



Rediscovery of a relict *Searsia tripartita* maquis in Southwestern Sicily (Italy) with data on habitat 5220*

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Abstract

This paper reports the presence of a nucleus of thermophilous maquis with *Searsia tripartita* within the “Monte San Calogero” Nature Reserve (Sciacca, Southwestern Sicily, Italy), within a Natura 2000 site (ITA040009). *S. tripartita* is a summer-deciduous shrub with a South-Mediterranean distribution range, which is relatively common in North Africa but with only a few disjunct occurrences in Sicily. Here we report on a site that is located at the northern limit of the species’ range. The local occurrence of the species was reported for the first time some 200 years ago by Gussone, as testified by two herbarium specimens kept in the Gussone Herbarium of Naples. This study explores the synecology and the dynamic trends of the *S. tripartita* maquis using vegetation field surveys and a diachronic analysis of historical images spanning 27 years, from 1998 to 2024. The plant community colonizes an extremely dry and stony area at the base of carbonate rocks, subject to dry-semiarid thermomediterranean bioclimatic conditions. The surveyed plant community can be referred to *Calicotomo infestae*-*Rhoetum tripartitae*, a distinct low maquis association considered endemic to southern Sicily, framed within the southern Mediterranean alliance *Periplocion angustifoliae* (order *Pistacio-Rhamnetalia alaterni*, class *Quercetea ilicis*). Additional considerations are given to the conservation status of the rare habitat of Community interest 5220* (Habitats Directive 92/43/EEC) in which this community is classified.

Keywords

Habitat fragmentation, *Periplocion angustifoliae*, priority coastal habitat, relict Mediterranean maquis, semiarid ecosystems

Introduction

Searsia tripartita (Ucria) Moffett [= *Rhus tripartita* (Ucria) Grande] is a spiny summer-deciduous shrub belonging to the Anacardiaceae family, growing up to 2.5–3.5 m tall. Its distribution range is mostly concentrated in the northern part of the African continent, from the Atlantic coasts of Mauritania and Morocco to Algeria, reaching into the Sahara, including the Tademaït Plateau and the Ahaggar Massif (Browicz 1982; Brullo et al. 1998; El-Ghanim et al. 2010; Al-

tamimi and Souheila 2021; Shaltout and Bedair 2023; African Plant Database 2025; GBIF.org 2025). The species is also common along the Mediterranean coasts of Tunisia, Libya, Egypt and Sinai, extending into the Red Sea area, reaching Sudan and the Arabian Peninsula, and also occurring in the Middle Eastern countries of Palestine, Lebanon, and Syria (Fig. 1). Very rare disjunct occurrences of *S. tripartita* are located also in the southern part of Italy (Fig. 2), specifically on the island of Linosa and in Sicily (Brullo and Siracusa 1996). It constitutes aspects of thermo-xerophytic (also

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known as “predesertic”) low maquis, referred to the habitat “5220* Matorral arborescent with *Ziziphus*”: given its rarity in Europe, it was included in Annex I of the Habitats Directive (92/43/EEC), as in need of rigorous protection.

Commonly called “African sumac” or “Tahounek” in tamahaq (Benaissa et al. 2019, 2021), “Sumac” or “Jdari” (Gamoun and Louhaichi 2019), this interesting species is typical of sub-desertic regions (Alcaraz 1991; Noumi et al. 2010). In Tunisia, it is often found in sparse xerophilous vegetation, together with *Retama raetam* (Forssk.) Webb & Berthel. subsp. *raetam*, *Stipa tenacissima* L. and *Periploca angustifolia* Labill., widespread in depressions, and sometimes also in gullies and wadis. In the Algerian Sahara it is found in other shrub communities, together with *Periploca angustifolia* (sub *P. laevigata* Aiton) and *Myrtus nivellei* Batt. & Trab. (Benaissa and Djebbar 2018).

S. tripartita is distributed in areas with an average annual rainfall of 100–500 mm, where it prefers calcareous substrates, but it can grow in a variety of types of soil, more or less deep and of different texture (Gamoun and Louhaichi 2019). The plant presents specific ecophysiological adaptations to cope with the extremely low availability of water in the soil, minimizing water loss through evapotranspiration (Noumi et al. 2013; Zouaoui et al. 2013, 2019). It has small, hard and sclerotized leaves that tend to curl to minimize stomatal openings; its branches are dense and very intricate, protecting the entire plant from excessive sunlight. It is a dioecious species with tiny clusters of yellowish-white flowers. The fruit is a small spherical drupe, which contains a single seed, red to black in color. Fruits can be dispersed by frugivores (Gamoun and Louhaichi 2019).

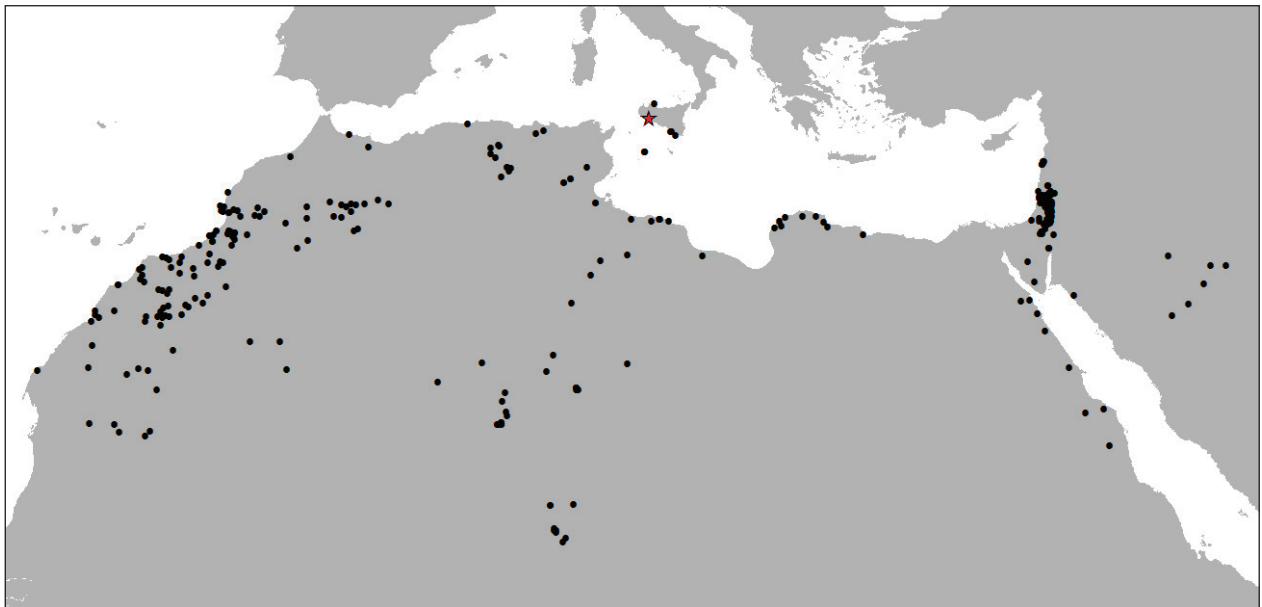


Figure 1. Distribution of *S. tripartita* (based on bibliographical references and our data); in red, the site subject of this survey.

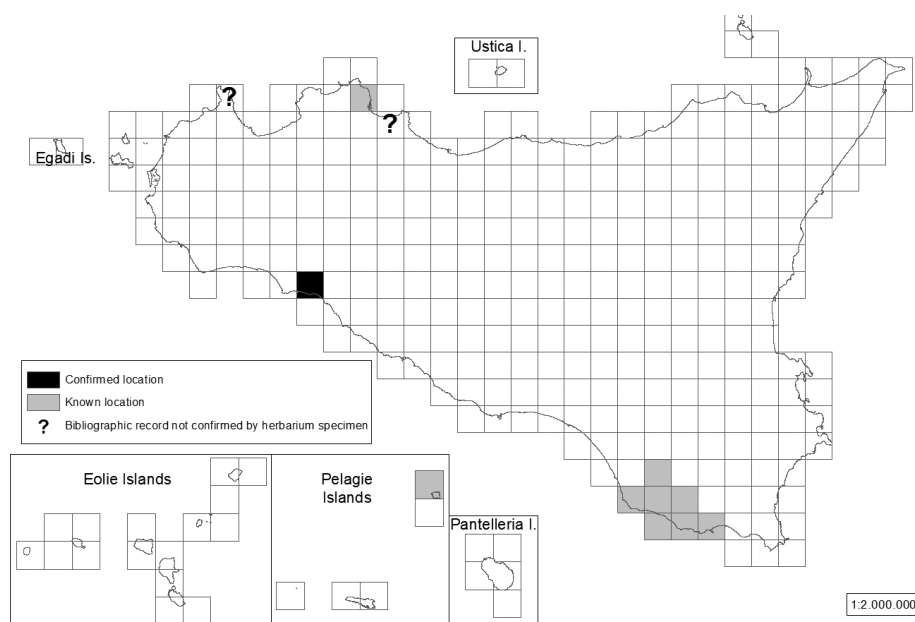


Figure 2. Distribution of *Searsia tripartita* in Sicily.

In Sicily, the most recent reports indicate the species only occurs spontaneously along the coastal area of the Hyblaean district [“Dintorni di Sampieri” (Brullo and Furnari 1970), “Costa del Carro di Sampieri, Cava d’Aliga” (Bartolo et al. 1982), “tra Sampieri e Cava d’Aliga, Fornace Penna di Sampieri” (Brullo and Marcenò 1985), “tra Marina di Ragusa e Pozzallo” (Raimondo et al. 1994)].

Sites where this species was reported in the 19th century for western Sicily have not been confirmed in the present [such as “Capo San Vito” (Tineo 1817; Ponzo 1900, 1940), “Santa Flavia” (Tineo 1817) and “Sciacca” (Gussone 1827)], with the exception of “M. Pellegrino a Villa Belmonte”, near Palermo (Fig. 2), which still hosts few dubiously native individuals (Lojacono-Pojero 1891; Raimondo et al. 1996). Another long-standing individual of the species is cultivated at the Botanical Garden of Palermo.

This article is focused on an isolated nucleus of *S. tripartita* (Fig. 3a, b, c, e, f) located on the southern shore of Sicily, near the summit of Mount San Calogero (municipality of Sciacca, Province of Agrigento), historically known as “Monte Kronio”, where the species was observed by Gussone (1827) (Fig. 3d). The nucleus falls within the “Monte San Calogero (Monte Kronio)” Nature Reserve and the “Monte San Calogero (Sciacca)” Natura 2000 site (SCA ITA040009) (Fig. 4). The local occurrence of *S. tripartita* is of great biogeographical interest, because it is located at the northern limit of the species’ distribution range and is extremely isolated.

This study is part of geobotanical and phytosociological research that has been carried out over the years in protected areas, i.e. SACs (Special Area of Conservation) in the region of Sicily [Pantelleria Island (Gianguzzi 1999), Marettimo Island (Gianguzzi et al. 2006, 2023), Levanzo Island (Romano et al. 2006), Sciare di Mazara and Marsala (La Rosa et al. 2021), Mt. Cofano (Gianguzzi and La Mantia 2009; Gianguzzi et al. 2023; Palermo Mts. (Gianguzzi et al. 1996, 2015, 2024), Sicani Mts. (Gianguzzi et al. 2012, 2014a, 2014b), Nebrodi Mts. (Rivieccio et al. 2020, 2021; Tavilla et al. 2022), coastal dune vegetation (Acosta et al. 2025)], which has also aimed to support activities to protect and safeguard the rich naturalistic and environmental heritage of the region.

The *S. tripartita* maquis fragment investigated in this study is considered to be of significant phytogeographical interest. It is about 200 km from the other closest sites known so far, located upstream of the Irminio River (Marina di Ragusa, south-eastern Sicily; Giardina 2010) and on the Island of Linosa (Canale di Sicilia; Brullo et al. 2009). Its presence was unknown for this area, despite being located within a Sicilian nature reserve and a Natura 2000 site.

In this study, the floristic, phytosociological, synecological and syndynamic characterization of the local plant community are presented, also through comparison with the associations dominated by *Searsia tripartita* already described for the southeastern sector of Sicily (*Calicotomo infestae*-*Rhoetum tripartitae*) and on the island of Linosa (*Periploco angustifoliae*-*Rhoetum tripartitae*). Additional

data are also provided on the conservation status of this habitat, which is extremely rare in Europe. Besides Sicily, this habitat is only present in southern Spain and on the island of Cyprus, where, however, *S. tripartita* does not occur.

Materials and methods

Study area

The studied maquis is located within the “Monte San Calogero (Monte Kronio)” Nature Reserve, according to the Regional Decree of the Territory and the Environment no. 366/44 (26 July 2000) and managed by the Department of Rural and Territorial Development. The reserve spans an area of 52.25 ha. Additionally, a Natura 2000 site (SCA ITA040009) is located within the area, which spans 112.538 ha; it is located northeast of the town of Sciacca (province of Agrigento), on the southern coast of Sicily (Fig. 4). Biogeographically, it falls within the Central Mediterranean Subregion of the Mediterranean Region, following the classification proposed by Rivas-Martínez et al. (2004). On a local scale, according to Brullo et al. (1995), it is part of the Sicilian Province, Eusiculo Sector, Western Subsector, Drepano-Panormitano District.

The study area is characterized by limestone outcrops belonging to the Meso-Cenozoic carbonate succession known as the “Saccense Unit”, dominated by calcareous rocky outcrops, namely stromatolitic limestones with *Megalodon*, dating back to the Upper Triassic-Lower Lias (Lentini and Carbone 2014; Basilone 2018). It culminates at Mount San Calogero (397 m a.s.l.), a rocky hill characterized by a complex karst system rich in caves known as the “Stufe di San Calogero”, “Grotta del Lebbroso”, “Grotta di Mastro”, “Grotta del Gallo” and “Grotta di Cucchiara” (Gulli 2013). This is influenced by secondary volcanic activity. The average temperature of the thermal vapors is around 38 °C (sometimes rising higher) which impedes a complete exploration of the site. The site also features well-known thermal baths, used historically for therapeutic purposes, built next to the Sanctuary of San Calogero, the patron saint of Sciacca (Badino and Torelli 2014).

Based on data from Sciacca’s thermo-pluviometric monitoring station (Duro et al. 1996), the local average annual rainfall is 564 mm, distributed over 65 rainy days (Table 1).

The average annual temperature is 17.9 °C, with a minimum of 7.9 °C in February and a maximum of 30.6 °C in July. According to Rivas-Martínez et al. (2004) bioclimatic classification, the area falls within the lower dry thermomediterranean bioclimatic belt (Bazan et al. 2015; Gianguzzi et al. 2016).

This study was carried out between the spring of 2023 and the summer of 2024. Besides field vegetation surveys, all the relevant literature and the available herbarium specimens of *Searsia tripartita* in Sicily [PAL, CAT, and Gussone Herbarium (NAP)] were checked, to compile data on the past and present regional distribution of the species.

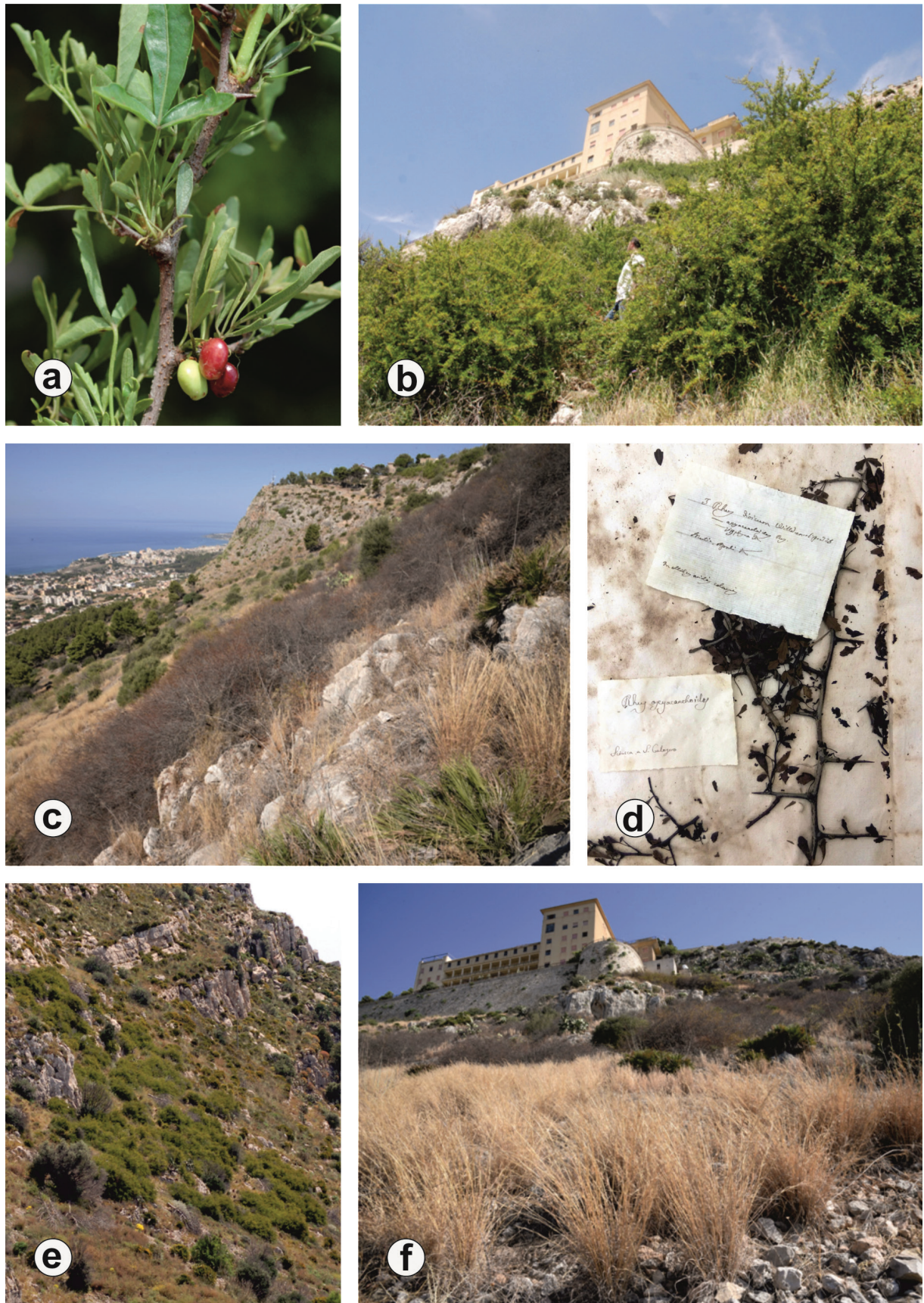


Figure 3. a. *Searsia tripartita*: general habit; b, c. Spring and summer habit of the maquis, respectively, referred to the association *Calicotomo infestae-Rhoetum tripartitae*; d. Detail of one of the *S. tripartita* herbarium specimens collected in Sciacca by Gussone and preserved in the Gussone Herbarium (NAP); e. View of the entire maquis; f. The perennial grassland dominated by *Hyparrhenia hirta* (*Hyparrhenietum hirta-pubescentis*), representing a secondary aspect of the local vegetation series.

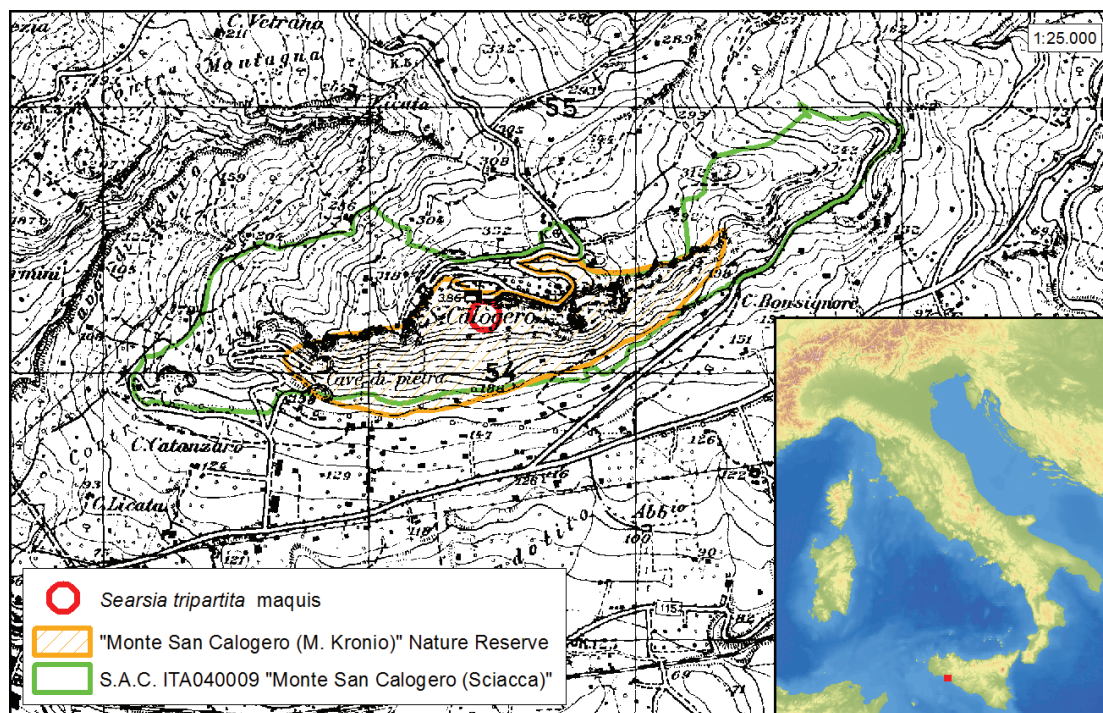


Figure 4. Location of the *S. tripartita* maquis in the nature reserve and the SAC ITA040009.

Table 1. Monthly and annual averages of temperatures (°C), rainfall (mm/m²) and number of rainy days recorded at the thermo-pluviometric monitoring station of Sciacca (Province of Agrigento) between 1926 and 1985 (from Duro et al. 1996).

Month	SCIACCA (56 m a.s.l.)					
	Temperatures				Rainfall	
	Max	Min	Med	Temp range	mm	Rainy days
January	14.9	8.0	11.5	6.9	80.5	10
February	15.2	7.9	11.6	7.3	69.0	9
March	16.7	8.9	12.8	7.8	58.3	8
April	19.3	10.7	15.0	8.6	37.2	5
May	23.5	13.7	18.6	9.8	19.3	3
June	27.7	17.4	22.6	10.3	6.4	1
July	30.6	20.0	25.3	10.6	8.0	1
August	30.4	20.5	25.5	9.9	8.0	1
September	27.8	18.9	23.4	8.9	28.2	3
October	23.9	15.6	19.8	8.3	74.1	6
November	19.9	12.3	16.1	7.6	84.7	8
December	16.3	9.4	12.9	6.9	95.4	11
Year	22.2	13.6	17.9	8.6	564	65

Vegetation was surveyed adopting the Zurich-Montpellier methodology. The observed plant taxa were identified using Pignatti et al. (2017–2019), following the nomenclature from the Portal to the Flora of Italy (2024), aside from *S. tripartita*, for which we referred to Plants of the World Online database (POWO 2025). Repeated field surveys were carried out between 2021 and 2024 that enabled the collection of several phytosociological relevés, adopting the abundance-dominance indices proposed by Braun-Blanquet (1964). The phytosociological relevés

were carried out both in spring (during the optimal vegetative period of the investigated community) and in late summer (with most of the species in vegetative stasis); this was done to better perceive variations in the floristic composition and the degree of coverage of the species present in the maquis vegetation.

For the syntaxonomic interpretation of the surveyed plant community, our field data was compared to that reported in existing literature (Brullo and Marcenò 1985; Brullo et al. 2009). Syntaxon names cited in the text agree with the International Code of Phytosociological Nomenclature (ICPN: Theurillat et al. 2021), whereas their syntaxonomic treatment agrees with Mucina et al. (2016). To produce a synoptic overview of phytosociological data concerning the Sicilian syntaxa with *S. tripartita* framed into the alliance *Periplocion angustifoliae*, reference was made to Brullo et al. (2009) and several recent works, cited in the text.

A diachronic analysis was conducted on vegetation dynamics in the areas occupied by maquis within the study site, using historical images from the Regional Orthophoto Repository or available on Google Earth (over 27 years, from 1998 to 2024).

Taxonomic treatment

Phylogenetic analyses of the *Rhus* complex, using DNA and gene spacers (Miller et al. 2001; Yi et al. 2004), have shown that the genus *Searsia* is clearly monophyletic and strikingly distinct from *Rhus* s.s. (Moffett 2007). Below, we provide a taxonomic prospect of all the epithets related to this species.

***Searsia tripartita* (Ucria) Moffett in *Bothalia* 37: 173 (2007)**

- ≡ *Rhamnus tripartitus* Ucria in Nuov. Racc. Opusc. Aut. Sicil. vi (Pl. Linn. Op. Addend. et Secund. Linn. Syst.): 249 (1793)
- ≡ *Rhus tripartita* (Ucria) Grande in Bull. Orto Bot. Regia Univ. Napoli 5: 62 (1918)
- = *Rhus oxyacantha* Schousb. ex Cav., Anal. Cienc. Nat. 3: 36 (1801)
- = *Rhus oxyacanthoides* Dum.-Cours., Bot. Cult. 3: 359 (1802)
- = *Rhus crataegiformis* Pers., Syn. 1: 326 (1805)
- = *Rhus dioica* Brouss. ex Willd., Enum. Pl.: 325 (1809)
- = *Rhus ziziphina* Tineo, Pl. rar. Sicil. Pugill. 1: 8 (1817) (nom. illeg.)

Results and discussion

Specimina visa

Sub *Rhus dioicum* [s.d., s.l., Gussone (NAP); Sciacca a S. Calogero; s.d., s.l., Gussone (NAP), two labels, the first reporting “*Rhus dioicum* Will. p. 328; – *oxyacanthoides* Pers.; – *ziziphina* Tin. Martio, Aprili. In collibus aridis calcareis”, while in the second we read “*Rhus oxyacanthoides* Dum. Sciacca a S. Calogero” (Fig. 3d); s.d., s.l., Todaro (PAL); in collibus sterilibus calcareis. Palermo a Monte Pellegrino / rupi calcaree colline marittime Villa Belmonte, gennaio, Todaro (PAL); ex insula Linosa/ in collibus aridis, aprile 1893, Sommer (PAL); rupi calcaree colline marittime Villa Belmonte, marzo, Lojacono-Pojero (PAL); Linosa, 9 giugno 1840, Ajuti (PAL)]; sub *Rhus ziziphina* [Linosa, 9 giugno 1848, s.c. (PAL); Belmonte, 26 febbraio, s.c. (PAL); S. Croce (near Palermo, authors’ note), s.d., s.c. (PAL); in collibus Palermo alle falde di M. Pellegrino, s.d., s.c. (PAL); Linosa, giugno, (Gussone) (PAL); S. Croce, s.d., s.c. (PAL); s.l., s.d., Gussone (PAL)]; sub *Rhus tripartita* [Linosa M. Vulcano, s.d., G. Scafidi (PAL); Scoglitti, s.d., s.c. (PAL); Scoglitti: neighborhoods, 36°52’N, 14°27’E, 16/06/1990, Raimondo et al. (PAL); Sampieri (Pozzallo), 07/10/968, S. Brullo, (CAT035332); Sampieri (RG), 30/04/2010, D’Agostino, Minissale e Sciandrello (CAT009735); Sampieri c.da Trippatore, 30/04/2010, Sciandrello (CAT); Cava d’Aliga, 30/04/2010, Sciandrello (CAT)].

Past and current distribution of *Searsia tripartita* in Sicily

Apart from the locality that is the focus of the present study, in Sicily’s regional area *Searsia tripartita* currently grows spontaneously in the southern and eastern sectors of the Hyblaean area and in Linosa Island. It was not possible to confirm the historical reports for the western coasts of Sicily, regarding San Vito Lo Capo (for which no herbarium specimens are present) and Santa Flavia (near Palermo).

S. tripartita usually dominates the shrubland where it grows (Brullo et al. 2009). It sometimes co-occurs with the congeneric *Searsia pentaphylla* (Jacq.) FA. Barkley [= *Rhus pentaphylla* (Jacq.) Desf.], another woody species that also has a North African distribution (Pignatti et al. 2017–2019). However, it should be noted that the distinguishing features between these two shrubs are quite subtle and primarily concerning the leaves (in *S. tripartita*, the leaves are divided into 3 obovate-digitate segments, while in *S. pentaphylla*, they are divided into 3–5 digitate segments that are linear-spatulate, entire, or with 3–5 teeth at the apex) and the size of the plant (*S. tripartita* does not exceed 3 meters in height, whereas *S. pentaphylla* can reach up to 5 meters). Both species are very rare and may co-occur in extremely arid coastal habitats. Indeed, as emphasized by Lojacono-Pojero (1891, translated by authors), “both species grow intermixed in several places in Sicily... They are highly polymorphic in their foliage, and whatever Gussone may say [...], they cause a serious aberration in the specific value attributed to them. Moreover, habitus is not a reliable clue for distinction; apart from the size of the leaves, I believe there is no character that is not shared by both species. In my opinion, the mixed growth has led to hybridizations that have produced intermediate forms”.

Regarding the earliest records concerning both species, some misleading bibliographic inconsistencies need to be clarified. According to Tineo (1817) *S. pentaphylla* (under *Rhus thezera*) grows “prope Xaccam” [= near Sciacca], whilst *S. tripartita* (under *Rhus ziziphinus*) only occurs “in montosis S. Flaviae” [Santa Flavia, district of Palermo] and in “S. Vitu” [= San Vito Lo Capo, district of Trapani]. Since much of Tineo’s collection was destroyed during the uprisings of 1820 (Borzi 1897), no specimen was available to confirm the identity of the plant in Sciacca and to ascertain that he personally observed it. It is possible that Tineo received this information from Gussone, whose herbarium (NAP) still contains two specimens bearing the toponym “Sciacca”. The first bears the handwritten note “*Rhus dioicum*. Sciacca a S. Calogero”, while the second has two herbarium labels, one reading “*Rhus dioicum* Will. p. 328; – *oxyacanthoides* Pers.; – *ziziphina* Tin. Martio, Aprili. In collibus aridis calcareis”, while the other reads “*Rhus oxyacanthoides* Dum. Sciacca a S. Calogero”. Although the labels of both specimens have no date, Gussone writes in his field excursion manuscript notes (Gussone unpublished) that he was there twice (May 12, 1817, and May 2, 1818). Thus, Gussone may have communicated the discovery of this nucleus before the publication of the first volume of *Pugillus* by Tineo (August 1817).

Later, Gussone (1827) reports *S. pentaphylla* (under *Rhus thezera* Pers.) for “Misilmeri, Bagheria, Sciacca, S. Croce, Comiso” and *S. tripartita* (and *Rhus “dioicum”* Willd.) for “S. Vito (Tin.), S. Croce, Sciacca, Scidi”. Gussone (1843) also adds Linosa for *S. pentaphylla* (under *Rhus “pentaphyllum”* Desf.). Based on our investigations, only individuals of *Searsia tripartita* were found within the study area.

Location and recent demographic population trend

After the discovery of the nucleus of maquis with *S. tripartita* on Mt. S. Calogero, the surroundings were systematically explored to assess the size and the conservation status of the population, to better identify the ecological requirements and the threats affecting the species and to survey the plant community where it grows. *S. tripartita* is located in a restricted area on the southern slope of a rocky hill, between 290 and 330 m a.s.l. (WGS84 coordinates: 41.54038°N, 33.3369°E). Specifically, the population forms a rather dense low maquis patch covering approximately 3,060 m² and consisting of around 70 mature individuals; however, as denoted by the findings reported in Table 2, natural regeneration of the species was not observed during our survey period.

This is another relict station of the species (Biondi et al. 2009; Mucina et al. 2016), as also demonstrated by its historic presence on the site, as already documented by Gussone (1827). Although the vegetation occupies a small area, the habitat is highly unique and conducive to its survival, considering the continuous and intense anthropic disturbance the vegetation still constantly faces today (fires, reforestation, grazing).

A diachronic analysis allowed us to trace the recent evolution of this maquis nucleus by comparing the images from the Regional Orthophoto Repository (Geoportale

Regione Siciliana 2024) or accessible on Google Earth (over 27 years, from 1998 to 2024). Photogrammetric interpretation (Fig. 5a–d) showed that during this time lapse this nucleus has remained almost unchanged in terms of the number of individuals, overall distribution pattern and occupied surface area. The steep slope hosting this nucleus appears quite xeric, as it is south-facing and presumably influenced by thermal vapors associated with the system of karstic-subterranean cavities characterizing the entire area.

The *S. tripartita* plants grow in a very steep area, characterized by numerous rocky outcrops intermittently covered by scree made of small incoherent clasts resulting from erosion processes affecting the slopes close to the top of Mt. S. Calogero. At the mountain summit, the thermal bath buildings stand alongside the Sanctuary of San Calogero, patron of the city of Sciacca, testifying that the surveyed site has been used by humans since ancient times.

Until the 1990s, the southern slope of Mt. S. Calogero was occupied by extensive almond orchards, occasionally interspersed with carob trees, alongside pastures and shrublands near the cliffs, within which the *S. tripartita* maquis was likely present. As documented by local testimonies, starting in 1990 this area underwent large-scale plantations of *Pinus halepensis* and *Eucalyptus camaldulensis* subsp. *camaldulensis*, before being incorporated into the newly established nature reserve and managed by the Regional Sicilian Forest Service. However, subsequently, the whole area and the entire hillside was struck

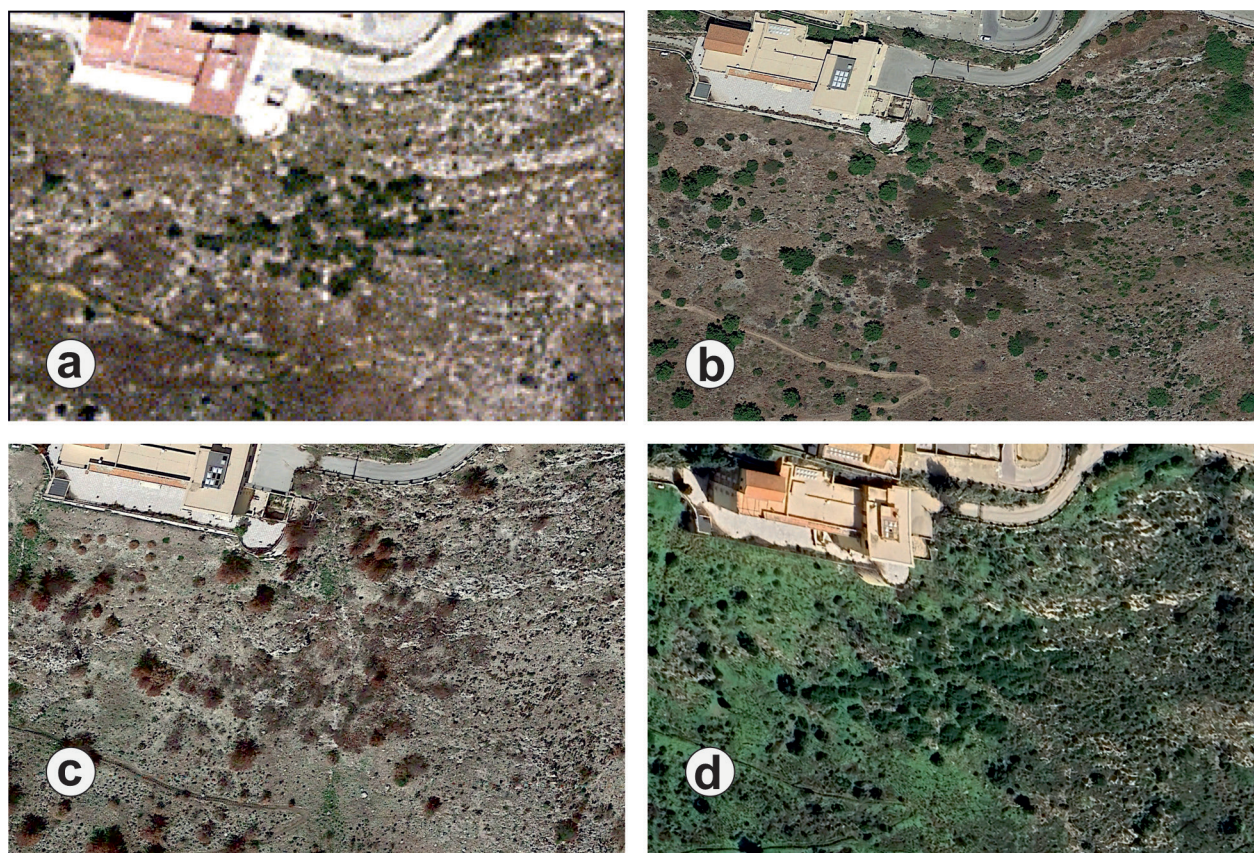


Figure 5. Comparison between the four different images taken from the Regional Orthophoto Repository (a) and Google Earth (b, c, d) relative to the relict *Searsia tripartita* maquis in the studied area (respectively: a) June 1998; b) June 2013; c) October 2017; d) April 2024).

by some significant wildfire events. A first major fire occurred in 1997, with slight damage in the lower part of the reforested area, where only the understory was affected, experiencing a light surface fire. The fire intensified further uphill, where the flames grew significantly taller, completely destroying the forest plantation and probably reaching the maquis with *S. tripartita* as well.

The problem of fires in this territory has become even more acute in recent years. In fact, according to the records reported in the Forestry Information System of the Region of Sicily, in the area of Mt. S. Calogero fires have occurred annually since 2008 to date, except for the years 2013 and 2022.

Consultation of the historical imagery available in the Regional Orthophoto Repository from 1998 proved invaluable for understanding the evolution of the landscape where the nucleus of *S. tripartita* maquis is located (Fig. 5a). The year after the first fire event, the green crowns of *S. tripartita* are easily recognizable and show evident signs of vegetative recovery after burning. Further diachronic sequences up to the present can also be tracked through other available satellite images from June 2013 (Fig. 5b), August 2014, May 2015, June 2016, October 2017 (Fig. 5c), and March 2024 (Fig. 5d). An image analysis revealed the gradual recovery of local maquis until June 2016, while the subsequent image from October 2017 (Fig. 5c) once again shows clear signs of extensive damage to the vegetation caused by a second summer fire event. Nonetheless, in recent years, the vegetation has been able to recover rapidly, recolonizing the habitat's surface and showing remarkable resilience. This further demonstrates its unique ecology, which emphasizes the remarkable sub-climatic potential of the maquis vegetation.

Focusing on the same color images shown in Fig. 5b – as well as on the others – the different colorations of the vegetation stand out, reflecting the various seasonal periods in which the photos were taken, highlighting the interesting phenomenon of the species estivating behavior. Indeed, during the winter-spring period – which corresponds to the vegetative peak of the community – the vegetation canopy typically appears spotted with the light green characteristic of *S. tripartita*. This contrasts sharply with the images from the summer-autumn months, where the brown color of the trunks and leafless branches of the dominant species is also prominent.

Phytosociological data

In Table 2, we present six relevés carried out within the investigated shrubland dominated by *S. tripartita*. The first four were carried out during spring, when the community was in full vegetation, while the last two were carried out at the end of July, when *S. tripartita*, *Euphorbia dendroides*, *Asparagus albus*, and other summer-deciduous woody plants were completely leafless, and the aboveground organs of almost all the perennial herbs were dry. The community is referred to the association

Calicotomo infestae-Rhoetum tripartitae, described by Bartolo et al. (1982) for eastern Sicily.

Calicotomo infestae-Rhoetum tripartitae Bartolo, Brullo et Marcenò 1982

Holotypus: in Bartolo et al. (1982): rel. 6 of table 30.

Phytosociological data: Tables 2, 3 (columns 1 and 2).

Diagnostic species: *Searsia tripartita* (dom.), *Cytisus infestus* subsp. *infestus*.

Short description: Dense, intricate, and impenetrable shrubland, with a clear dominance of *S. tripartita*, reaching heights of 1.5–3 m. Other recorded species in the woody layer, which are all sporadic, include *Euphorbia dendroides*, *Cytisus infestus* subsp. *infestus*, *Olea europaea*, *Teucrium fruticans* and *Chamaerops humilis*. The herbaceous layer is also somewhat sparse, mainly consisting of rhizomatous and bulbous species such as *Acanthus mollis*, *Arisarum vulgare*, *Allium subhirsutum*, found beneath the very dense canopy. *S. pentaphylla* does not occur in the similar plant communities previously described for the coastal limestone substrates of southeastern Sicily (Bartolo et al. 1982; Brullo et al. 2009).

Substrate: Rocky coastal S-facing slopes on shallow and nutrient-poor and stony soils, on calcareous substrates.

Bioclimate: Mediterranean pluvioseasonal-oceanic, lower thermomediterranean thermotype, lower dry ombrotype.

Syntaxonomic notes: The association *Calicotomo infestae-Rhoetum tripartitae* is referred to the alliance *Periplocion angustifoliae* (order *Pistacio-Rhamnetalia alaterni*, class *Quercetea ilicis*); according to Mucina et al. (2016), this alliance includes “thermomediterranean semiarid deciduous relict low matorral of the coastal regions” in the south-western Mediterranean (Rivas-Martínez 1975). It is characterized by summer deciduous species, specifically *S. tripartita*, *S. pentaphylla*, *Periploca angustifolia*, and *Ziziphus lotus* subsp. *lotus* [along with other North African species such as *Gymnosporia senegalensis* subsp. *europaea* and *Calicotome intermedia*, which however are not present in the area of Sea of Sicily]. The alliance distribution range includes the coasts of the western part of the Euro-Mediterranean Region (Spain, Sicily) and North Africa (Rivas-Martínez 1975) as well as the islands south of Crete (Brullo and Guarino 2000). In the Tyrrhenian area, it is present in some small circum-Sicilian islands of the Strait of Sicily (Egadi and Pelagie archipelagos, Pantelleria Island and Maltesi Island) and along the coasts of south-eastern Sicily (Brullo et al. 1977; Brullo and Marcenò 1985; Brullo et al. 2009; Gianguzzi et al. 2016). Similar association to the *Calicotomo infestae-Rhoetum tripartitae* is the *Periploca angustifoliae-Rhoetum tripartitae*, also dominated by *S. tripartita*, located on the Island of Linosa, at Montagna Rossa (Brullo et al. 2009). In addition, in the regional area of Sicily other rare associations of the alliance *Periplocion angustifoliae* are described, in which *S. tripartita* is absent. They are as follows: a) *Periploca angustifoliae-Euphorbietum dendroidis* [Islands of Levanzo, Favignana, Marettimo (Brullo and Marcenò 1983; Brullo et al. 2009), Linosa (Brullo and

Table 2. *Calicotomo infestae-Rhoetum tripartitae* Bartolo et al. 1982 [Sciaccia at Mt. S. Calogero: rels. 1–4 (28.04.2021); rels. 5–6 (31.07.2024)]; the values indicated in brackets concern species which were identified visually during field surveys performed during vegetative dormancy).

Relevé number	1	2	3	4	5	6	P	F
Elevation (m a.s.l.)	285	290	300	290	285	295	R	R
Slope (°)	40	40	40	40	40	40	E	E
Aspect	S	S	S	S	S	S	S	Q
Surface (m²)	100	100	100	100	100	100	E	U
Total cover (%)	95	95	98	95	85	85	N	E
Shrub cover (%)	100	100	100	100	85	85	C	N.
Herb cover (%)	20	15	20	15	20	20	E	
Average vegetation height (m)	2.5	2.3	2.3	2.1	2.7	2.5		C.
No. of species	25	25	26	28	26	29		L.
Char. and diff. assoc. and alliance <i>Periplocion angustifoliae</i>								
<i>Searsia tripartita</i> (dom.)	5	5	5	5	4	4	6	V
<i>Cytisus infestus</i> subsp. <i>infestus</i>	1	1		1		1	4	IV
Char. ord. <i>Pistacio-Rhamnetalia alaterni</i>								
<i>Olea europaea</i>	2	2	1	2	1	2	6	V
<i>Chamaerops humilis</i>	1	2	2	1	1	2	6	V
<i>Euphorbia dendroides</i>	2	2	1	1	1	1	6	V
<i>Teucrium fruticans</i>	+	1	1	1	1	2	6	V
<i>Stachys major</i>	+	1	1	1	+	1	6	V
<i>Asparagus albus</i>	1	1	+	+	1	1	6	V
<i>Artemisia arborescens</i>	.	.	2	1	1	1	4	IV
Char. cl. <i>Quercetea ilicis</i>								
<i>Ruta chalepensis</i>	+	1	1	1	2	1	6	V
<i>Allium subhirsutum</i>	+	1	1	+	(+)	(+)	6	V
<i>Cyclamen repandum</i>	+	+	.	+	.	.	3	III
<i>Rubia peregrina</i>	+	.	1	.	+	.	3	III
<i>Ampelodesmos mauritanicus</i>	.	1	.	.	.	1	3	III
<i>Asparagus acutifolius</i>	.	1	.	.	.	.	.	I
Other species								
<i>Hyparrhenia hirta</i>	1	1	1	2	1	1	6	V
<i>Brassica villosa</i> subsp. <i>bivonana</i>	1	1	1	+	+	1	6	V
<i>Acanthus mollis</i>	2	2	2	1	(+)	(+)	6	V
<i>Squilla pancration</i>	+	1	1	+	(+)	(+)	6	V
<i>Lathyrus clymenum</i>	+	1	1	1	(+)	(+)	6	V
<i>Oxalis pes-caprae</i>	+	+	+	+	(+)	(+)	6	V
<i>Vicia macrocarpa</i>	+	+	+	1	(+)	(+)	6	V
<i>Capparis rupestris</i>	.	1	1	+	1	1	5	V
<i>Bituminaria bituminosa</i>	.	+	+	+	(+)	(+)	5	V
<i>Convolvulus althaeoides</i>	.	+	+	1	(+)	(+)	5	V
<i>Pseudodictamnus hispanicus</i>	.	1	1	+	(+)	(+)	5	V
<i>Lobularia maritima</i>	+	.	.	+	+	1	4	IV
<i>Mercurialis annua</i>	.	.	+	+	(+)	(+)	4	IV
<i>Galium aparine</i>	.	.	+	+	(+)	(+)	4	IV
<i>Geranium molle</i>	+	.	+	+	.	(+)	4	IV
<i>Carlina sicula</i>	1	.		1	1	.	3	III
<i>Melica ciliata</i>	1	.	1	.	.	(+)	3	III
<i>Micromeria graeca</i>	1	.	.	.	.	1	2	II
<i>Torilis arvensis</i>	+	.	.	.	(+)	.	2	II
<i>Foeniculum vulgare</i> subsp. <i>vulgare</i>	.	1	.	.	.	1	2	II
<i>Allium ampeloprasum</i>	.	.	.	+	.	+	2	II

Table 3. Simplified synoptic table of the Sicilian *S. tripartita* associations referred to the alliance *Periplocion angustifoliae*: **1** – *Calicotomo infestae-Rhoetum tripartitae*, Table 2; **2** – *Calicotomo infestae-Rhoetum tripartitae*, south-eastern Sicily (from Brullo and Marcenò, 1985: table 18); **3** – *Periploco-Euphorbietum dendroidis* subass. *typicum*, Linosa Island (from Brullo and Siracusa, 1996: table 1); **4** – *Periploco-Rhoetum tripartitae*, Linosa Island (from Brullo et al. 2009, table 1d).

N° Column	1	2	3	4
N° Relevés	6	19	8	4
Char. and diff. association				
<i>Searsia tripartita</i> (dominant)	V	V	II	4
<i>Cytisus infestus</i> subsp. <i>infestus</i>	IV	V	.	.
<i>Searsia pentaphylla</i>	.	I	.	.
Char. all. <i>Periplocion angustifoliae</i>				
<i>Periploca angustifolia</i>	.	.	V	4
<i>Lycium intricatum</i>	.	.	V	4
Char. ord. <i>Pistacio-Rhamnetalia alaterni</i>				
<i>Euphorbia dendroides</i>	V	III	V	2
<i>Stachys major</i>	V	V	V	.
<i>Olea europaea</i>	V	IV	III	.
<i>Pistacia lentiscus</i>	.	V	V	4
<i>Chamaerops humilis</i>	V	V	.	.
<i>Teucrium fruticans</i>	V	V	.	.
<i>Asparagus albus</i>	V	III	.	.
<i>Ceratonion siliqua</i>	.	V	.	.
<i>Asparagus horridus</i>		III	.	.
<i>Asparagus aphyllus</i>	.	.	IV	.
Char. cl. <i>Quercetea ilicis</i>				
<i>Ruta chalepensis</i>	V	III	IV	.
<i>Asparagus acutifolius</i>	I	V	III	.
<i>Rubia peregrina</i>	III	IV	II	.
<i>Arisarum vulgare</i>	.	V	III	.
<i>Clematis cirrhosa</i>	.	II	III	.
<i>Cyclamen repandum</i>	I	.	.	.
<i>Phillyrea latifolia</i>	.	III	.	.
<i>Smilax aspera</i>	.	II	.	.
<i>Rhamnus alaternus</i>	.	I	.	.

Siracusa 1996), Lampedusa (Bartolo et al. 1990), Pantelleria (Brullo et al. 1977; Gianguzzi 1999) and Malta (Brullo and Marcenò 1985)]; b) *Periploco angustifoliae-Juniperetum turbinatae* [Islands of Lampedusa (Bartolo et al. 1990), Linosa (La Mantia 2003) and Pantelleria (Gianguzzi 1999); it has also been recorded on Khrisi, a small island south of Crete (Brullo and Guarino 2000) and Tunisia (Brullo et al. 2009)]; c) *Lycio intricati-Pistacietum lentisci* [South Sicily, between Palma di Montechiaro and Scoglitti (Brullo et al. 2000, 2009; Turrise et al. 2002)]; d) *Asparago stipularis-Retametum gussonei* [South Sicily, between Gela and Punta Braccetto (Brullo et al. 2000, 2001, 2009)]; e) *Asparago acutifolii-Ziziphietum loti*: this association [described for the coastal strip of the north-western sector of Sicily and previously classified into the *Oleo-Ceratonion siliquae* (Gianguzzi et al. 1996)] should also be referred to the *Periplocion angustifoliae* where it also constitutes a thermoxerophilous scrub dominated by *Ziziphus lotus*, a summer deciduous species characteristic of this alliance.

Vegetation series: Southern Sicilian, dry thermomediterranean climatophilous series of the African sumac: *Calicotomo infestae*-*Searsia tripartitae* sigmetum. Secondary aspects are represented by the xerophilic perennial grassland dominated by *Hyparrhenia hirta* (*Hyparrhenietum hirta-pubescentis* A. et O. Bolòs et Br.-Bl. in A. and O. Bolòs 1950) and annual swards within the class

Stipo-Trachynietea distachyae S. Brullo in S. Brullo et al. 2001. On carbonate rock outcrops, it is replaced by the wild olive series (*Ruto chalepensis*-*Olea sylvestris* sigmetum; Gianguzzi and Bazan 2020), while on rocky walls it is dynamically connected with cliff microgeosigmetum, mainly characterized by the chasmophytic *Scabiosa creticae*-*Centauretum ucrae* association (Figs 3e, f, 6).

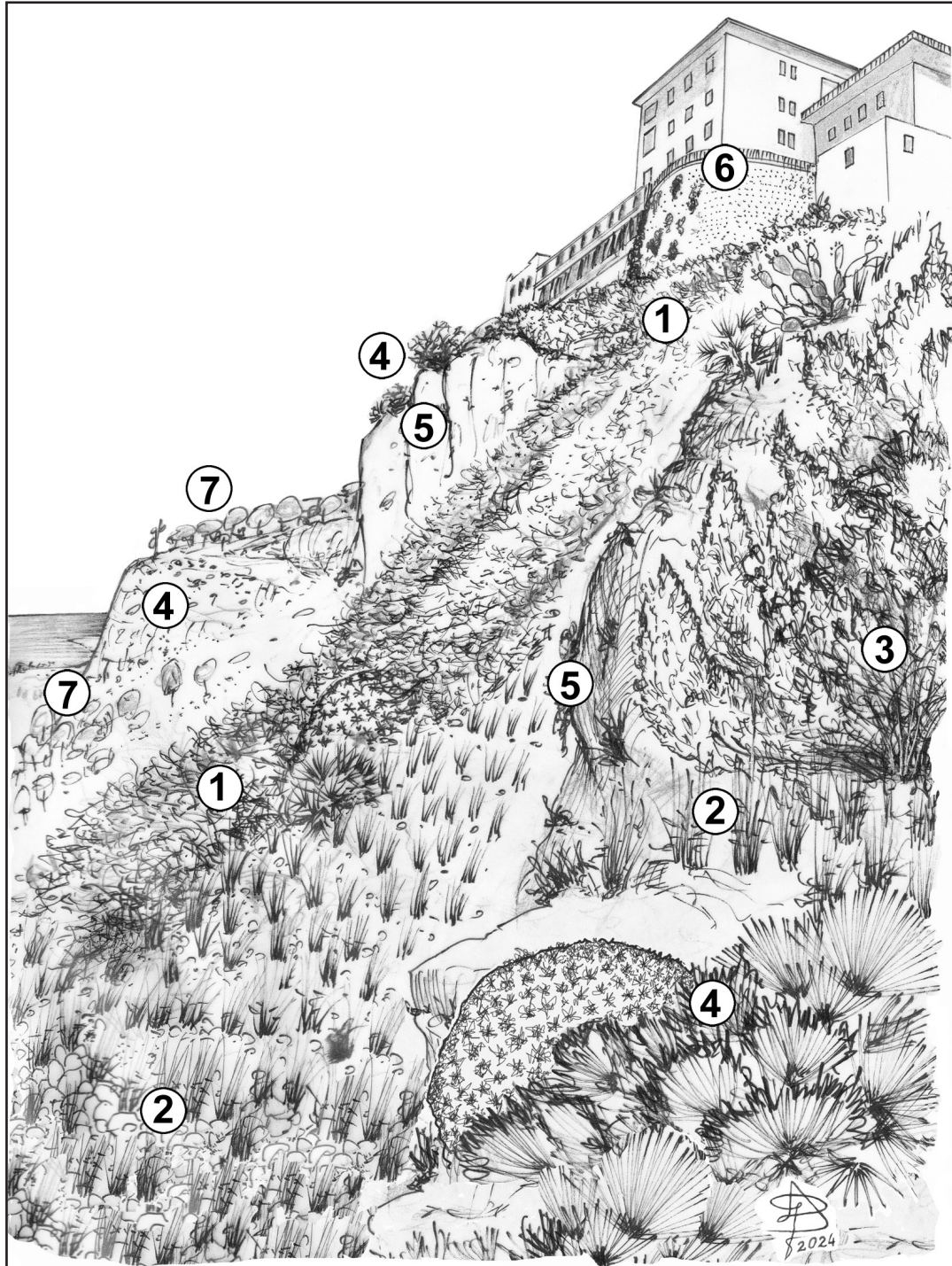


Figure 6. Schematic representation of the vegetation units co-occurring in the study area: (1) maquis with *S. tripartita* (*Calicotomo infestae*-*Rhoetum tripartitae*); (2) perennial grassland with *Hyparrhenia hirta* (*Hyparrhenietum hirta-pubescentis*); (3) maquis with *Olea europaea* var. *sylvestris* (*Ruto chalepensis*-*Oleetum sylvestris*); (4) scrub with *Chamaerops humilis* (*Pistacio lentisci*-*Chamaeropotum humilis* Brullo et Marcenò 1985); (5) chasmophytic community (alliance *Dianthion rupicolae*); (6) chasmophytic community dominated by *Capparis spinosa* (*Capparidetum rupestris* O. Bolòs et Molinier 1958); (7) forest plantation with *Pinus halepensis*.

Synchorology: The association has been initially described for the coastal stretch between the localities of Sampieri and Cava D'Aliga (Bartolo et al. 1982; Brullo et al. 1998), considered endemic to the coastal belt of southern Sicily. In fact, the presence of *S. tripartita* has also been recorded in other coastal locations (Giardina et al. 2007; Brullo et al. 2009), albeit as small nuclei or isolated individuals, indicating a broader potential for the formation of maquis.

Annex I Habitat: 5220* Arborescent matorral with *Ziziphus* and other xerophilous species to the alliance *Periplocion angustifoliae* (Biondi et al. 2009; Angelini et al. 2016).

EUNIS Classification system: S.54 (formerly: F5.5) Thermomediterranean arid scrub (Chytrý et al. 2020).

The synoptic table (Table 3) compares the floristic composition of the shrubland of Mt. S. Calogero with the two other similar communities dominated by *S. tripartita* previously described for the coasts of southeastern Sicily (*Calicotomo infestae-Rhoetum tripartitae*, to which this community is referred) and for the island of Linosa (*Periploco angustifoliae-Rhoetum tripartitae*), respectively.

From a phytosociological point of view, the surveyed vegetation should be referred to *Calicotomo infestae-Rhoetum tripartitae*, an association considered endemic to the coastal belt of southern Sicily. Besides its specific ecology, it is distinguished by the presence of *Cytisus infestus* subsp. *infestus*, albeit it is not very common. The first four relevés, performed in spring, represent the optimal facies of the coenosis, while the other two are related to the summer period, with the plant community in full estivating phase. As an adaptation to extreme summer aridity, several shrubby species appear leafless (*S. tripartita*, *Cytisus infestus* subsp. *infestus*, *Euphorbia dendroides*, *Asparagus albus*, *Teucrium fruticans*), as do many herbaceous plants, which also exhibit completely dry aerial parts. Sclerophylls that even retain their green foliage even in the summer are limited to *Chamaerops humilis* and *Olea europaea*; herbaceous annual plants disappear or are sometimes recognizable by their aerial parts, entirely desiccated, namely hemicryptophytes and geophytes.

The *Periploco angustifoliae-Rhoetum tripartitae* association (Brullo et al. 2009), which also occurs on the island of Linosa, especially on Montagna Rossa, is indicated as vicariant of the *Calicotomo infestae-Rhoetum tripartitae*. Also, while this shrubland community is dominated by *S. tripartita*, instead it colonizes incoherent volcanic substrates and is differentiated by the presence of other summer-deciduous plants, such as *Periploca angustifolia* and *Lycium intricatum*.

From the phytosociological viewpoint, the above-mentioned plant communities are classified within the alliance *Periplocion angustifoliae* characterized by few summer-deciduous species which dominate the most drought-tolerant shrubland communities throughout Europe. Due to their rarity, according to the Habitats Directive, they were assigned to a priority habitat (code: 5220; name: "Predesertic scrubs"). This vegetation is at its vegetative peak during the rainy (autumn-winter) season, while a total vegetative stasis occurs between the end of spring and the end of summer.

Given both the rarity of the species at the European scale and the small size of the nucleus, extending over

just 3,000 square meters, this plant community should be listed as an Italian threatened ecosystem (Capotorti et al. 2020; Casavecchia et al. 2021). This habitat is affected by at least three threat factors identified by IUCN-CMP (2019), namely "1.1 - Habitat loss/degradation, agriculture", due to the potential decrease in available habitat located within areas undergoing reforestation, "10.5 - Human disturbance, fire" and "12.1 - Other threats", including habitat fragmentation, the small size of the subpopulation and its distance from the nearest nuclei, located approximately 200 km afar in the coastal sector of the Hyblaean district.

Conclusions

More than two centuries after being discovered by Gussone, we confirmed the presence of a small nucleus of *S. tripartita* maquis, located on Mt. S. Calogero, near Sciacca (Sicily, Italy). This species forms a shrubland patch exhibiting characteristics of subclimax vegetation, in balance with the site's xeric conditions and substrate, probably also influenced by the emission of thermal vapors. The nutrient-poor, stony and steep slope where it grows is subject to very frequent disturbance due to the almost continuous rockfall from the overlying cliffs. Despite the long-lasting and complex history of local natural and human disturbance and its very localized distribution, the species has shown remarkable resilience, recovering many times without being outcompeted by other potential invasive plant species.

The confirmation of the presence of *S. tripartita* at the extreme northern limit of its distribution range is rather surprising, representing an isolated spot of pre-desert maquis within a typically Mediterranean landscape. It denotes an evident parallelism with the distribution of *Ziziphus lotus* subsp. *lotus*, an ecologically similar species with a wide North African distribution and with small, isolated occurrences along the driest coastal strip of Sicily (Gianguzzi et al. 1996; Troia 2006; La Mantia and Scuderi 2021).

The rediscovery of *S. tripartita* on Mt. S. Calogero (Sciacca) underscores the importance of the coastal limestone outcrops of Sicily as hotspot of species and plant communities of very high biogeographic and conservation interest, which are often extremely narrow-ranged and/or with extremely fragmented distribution. Climatic fluctuations that occurred during the Quaternary have led to repeated processes of extinction and recolonization of species from other areas, establishing unique types of vegetation sporadically scattered throughout the Mediterranean landscape (Comes and Kadereit 1998; Hewitt 2004).

Syntaxonomic scheme of the associations of the alliance *Periplocion angustifoliae* in Sicily

QUERCETEA ILICIS Br.-Bl. ex A. et O. Bolòs 1950
 PISTACIO LENTISCI-RHAMNETALIA ALATERNI
 Rivas-Martínez 1975

Periplocion angustifoliae Rivas-Martínez 1975

- Calicotomo infestae-Rhoetum tripartitae* Bartolo, Brullo et Marcenò 1982
- Periploco angustifoliae-Rhoetum tripartitae* Brullo, Gianguzzi, La Mantia et Siracusa 2009
- Periploco angustifoliae-Euphorbietum dendroidis* Brullo, Di Martino et Marcenò 1977
- Periploco angustifoliae-Juniperetum turbinatae* Bartolo, Brullo, Minissale et Spampinato 1990
- Lycio intricati-Pistacietum lentisci* (Brullo, Guarino et Ronsisvalle 2000) Brullo 2020 in Cambria et Giusso del Galdo 2020
- Asparagus stipularis-Retametum gussonei* Brullo, Guarino et Ronsisvalle ex Brullo, Giusso, Siracusa et Spampinato 2001
- Asparagus acutifolii-Ziziphietum loti* Gianguzzi, Ilardi et Raimondo 1996

Author Contributions

Conceptualization, A.L.M., L.G.; methodology, A.L. M., R.R., L.G.; investigation, A.L.M., R.R., L.G.; data curation, A.L.M., L.G.; data elaboration, A.L.M., L.G.; writing—original draft preparation, A.L.M., R.R., L.G.; writing—review and editing, A.L.M., R.R., L.G.; drawings, L.G. All authors have read and agreed to the final version of the manuscript.

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