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Endemic Species

*Edited by Eusebio Cano Carmona,
Carmelo Maria Musarella and Ana Cano Ortiz*



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Salvia ceratophylloides Ard. (Lamiaceae): A Rare Endemic Species of Calabria (Southern Italy)

*Giovanni Spampinato, Valentina Lucia AstridLaface,
Ana Cano Ortiz, Ricardo Quinto Canas
and Carmelo Maria Musarella*

Abstract

Salvia ceratophylloides Ard. is a very precious narrow endemism of Southern Italy. It grows in the suburban surroundings of Reggio Calabria, on coastal strip hilly ridges between 250 and 450 m a.s.l. At the beginning of 1900, it was present in several localities, as evidenced by literature, where it was already very rare. Afterward, despite the research carried out by various botanists, the species was no longer found, due to its disappearing in the places mentioned in literature resulting from the intense environmental transformations suffered by the territory. Therefore, the species since 1997 was included in the “Red Book of the flora of Italy” among the extinct species. The successive research carried out in 2008 made it possible to ascertain new localities at about 10 km of distance from those reported in the literature. The actual population consists of about 1000 individuals, and according to IUNC criteria, the conservation status is critically endangered (CR). The threats to survival and spread of the species are different, but above all, it is the habitat destruction due to urbanization to threaten this species.

Keywords: endemism, reggio calabria, critically endangered species, Italy

1. Introduction

The genus *Salvia* has a cosmopolitan distribution and is probably the richest in species of the *Lamiaceae* family. Many species have considerable economic importance for medicinal, food, or ornamental uses. The authors that have dealt with this genus estimate that it contains between 900 and 1000 species [1, 2]. The Mediterranean and Western Asia, with about 240 species, are one of the diversity centers of the genus *Salvia* [2]. The Italian flora includes 20 species of the genus *Salvia* [3] among which *Salvia ceratophylloides* Ard., is a rare endemism of a small hilly area close to the city of Reggio Calabria in Southern Italy (**Figure 1**).

Until 2008, *Salvia ceratophylloides* was considered “extinct in the wild” (EW) by the “Red regional lists of Italian plants” [4], by the “Atlas of endangered species” of Italian flora [5], and by authors who have studied the genus *Salvia* in Italy [6]. The intense urbanization of the areas surrounding the city of Reggio Calabria has led to profound changes in the landscape with the reduction, degradation, and

disappearance of natural habitats. All this caused the extinction of the species from the places where it was collected until the beginning of 1900 by various authors [7].

Field surveys carried out in the last decade have, however, allowed us to verify the presence of the species in other localities and to define its taxonomic and ecological characteristics as well as the conservation status [8].

Salvia ceratophylloides currently occurs in small and isolated populations, which are expected to face extinction mainly due to the habitat destruction.

We present a study on the distribution, taxonomy, and conservation status of *S. ceratophylloides*, aimed at identifying the criteria for the management and conservation of this rare species of Italian flora.



Figure 1. *Salvia ceratophylloides* Ard. (A) habit, (B) inflorescence, (C) leaves, and (D) flower.

2. Materials and methods

We define the distribution of *Salvia ceratophylloides* by several ways such as analysis of herbarium collections, literature data, and through a deep field investigation carried out from 2010 until 2018. To map the distribution, all sites of species were geo-referenced in the field and the coordinates archived in a geographical information system (GIS).

The morphological traits were measured on 10 herbarium specimens with a stereomicroscope. The specimens are kept at the “Mediterranea” University of Reggio Calabria Herbarium (REGGIO). To assess population size and the habitat, several surveys were carried out on the *S. ceratophylloides* biotope. Conservation status was assessed according to the IUCN Red List criteria [9], which is actually the more widely used in the world to assess extinction risk. The nomenclature of the species is according to [10].

3. Historical vicissitudes

The first news on this species dates back to the pre-Linnaean period and is due to Cupani [11], a Franciscan monk, an expert on Sicilian flora, who in his monumental work “*Panphyton siculum*” published the iconography and description of many species of Sicilian flora. The work published posthumously by the publisher



Figure 2.
Iconography from the “*Panphyton Siculum*” by Cupani of 1713 related to *Salvia ceratophylloides*.

in 1713 [12] contains an iconography (t 186) clearly referable to *Salvia ceratophylloides* (**Figure 2**) that Cupani describes with the phrase “*Sclarea verbenae petalis purpurates florum*.” Cupani described many species in his book that he collected spontaneously in Sicily, but also non-native, grown at the botanical garden of Misilmeri in Sicily, of which he was the curator [13]. This has created confusion in Sicilian botanists who for a long time have attributed this species also to the Sicilian flora [14].

The species was described with the binomial system by Pietro Arduino (1728–1805) [15] as *Salvia ceratophylloides*, in “*Animadversionum botanicarum specimen alterum*” (**Figure 3**).

Arduino for the description used plants grown at the Botanical Garden of Padua, obtained from seeds that received from a friend from Sicily as he says “*Ex seminibus e Sicilia ab amico delatis, et in horto hoc nostro satis quinque anni sab hinc nata est.*” Also for this reason, Sicily was considered for a long time the place of origin of this species, although no one has ever collected samples in the wild. Arduino attributed to this sage the epithet “*ceratophylloides*” to highlight the similarity that



Figure 3.
Iconography of *Salvia ceratophyllales* from Arduino [15].

in his opinion, this species has with *Salvia ceratophylla* L., a species distributed in the Irano-Turanian region absent in Italy (from the Greek εἶδος *eidos* appearance, resemblance). Arduino describes the species as: “*Salvia ceratophylla sed luxuriantis similis; forte diversa ac distincta*”).

Arduino deposited the type specimens used for the species description, in its herbarium of Vicenza, which unfortunately was destroyed during the Second World War. He sent some herbarium samples to Linnaeus in 1763, still preserved at the Linnaean herbarium at London. The sample sent and inserted by Linnaeus in his herbarium No. 42.55 (**Figure 4**) shows the name of the species and connected to a list attached to some *exsiccata* sent by Arduino to Linnaeus.

Lacaita [7] organized the taxonomic framework of *Salvia ceratophylloides*, clarifying the real place of origin of the species. He pointed out that the species has never been found spontaneously in Sicily and that the few specimens present in various herbaria are all coming from southern Calabria or from crops obtained by seeds always coming from these localities.

Lacaita [16] found that the samples named by Linnaeus as *Salvia ceratophylla* L. and by subsequent authors as *S. ceratophylloides* L. are, in fact, to be attributed to *Salvia ceratophylloides* Ard. Therefore, *S. ceratophylloides* L. is a synonym of *S. ceratophylloides* Ard., which has a nomenclatural priority.



Figure 4. The herbarium specimens of *Salvia ceratophylloides* sent by Arduino to Linnaeus in 1763 and stored in the Linnaean herbarium at London (LINN 42.55).

Until the beginning of 1900, *Salvia ceratophylloides* was collected by various botanists [7, 17, 18] from some locations around Reggio Calabria: Gallico Superiore, Terreti, Straorino, Orti, Vito Superiore, Pietrastorta, even then the species was very rare [7]. In the following decades, the species was not found again despite the research carried out by various botanists, as the profound environmental transformations due to the urban expansion of the city of Reggio Calabria determined the destruction of the habitat and disappearance of the species. In 1997, the species was considered extinct and included in the “Red Book of the flora of Italy” as extinct species (EX) [4–6, 19]. Field research started in 2008, however, allowed to discover some small new populations of *S. ceratophylloides* around Reggio Calabria (Puzzi, Cataforio) [20]. Later were found other small populations in places hardly accessible, always in the surroundings of Reggio Calabria [21].

4. Morphological trait

Salvia ceratophylloides (Figures 1, 3 and 4) is a perennial herbaceous plant (scapose hemicryptophyte), densely pubescent for both glandular and simple patent hairs. The plant is 30–90 cm tall, has upright or ascending stems, normally lignified and much ramified at the base. The leaves are pinnate-partite, with toothed lobes, the basal of 10–12 × 4–6 cm, and the cauline of 3–4 × 1–2 cm. The leaf blade, wrinkled on both sides, is glandular and pubescent, more evident on the lower one. The inflorescences are very showy, 20–30 cm long, normally ramified at the base, and are made up of 5–6 verticillaster each with 4–6 flowers. The calyx, 8–10 × 3–5 mm, is zygomorphic, ferruginous, and covered with numerous sessile or pedicel glandular hairs. The bilabiate corolla, violet, 15–25 mm long (three times the calyx) has an upper lip strongly folded to the cap on the stamens pubescent-glandular on the outside. The two stamens are 10 mm long and the style 20–30 mm long, protrudes over 10 mm from the upper lip and has a deeply bifurcated purple-colored stigma at the extremity. The fruit is a peculiar schizocarp: a microbasarium made up of four dark brown, spherical to ovoidal mericarp; each mericarp, 2–3 mm long, has a thickened margin.

Salvia ceratophylloides has a main flowering period in spring from April to June and a second flowering period in autumn from October to November. The fruiting occurs after some flowering weeks.

It is a strongly aromatic plant, rich in essential oils [22], and of future potential economic interest. The composition of volatile substances produced by glandular hairs suggests that these substances are involved in chemical defense against insects.

5. Taxonomic remark

The taxonomic rank of *S. ceratophylloides* is controversial. Hedge [23] considers it a synonym of *Salvia pratensis* subsp. *pratensis*, instead the greater number of the authors indicate it as a good species [19, 24]. The species is reported with different taxonomic classification in the Italian floras: Fiori & Paoletti [25] reported *S. ceratophylloides* as a variety of *S. pratensis*, Tenore [17] and Pignatti [3], considering it as an autonomous species. The most recent checklists of the Italian flora [10] and the authors who dealt with the taxonomy of the *Salvia* genus in Italy [6] also consider *S. ceratophylloides* an autonomous endemic species of Southern Calabria.

Salvia ceratophylloides Arduino Animad. Bot. Spec. Alt. 12, tab 2.1764.

Synonyms: *Salvia ceratophylloides* L., Mantissa Pl., 26, 1767; *Salvia pratensis* L. var. *ceratophylloides* (Ard.) Fiori e Paoletti, Flora Analitica d'Italia, 5: 255, 1909; and *Salvia ceratophylloides* Ten. var. *A* Ten., Flora Napolitana 3: 25, 1829.

	Plant	Lamina of the cauline leaves	Inflorescence	Corolla
<i>S. ceratophylloides</i>	30–90 cm high, pubescent and very glandular	Pinnate-partite with serrated lobes	Wide, very branched	15–25 mm long with numerous glandular hairs
<i>S. pratensis</i> subsp. <i>pratensis</i>	30–60 cm high pubescent and little or not glandular	Ovate-oblong with slightly crenate or incised lobed margin	Cylindrical, little, or not branched	13–20 mm long without or with few glandular hairs
<i>S. pratensis</i> subsp. <i>saccardiana</i>	50–110 cm high, pubescent, and glandular	Cordate-ovate, with lobed-crenate margin	Cylindrical, little, or not branched	28–25 mm long, with numerous glandular hairs
<i>S. haematodes</i>	50–120 cm high, pubescent and very glandular	Triangular, with crenate margin	Wide, very branched	28–35 mm with numerous glandular hairs
<i>S. virgata</i>	30–100 cm high, pubescent and glandular especially in the upper part	Ovate-oblong with slightly crenate or incised lobed margin	Wide, very branched with arcuate-erect branches	13–16 mm glandular only at the margin

Table 1.
 Main morphological differences between species of *Salvia pratensis* group in Italy.

Salvia ceratophylloides belongs to Subgenus *Sclarea* (Moench) Benth., Section *Plethiosphace* Benth., characterized by a campanulate calyx, above two furrowed, concave, with three conniving teeth and corolla with a crescent-shaped upper lip and compressed. It is a part to the group of *S. pratensis* present in Italy with: *S. pratensis* L. subsp. *pratensis*, *S. pratensis* L. subsp. *saccardiana* (Pamp.) Poldini, *S. haematodes* L., *S. virgata* Jacq., and *S. ceratophylloides* Ard. [3]. *S. ceratophylloides* is well distinguished from the other sages species of the *Salvia pratensis* group, above all for the pinnate-partite leaf with toothed lobes. **Table 1** shows the main morphological differences between the species of *Salvia pratensis* group in Italy.

The type of *Salvia ceratophylloides* was lost because the Arduino herbarium was destroyed during the Second World War. Del Carratore et al. [26] carried out the lectotyping of *S. ceratophylloides* Ard. Among all the samples, present in the various legally recognized herbarium, they are indicated as the lectotype of *Salvia ceratophylloides*, the specimen that Arduino sent to Linnaeus stored in the Linnaean Herbarium of London at N° 42.55 (**Figure 4**).

6. Habitat

Salvia ceratophylloides grows near Reggio Calabria, on the hills of the western side of the Aspromonte facing the Strait of Messina (Southern Italy), at altitudes between 250 and 400 m a.s.l. especially on the cooler slopes with the north or northwest exposition. The geology of the area is characterized by layers of loose sand alternating with benches of soft calcarenites of Pliocene origin. The soils have a sandy texture with a basic pH and fall into the group Calcaric Cambisols [27].

The area has a typically Mediterranean climate with average annual temperatures of 18°C and average annual rainfall of 600 mm, concentrated in the autumn



Figure 5.
Habitat of Salvia ceratophylloides.

months of November and December, and a summer dry period of about 5 months. According to Rivas Martinez et al. [28], the macro-bioclimate is “Mediterranean pluvisesonal oceanic, with thermo Mediterranean bioclimate” (upper thermo Mediterranean thermotype and a lower subhumid ombrotype).

Salvia ceratophylloides grows spontaneously in the habitat of the EEC directive 43/93: “5330 thermo Mediterranean and pre-desert scrub” subtype “32.23 Diss-dominated garrigues.” This habitat includes Mediterranean steppe and garrigue dominated by *Ampelodesmos mauritanicus* (Poir.) Dur. & Schinz. or *Artemisia campestris* L. subsp. *variabilis* (Ten.) Greuter (**Figure 5**) [29, 30]. The most frequently growing species with *S. ceratophylloides*, in addition to the aforementioned species, are some grasses (*Lagurus ovatus* L., *Avena barbata* Link, *Briza maxima* L., *Hyparrhenia hirta* (L.) Stapf., *Dasypyrum villosum* (L.) P. Candargy), several dwarf shrubs (*Cistus creticus* L., *Cistus salviifolius* L., *Micromeria graeca* (L.) Benth. ex Rechb., *Thymbra capitata* (L.) Cav., *Phlomis fruticosa* L.), and some shrubs (*Cytisus infestus* (C. Presl) Guss. subsp. *infestus*, *Spartium junceum* L.). Mostly, they are widespread species in the steppic grassland and in the Mediterranean garrigues.

7. Distribution and abundance of the population

The field researches conducted in 2008–2010 allowed discovering four small new populations of *S. ceratophylloides* around Reggio Calabria (Puzzi, Cataforio). Each population consisted of a few dozen individuals, for a total census of 100 mature individuals [20, 31]. After looking everywhere, in recent years, other eight small populations of *S. ceratophylloides* in places hardly accessible were found, always in the surroundings of Reggio Calabria (**Figure 6**). The total area occupied by the 12 sites is about 4200 m². In these sites, the plants are distributed as follows: 601 breeding without flowers or fruits, 22 flowering individuals, 3 fruiting individuals, 216 seedlings, 259 juvenile individuals nonbreeding, and 17 dead individuals. For a total of about 1100 individuals [21]. The distribution of plants in the fragmented subpopulations is very irregular in relation to the quality of the habitat. In some sites, the number of plants is more abundant, with about 250 individuals; in other sites, the individuals do not exceed 3 units.

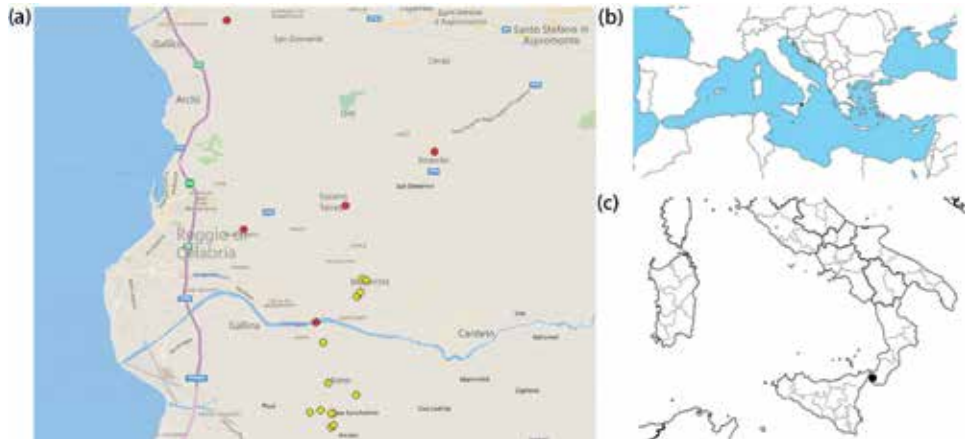


Figure 6.
(a) Distribution map of *Salvia ceratophylloides*: red dot—populations cited in the literature and extinct; yellow dot—population currently existing found after 2008. (b) Mediterranean Basin: black dot—distribution area and (c) Southern Italy.

8. Conservation status

As a consequence of population disappearance from the historical places where *Salvia ceratophylloides* was collected at the beginning of the 1900s, it was considered extinct globally (EX) [4, 5]. In 2010, after the discovery of some sites, an assessment was made from Crisafulli et al. [20], and according to the IUCN criteria, the species was ascribed to the “critically endangered” risk categories (CR). Research carried out more recently by Laface et al. [21] ascertained an increasing population size in number of breeding adults and in the area of occupied populations. Nevertheless, the new assessment, using the IUCN criteria B, C, and D, confirmed the status of “critically endangered” species. So, *S. ceratophylloides* is seriously threatened, facing an immediate high risk of extinction.

S. ceratophylloides has a naturally small population and therefore susceptible to damaging influences. The remarkable fragmentation of the habitat, also due to the environmental transformations caused mainly by various anthropic activities, is the major conservation problem.

According to EIONET classification [32], the threats that influence the survival of this sage can be codified as follows: F01: conversion from other land uses to housing, settlement or recreational areas (excluding drainage and modification of coastline, estuary, and coastal conditions); A02: conversion from one type of agricultural land use to another (excluding drainage and burning); A03: conversion from mixed farming and agroforestry systems to specialized (e.g., single crop) production; A15: tillage practices (e.g., plowing) in agriculture; A16: other soil management practices in agriculture; A17: harvesting of crops and cutting of croplands; B01: conversion to forest from other land uses, or afforestation (excluding drainage); C01: extraction of minerals (e.g., rock, metal ores, gravel, sand, shell); A11: burning for agriculture; A13: burning for forestry; I02: other invasive alien species (other than species of Union concern); and L06: interspecific faunal and floral relations (competition, predation, parasitism, pathogens). The latter threat, due to insects that feed on fruits and flowering stems, is particularly serious and strongly compromises the reproductive capacity of the species.

Salvia ceratophylloides currently is not safeguarded *in situ* from protected areas or from Sites of Community Importance (SCI) according to Directive CEE 43/92.

The *ex situ* conservation is carried out in the Messina Botanical Garden “Pietro Castelli,” where it is successfully reproduced by seed and where currently there are about thirty individuals.

Some environmental organization proposed the inclusion of *S. ceratophylloides* in the lists to the laws of the Calabria Region on the autochthonous flora protection (L.R. n.30 of 26/11/2001; L.R. n.47 of 07/12/2009) [33]. Researchers from the Department of Agriculture of the Mediterranean University of Reggio Calabria have initiated, on its own initiative, monitoring and research on the biological conservation of this rare sage [21].

9. Conclusion

Endemic species have a high conservation priority, as they are exclusive to a geographically restricted and limited territory. Being often rare and ecologically infrequent, any unfavorable change can cause their rapid extinction [34]. The exclusive endemisms deserve the conservation priority since the disappearance of the local populations caused the complete extinction of these species. Considering the regional responsibility for the conservation of species [35] and that *S. ceratophylloides* is one of the most endangered rare endemic plants, this species should be the subject of specific *in situ* and *ex situ* conservation actions.

The involvement of local authorities (Calabria region and metropolitan city of Reggio Calabria), responsible for the conservation of natural resources and the environment, is essential to take concrete actions aimed at the conservation of this species.

To protect populations of this species and preserve them over time, the establishment of microreserves, following the example applied in Spain [36], could be a good solution for the *in situ* conservation of this rare sage. These are small protected areas created in order to ensure the future study and monitoring of the endangered endemic flora plants, which can be entrusted to environmentalist associations or to the landowner.

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This book consists of several thematic groups, including botany, zoology and topics related to human health. In regards to botany, chapters discuss endemic plants of Bolivia, Mexico, Italy and the Caribbean. They show the diversity, distribution and conservation of many species. In regards to zoology, the book highlights endemic primates and reptiles. Additionally, the book presents other environmental issues relevant to conservation.

This volume also presents topics related to health, some of which are relevant for their implications on health and the economy, is the case of the presence of toxins in the Pacific plankton. All chapters present relevant content for future research or because they are fundamental for territorial management.

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