistus ladanifer* var. *ladanifer* presents five white petals, with a basal deep purple blotch each, although variants were described with pure white petals (*Cistus ladanifer* var. *albi-florus* Dun.) (Dansereau, 1951). This tall rockrose makes impressive specimens, with their unusually long, sticky dark green leaves, large, 8.1 × 1.8 cm, that are felted in gray backing, and 7.5–10 cm white flowers, each with a 1 × 0.5 cm, blood red mark at the base, that are crinkled at the edges (Demoly and Montserrat, 1993; Kudrnovsky et al., 2020; Wuerpel, 1974). *Cistus ladanifer* var. *maculatus* Dun. (= *C. ladanifer* f. *maculatus* (Dun.) Samp.), is a vigorous variety, soon reaching its mature height, with slender bright green foliage, rippled at the edges, with very large, 8.5–10.5 cm bright white flowers featuring a ring of neatly triangular crimson marks, 1.5 × 1 cm, at the base. The cultivar *C. × purpureus* ‘Alan Fradd’ with white flowers, notwithstanding the purple color of the flowers in the type of this hybrid, presents similar purple spot on the petals.

Other *Cistus* species, hybrids and cultivars with similar white, dark red blotched, flowers include: *Cistus × cyprius* Lam., is a natural

hybrid between *C. ladanifer* and *C. laurifolius* L. It is a tall rockrose, which can reach 1.5 to 2 m in height and 1 meter in spread. Its thick, leathery leaves are dark green with slightly wavy edges. It features 5–8 cm pure white flowers marked with crimson blotches, 0.9 × 0.7 cm, faintly golden at the base, set against slender, very sticky, dark green, glossy leaves that are silvered beneath and give off a strange, slightly pine-like aroma. The young shoots are sticky and very aromatic, especially when grown in warm climates. It flowers profusely from April to early June, and its flowers are large white with dark red spots. It can be grown in full sun or semi-shade, in acidic, neutral or slightly calcareous, very well-drained soil. The plant may yellow from chlorosis if grown in clay soils. It is resistant to –12 to –15 °C and very drought tolerant, being code 5 (plants that thrive in regions where summer drought lasts five to six months) (Filippi, 2023). This rockrose can be used as an isolated specimen, in shrub beds, hedges and aromatic gardens (Dansereau, 1951). *Cistus palhin-hae* N.D.Ingram (= *Cistus ladanifer* subsp. *sulcatus* (Demoly) P.Monts.), this low and spreading variety, usually reaching twice or thrice as

**Table 2**

Comparison of the major aroma compounds of *Cistus ladanifer* var. *supermaculatus*, and the type *Cistus ladanifer* var. *ladanifer*.

Compounds <sup>2</sup>	<i>C. ladanifer</i> var. <i>supermaculatus</i>	Quality%	<i>C. ladanifer</i> var. <i>ladanifer</i>	Quality%	Literature <sup>*</sup>
alpha-Pinene	14.58%	95	3.62%	97	Ma
Ledol	11.98%	95	5.10%	94	Ma
Sclareol oxide	1.02%	62	10.76%	76	—
Limonene	1.20%	90	0.30%	35	Ma
Terpinen-4-ol	1.49%	94	1.16%	94	Ma
Bornyl acetate	1.54%	98	1.80%	98	Ma
Hydrocinnamic acid	2.27%	95	0.93%	94	—
Pinocarveol	1.33%	53	1.56%	78	Ma
Pinocarpone	0.93%	93	1.24%	93	Ma
Verbenone	1.42%	98	1.44%	98	Ma
delta-Cadinene	1.28%	93	3.93%	93	—
alpha-Copaene	1.25%	93	1.90%	70	—
2,2,6-Trimethylcyclohexanone	1.20%	91	0.72%	91	Ma
Acetophenone	0.98%	87	1.57%	91	Ma
Guaiol	—	—	5.35%	81	—
Viridiflorol	—	—	5.10%	91	Ma
9-Octadecyne	—	—	4.38%	53	—
Eugenol	—	—	0.95%	98	Ma
Muroladiene	—	—	2.15%	95	—
Camphene	0.50%	64	—	—	Ma
p-Cymene	1.29%	94	—	—	Ma
Globulol	3.64%	93	—	—	Ma

Note: Fresh leaves were collected from both varieties at the locality of Los Cortijos (Ciudad Real, Spain) on April, 22, 2023. The values in the first column of each variety represent the percentage of the surface area of each peak in relation to the total chromatogram, the second column represents the quality of the identification. (\*) Consulted literature: Morales et al. (2015); Teixeira et al. (2007). Abbreviations: Ma, major constituents in different *Cistus ladanifer* populations, in **bold characters** appear constituents in proportions above 3%.

wide as high, has narrow, dark green, rather sticky foliage, leaves  $4.2 \times 1.6$  cm, and 5 cm white flowers, blotched or not. It forms sclerophyllous scrubs (Wuerpel, 1974; Demoly and Montserrat, 1993; Kudrinsky et al., 2020). *Cistus* 'Decumbens', this low and spreading variety, usually reaching twice as wide as high, has narrow, dark green, rather sticky foliage and 5 cm white flowers, boldly marked in crimson at the base. *Cistus* 'Snow Fire', developing into a plant at least twice as wide as high, with, 6 cm, evenly flat flowers with pure white overlapping petals, each with a basal blotch,  $1 \times 0.8$  cm, in brighter red than in most *Cistus* species (Filippi, 2023).

Other *Cistus* species, hybrids and cultivars with pink to purple, dark red blotched, flowers include: *C. × purpureus* Lam., which is a cross between *C. ladanifer* and *C. creticus* L., with pink flowers with purple spots. It is the most cultivated hybrid in gardening. Quite resistant to cold and spectacular in bloom. This small rockrose has reddish stems that look good with the dark, wavy-edged foliage. The prettily crinkled, 5–7 cm, flowers are rich rosy red, each petal with a bold crimson, mark,  $1.5 \times 1$  cm, at the base (Table 1). *Cistus ladanifer* var. *sanguineus* A.Tejerina & F.M.Vázquez was recently described with pink to purple petals which present a dark red blotch near their base (Tejerina and Vázquez, 2021).

After the discovery in two different localities of Ciudad Real (Spain) of rockrose individuals with a peculiar flower type, the aim of the research was to observe for the first time this extremely rare variety as it grows wild in the field and under cultivation, from seed germination onwards to flowering, and to proceed to its formal description. The obtained results broaden knowledge about *C. ladanifer* in terms of reproduction potential, flowering process, plant morphology and ornamental potentialities.

For this study, samples of *Cistus ladanifer* var. *supermaculatus* were collected in April 2023 from the community where this new variety naturally occurs at Los Cortijos (Ciudad Real, Spain). Also, specimens raised from seeds collected in Nava de Estena (Ciudad Real) were analyzed. We analyzed, using Headspace – Gas Chromatography – Mass Spectrometry techniques, the volatile compounds in leaves collected from plants belonging to the new variety and to the type variety (Table 2).

*Cistus ladanifer* var. *supermaculatus* Buitrago et al. var. nov.

*Haec nova varietas notabiliter differt a typica varietate specie per colorem florum, quae magnam maculam exhibent, a profunda purpurea ad rubram valde obscuram, fere 80% superficiei petalorum obtegens.*

This new variety differs notably from the typical variety of the species by the colors of their flowers, which present a large blotch, deep purple to very dark red, covering almost 80% of the petal surface.

TYPE: Holotype, specimen at ALBA (no. 13,699), Los Cortijos, (Ciudad Real, Spain) (N  $39^{\circ} 19' 21''$ , W  $4^{\circ} 01' 50''$ , 820–830 m.a.s.l.), 22-April-2023. Collected by: Pedro Pablo Buitrago, Rafael Ubaldo, Arturo Valdés, Diego Rivera, Concepción Obón and Alonso Verde s.n. (Fig. 1). ISOTYPES: ALBA no. 13,697 and 13,698.

The new variety is characterized and differentiated from other varieties, subspecies and species by the extensive purple spot that covers a good part of each of the petals except for the white band in the outer zone and the pale-yellow base (Fig. 2). The plant dimensions are somewhat smaller than in the type, but the flowers are relatively large (Table 1). The aroma that characterizes the plant is defined by dozens of compounds, mostly those already described for the species *C. ladanifer*, of which the most relevant are presented in Table 2. There are notable differences between the samples from new variety, in the presence/absence or quantities of some compounds, and those from the typical plant sample, but the great variability detected in other populations of this species must be considered in order not to attribute excessive chemotaxonomic value to the detected differences. Borneol, 2-Phenylethanol and 15-nor-labdan-8-ol which are common constituents of the essence in other localities (Teixeira et al., 2007; Morales et al., 2015) do not appear in the



Fig. 1. *Cistus ladanifer* var. *supermaculatus* HOLOTYPE. (ALBA no. 13,697). Image courtesy of the herbarium ALBA, reproduced with permission.

analyzed samples of the type and of the new variety. The species that accompany these rockroses (in populations where the type and the new variety coexist) are trees such as *Quercus rotundifolia* Lam., *Quercus suber* L. and *Quercus faginea* Lam. Shrubs such as *Lavandula pedunculata* (Mill.) Cav., *Cytisus scoparius* (L.) Link, *Adenocarpus telonensis* (Loisel) DC., *Rosmarinus officinalis* L. or *Daphne gnidium* L. and bulbous plants such as *Asphodelus aestivus* Brot. However, the specimens analyzed at Los Cortijos grow in the strip at the edge of the community, an area that was plowed in 2018 and suggesting an age of five years for those individuals.

The present research contributes to the knowledge of the floral diversity within *Cistus*. Given the ornamental potentialities of this new variety we are in parallel developing a strategy of propagation under cultivation. The obtained plants can be used not only with





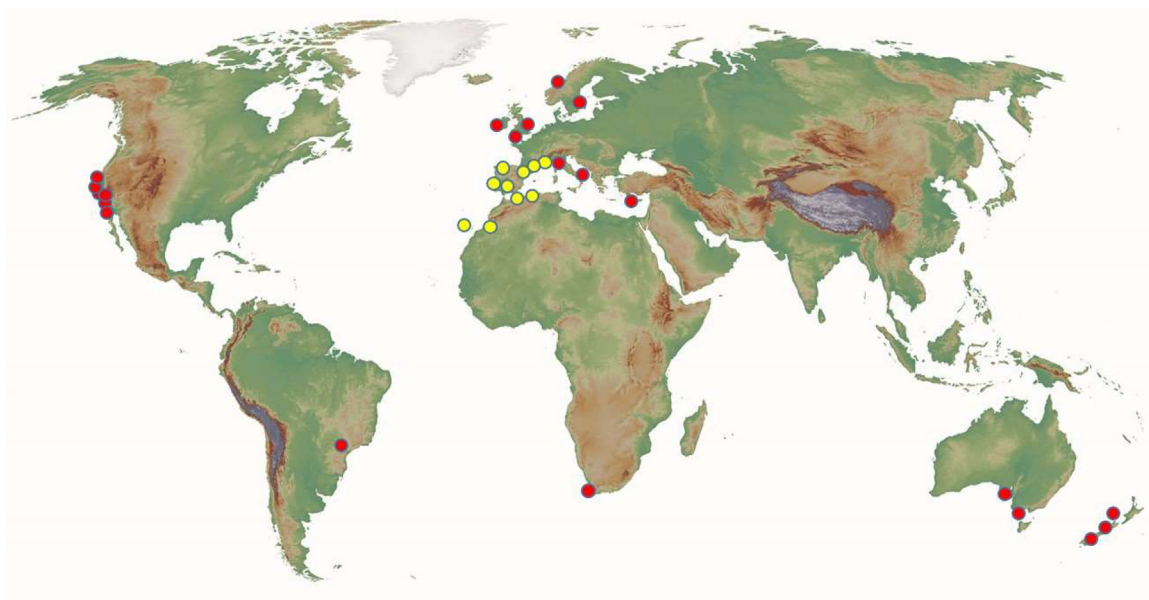
**Fig. 2.** *Cistus ladanifer* var. *supermaculatus* compared with typical *C. ladanifer*: A – *Cistus ladanifer* var. *ladanifer*, with blotched white flowers, B – *Cistus ladanifer* var. *supermaculatus* flowers and leaves, C – *Cistus ladanifer* var. *albiflorus* Occasionally appearing in the population, D – Detail of the *Cistus ladanifer* var. *supermaculatus* flower, E – Blooming specimen of *Cistus ladanifer* var. *supermaculatus* from which type material was collected at Los Cortijos (Ciudad Real). Images: D. Rivera and C. Obón.

ornamental purposes but also in the process of protection and preservation of *Cistus* diversity.

The species as a whole is a native taxon, endemic to the western Mediterranean region and some islands of Macaronesia (Fig. 3) ((accessed 6-9-2023); Fédération des, 2023), which grows in soils poor in bases, developed on siliceous or volcanic substrates. Outside this area it is cultivated as an ornamental species in open-air gardens and as a consequence it can escape, generally occupying spaces more or less altered by human activity, from which, once established, it can

mix with the open autochthonous vegetation as an allochthonous species that could eventually be considered invasive. This status has been proposed for the Cape region of South Africa by Du-Plessis et al. (2018) but it also occurs in Ireland, the British Islands, California (USA), New Zealand and Tasmania (Fig. 3) (GBIF, 2023; Kew, 2023).

The areas where the danger of the species behaving as an invader is greater are those with a Mediterranean climate, both around the Mediterranean Sea, such as Liguria (Italy) or the island of Cyprus, where it is considered an established allochthonous species (Raab-



**Fig. 3.** *Cistus ladanifer* area: Yellow dots: areas where the species is autochthonous. Red dots: areas where the species is allochthonous and occasionally escapes from cultivation. Image: D. Rivera and C. Obón.

Straube, 2018; Dryades, 2023), as well as in territories in America, South Africa or Australia.

The presence in South Africa of *C. ladanifer* in Kenilworth Racecourse Conservation Area (KRCA) and Kirstenbosch Botanical Gardens estate (Du-Plessis et al., 2018) is linked in both cases to intense human activity in the environment, urban in the first case, or to the planting of the species in the past in the context of a botanical garden in the second. Soil removal associated with acacia extraction activities favors seed germination.

The behavior of the new variety does not seem to be as threatening as that of the type since it has only been found in the field in previously ploughed areas, see above, and not in dense rockrose scrub formations. It is likely that in dense natural formations of fynbos it would not be easily established. On the contrary, in those subject to intense management involving soil removal, the risk is high and it is therefore recommended not to cultivate the new variety in areas close to areas with open natural vegetation, especially in the context of protected areas.

### Supplementary materials

No supplementary material is associated with this article.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Acknowledgments

We are grateful to José Rodríguez Martínez of the Servicio de Instrumentación Científica (Universidad de Murcia) for the GC–MS analysis and to Amelia Plaza Pérez de Madrid for caring the specimens raised in cultivation.

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