Article

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Biodiversity in some populations of *Crataegus* (*Rosaceae*) from western Sicily: Description of two new species and notes on conservation and valorisation

Abstract

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The genus *Crataegus*, distributed across the temperate regions of almost all continents, constitutes an extremely variable taxon within *Rosaceae* family. Hundreds of tree and shrub species have been described within it, along with an unknown number of subspecies, varieties and hybrids, partly of medicinal interest and in some cases also with edible fruits. According to recent studies, Sicily – an island in the center of the Mediterranean – constitutes a biodiversity hotspot for this genus in Italy. In this article the authors outline the biological diversity of Sicilian populations recognized at various taxonomic levels. In addition to the known specific and infraspecific taxa, two new species are described: *Crataegus drepanensis* and *Crataegus zichichii*. Also, the results of recent studies on the biological activity of extracts of flowers or fruits of some Sicilian populations of hawthorn investigated so far are recalled, thus proving that they represent a valuable resource of natural health products. Regarding one of the described species (*C. zichichii*), on the basis of the environmental and landscape value it possesses – as well as decorative – a possible enhancement of it in the forest nursery field and in urban greenery is advocated. Finally, in view of the dangers to which the populations are subjected – particularly that of *C. drepanensis* – ways of i*n situ* and *ex situ* conservation are envisaged, and for this possible actions to be implemented are proposed.

Key words: dendrological biodiversity, Central Mediterranean, *Crataegus drepanensis*, *Crataegus zichichii*, bioactive compounds, safeguard measures.

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Introduction

In the Mediterranean region, Sicily is one of the most heterogeneous and biologically rich territories due to its unique geo-morphological, pedological and climatic features, as well as its central location in the Mediterranean Sea. This combination creates numerous environments that contribute to its remarkable biodiversity (Raimondo 2004).

In the native vascular flora of Sicily, consisting of about 2,770 specific and infraspecific taxa (Bartolucci & al. 2024), trees are represented by a modest number of units, which amount to about 135 taxa. The Sicilian dendroflora is diverse and enriched by woody or shrubby polycormic species that, under certain conditions and with age, can attain tree-like dimensions. Some genera, such as *Quercus* L., *Crataegus* L., *Tamarix* L., *Pyrus* L., *Aria* (Pers.) Host, exhibit high taxonomic diversity (Raimondo 2013; Spadaro & Raimondo 2023).

Crataegus, contains 140-265 or even up to 1,200 species; these are shrubs or trees, widespread mainly in the temperate regions of the northern hemisphere (Christensen 1992).While it is a well-defined genus, it presents taxonomic challenges due to its variability resulting from extensive hybridization, apomixis and polyploidy (Dickinson & Campbell 1991; MirAli & al. 2011). Intense and prolonged human activity appears to be an important evolutionary factor that has shaped the taxonomic diversity of hawthorn. The creation of new habitats has disrupted dispersal barriers, increased gene flow between isolated populations, and facilitated hybridization, potentially leading to new species adapted to human-induced environmental changes (Oklejewicz 2013).

Moreover, *Crataegus* species are ecologically significant, providing excellent nesting sites for birds, while their fruits serve as a food source for songbirds, game birds, small mammals, and ungulates (Fichtner & Wissemann 2021).

In addition to their ornamental and ecological value, *Crataegus* species are renowned for their medicinal and nutraceutical properties. Hawthorn fruits, leaves and flowers are rich in bioactive compounds, such as antioxidants, flavonoids and phenolic acids, which have beneficial effects on human health. These components are used in traditional medicine to treat various conditions, including heart and digestive disorders (Nazhand & al. 2020).

Species of the genus *Crataegus*, commonly known as hawthorn, represent a significant element of biodiversity in Sicily. It includes the following specific and infraspecific taxa and nothotaxa: *Crataegus azarolus* L. var. *azarolus, C. azarolus* var. *aronia* L., *C. azarolus* var. *chlorocarpa* (Moris) K.I. Chr., *C. laevigata* (Poir.) DC., *C. monogyna* Jacq. var. *monogyna, C. monogyna* subsp. *azarella* (Griseb.) Franco, *C. monogyna* var. *lasiocarpa* (Lange) K.I. Chr., *C. laciniata* Ucria*, C. orientalis* subsp. *presliana* K.I. Chr., *Crataegus* × *media* nothovar. *sicula* (K. Koch) K.I. Chr., *Crataegus* × *sinaica* nothosubsp. *rossii* (Lange) K.I. Chr. Doubt remains *C. insengae* (Tineo ex Guss.) Bertol. (Pignatti 1982, 2017; Barone & al. 2023).

The study of Sicilian *Crategus* populations, particularly those in the western part of the island, revealed that those populations do not correspond to any of the aforementioned taxa, nor to those occurring in the rest of the Italian, European, Middle Eastern and North African regions. Due to the population size and the recurrence of unique morphological, phenological, ecological and distributional features, these populations deserve to be described at a specific level.

Materials and Methods

Field trips were conducted across western Sicily, particularly in the provinces of Palermo and Trapani where the *Crataegus* populations that occur there are very diversified. Phenological observations were made in the field, and ecological data were collected.

Additionally, specimens were also collected for taxonomic analysis in the laboratory and dried for preservation as documentation at the *PLANTA* Research Center in Palermo and at the herbaria of Palermo (PAL-Gr) and Florence (FI). The taxonomic study was carried out using analytical keys and comparisons with *exsiccata* preserved in major herbaria and available online.

Regarding pharmacognostic aspects, the data presented and discussed come from existing literature and recent studies, of which we are co-authors (Mirabile & al. 2024; Cacciola & al. 2024).

Results

List of taxa and nothotaxa of the genus Crataegus *occurring in the studied area*

Based on previous literature (Giardina & al. 2007; Christensen & Zieliński 2008; Raimondo & al. 2023) and the authors' collections kept at the *PLANTA* Center in Palermo, as along with field and laboratory observations, we can confirm the presence in western Sicily of populations referable to the following specific, infraspecific and hybrid taxa:

Crataegus azarolus L. var. *azarolus*
C. azarolus var. *chlorocarpa* (Moris) K.I.Chr.
C. azarolus var. *aronia* L.
C. laevigata (Poir.) DC.
C. laciniata Ucria
C. monogyna Jacq. var. *monogyna*
C. ×*sinaica* Boiss.
C. ×*media* Bechst.

Although *C. insengae* (Tineo ex Guss.) Bertol. ('*insegnae*') has been considered a distinct species (Lojacono-Pojero 1891; Bartolucci & al. 2024), its taxonomic status remains uncertain. Similarly doubts have also arisen regarding the presence of *C. monogyna* subsp. *azarella* (Griseb.) Franco in western Sicily, as recently highlighted by Raimondo & al. (2023).

In conclusion, two populations from the Trapani area mainly following the taxonomic study carried out on a phenotypic, ecological and phenological basis, are difficult to attribute to already known taxa. Therefore, their establishment as new species is proposed here. These are *Crataegus drepanensis* (sect. *Azaroli* Loud.) and *C. zichichii* (sect. *Crataegus*).

New specific taxa

The analysis of the diagnostic features of the two populations studied, compared with the specific characters of the taxa mentioned above, therefore allows us to recognize the following new species:

Crataegus drepanensis Raimondo, Marino & Scuderi **sp. nov.**

Diagnosis. – Planta fruticosa, affinis C. azarolus var. aronia cum qua convivet, differt ab eo compacto habito, rigido ac potius spinoso; ab foliis parvis, angustis et elongatis; ab ramulis juvenilibus rubro-violaceis, spinis brevibus robustisque, longis, robustis et pluricuspidatis in macroblastis; ab inflorescentia densa, floribus numerosis brevibus pedunculis pubescentibus sustentis; petalis minoribus, item calice sepalis pubescenti-

bus dorso constituto. Differt etiam ab fructu minore (2-)3 semina continente; ab calicis reliquiis condensatis et prominentibus.

Types. – Holotype (Fig.1): Sicily, near Tonnara del Secco, San Vito Lo Capo (Trapani), 38°10'08.40"N -12°45'55.49"E, carbonatic lithosol, c. 8 m a.s.l., 3-09-2023, *Raimondo* (PAL-Gr); isotype (FI).

Etymology. – The name recalls the province in which the *locus classicus* falls and the know distribution area of the species.

Description (Fig. 2). – Shrub about 1.5–2 m tall, branched from the base, with stiff, intricate, very thorny branches. Conical thorns, short in brachyblasts, very long, stiff and pluricuspidate in macroblasts, stout and grayish. Twigs and young thorns red-violet. Leaves 3–5 lobed, narrow and elongated, 2–4 cm × 1.5–2.5 cm, hairy, the upper ones shorter and trilobed. Flowers numerous, with short hairy pedicels and grouped in dense corymbs, entirely pubescent; Petals minute, white-cream, trilobed yellowish stylus, stamens 20 with pale-yellow anthers. Pome subspherical to obovate, about 13–15 × 12–14 mm, yellow-orange when ripe, crowned by prominent residual calyx; seeds (2)3 in number.

Phenology. – Flowering in April and ripening its fruits in September-October.

Ecology (Fig. 3). – This shrub, adapted to hot-arid environments, is found along the northwestern coastal plain of Sicily. It occurs in phytocoenoses where it contributes to dominance along with other woody plants of *Rosaceae* family, especially *Crataegus azarolus* var. *aronia*, and various Mediterranean scrub elements, including *Chamaerops humilis* L. A notable feature is the frequent occurrence of *Asparagus pastorianus* Webb & Berthel. Occasionally, this new taxon is also found in aspects of steppe grasslands dominated by *Hyparrhenia hirta* (L.) Stapf on calcareous lithosols.

Distribution (Fig. 4). – *C. drepanensis* is found in the Trapani area across the entire coastal plain from San Vito Lo Capo to Monte Cofano (Trapani).

Affinities. – A species related to *C. azarolu*s var. *aronia,* with which it coexists, but differs in its compact, rigid and rather spiny habit; in its small, narrow and elongated leaves; in its short, stout, red-violet young twigs with conical thorns; and in its inflorescence consisting of numerous flowers with short pubescent peduncles. The petals are smaller, as is the calyx, which consists of pubescent sepals on the back. It also differs in pome shape, which ranges from subspherical to obovate, and is smaller (Fig. 5). Biologically, it differs from all other native species in Europe and the Mediterranean. It is characterized by an annual biological cycle that includes autumn vegetative regrowth, spring flowering, and fruit ripening in late summer. Leaf fall occurs when the fruit ripens, marking the end of the cycle, while the simultaneous opening of vegetative buds signals the beginning of the new one (Fig. 6).

Conservation status. – The entire distribution area of this species lies in a densely populated territory that has undergone radical environmental transformation over the past 50 years, due to agricultural activities, pastoralism, and coastal fishing. The expansion of tourism-related infrastructure and the surge in residential construction, particularly around the coastal areas, have drastically reduced subnatural and seminatural areas, resulting in the loss of biodiversity and, for our species, its habitat. A recent fire (Fig. 7) that affected a large area west of the inhabited area of San Vito Lo Capo has reduced the natural distribution area of the species by half, significanlty reducing its population.

Fig. 1. Holotype of *Crataegus drepanensis* (PAL-Gr).

Fig. 2. *Crataegus drepanensis*: a) flowering plant in the *locus classicus*; b) young twings; c) corymbs in anthesis; d) detail of the corymb showing floral structures; e) twigs showing details of thorns and leaf morphology; f) branches with ripe pomes.

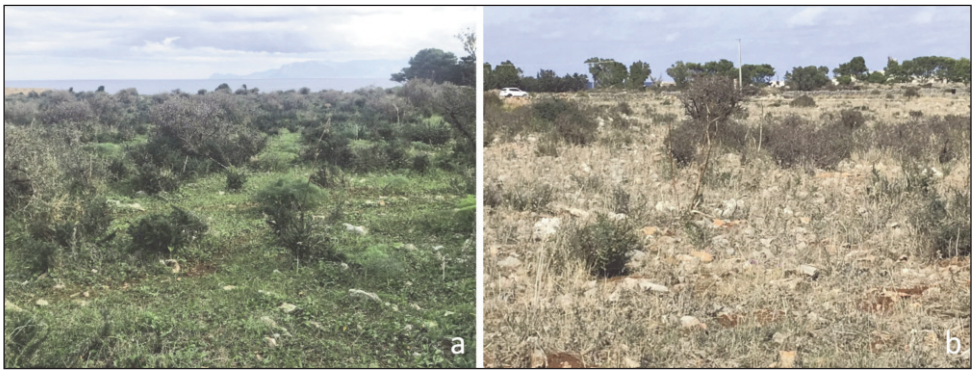

Fig. 3. Phytocoenosis physiognomised by *Crataegus azarolus* var. *aronia* and *C. drepanensis*: a) winter and b) summer aspects.

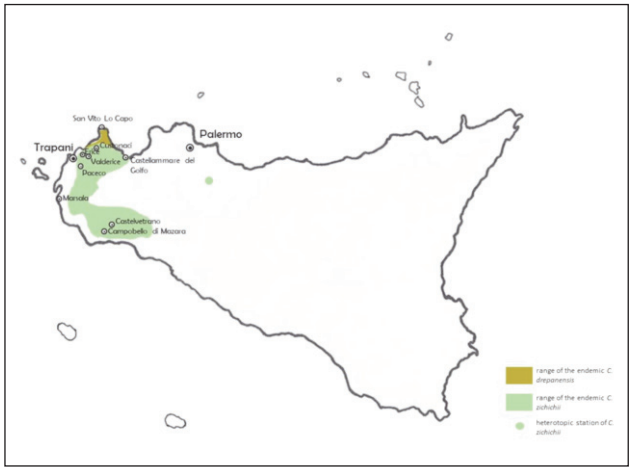

Fig. 4. Localization and distribution range of *Crataegus drepanensis* and *C. zichichii* populations.

Fig. 5. Comparison of the pomes of *Crataegus drepanensis* (a) and *C. azarolus* var. *aronia* (b) from the same locality.

Fig. 6. Some phases of annual biological cycle of *Crataegus drepanensis*: a) spring flowering; b) late summer defoliation; c) autumn vegetative regrowth.

This catastrophic event, which may worsen in the coming years due to ongoing climate change, underscores the urgent need for protective measures.

According to the IUCN Red List categories and criteria (2001), *C. drepanensis* should be classified as "*Critically Endangered"* (CR–B1,2:a,b[iii]).

Fig. 7. Post-fire effect of distant heat on a) leaves and b) pomes of *Crataegus drepanensis.*

Crataegus zichichii Raimondo, Spadaro & Venturella **sp. nov.**

Diagnosis. – Frutex vel arbor parva affinis C. laevigata; differt ab eo habito arborescente, foliis maioribus et distincte lobatis; foliis macroblastorum magnis, stipulis valde inciso-dentatis praeditis. Differt etiam ab fructu maiore, subsphaerico vel obovato. Pomum maturitate cum calice persistente et sepalis triangularibus, primo carnosis deinde squamosis, reflexis et fructui adhaerentibus.

Types. – Holotype (Fig, 8): Sicily, Erice (Trapani), northern slopes of Monte S. Giuliano, 38°02'37.16"N – 12°35'35.50"E, on carbonatic soil, 455 a.s.l., 5-09-2023, *Raimondo* (PAL-Gr); isotype (FI).

Description (Fig. 9). – Shrub or treelet up to 3–5 m tall, branched, with decumbents twigs and short brownish thorns. Leaves up to 7(8) cm long and up to 6 cm wide with lamina incised more or less deeply, with 3–7 irregularly toothed lobes; petiole up to about 2 cm. Stipules wide, irregularly incised or dentate. Flowers 3–10, white, in drooping corymbs. Pedicels 1–3 cm. Stylus (bi-)trilobed; stamens 20 with purple anthers. Pome subspherical to spherical (10)14–15 × (11)15–16 mm, crowned by persistent calyx with triangular sepals, first fleshy and then scaly, reflected and adherent to fruit, usually containing 2(3) seeds.

Phenology. – Flowering in April and ripening its fruits in (September) October- November.

Etymology. – The species is named in honor of Professor Antonino Zichichi, physicist emeritus and native of Trapani (1929), recognizes for his tireless promotion of the cultural and scientific life of the City of Erice and its territory.

Fig. 8. Holotype of *Crataegus zichichii* (PAL-Gr).

Fig. 9. *Crataegus zichichii*: a) plant in the *locus classicus*; b) fertile twigs; c) macroblasts with leaves showing the wide stipules and deeply incised lobed lamina; d) detail of the corymb showing the flower structures; e) detail of the twigs in full fruiting; f) detail of the ripe pomes crowned by persistent calyx.

Ecology. – A species of open hilly environments, it characterizes clearings and pioneer communities dominated by *Fraxinus ornus* L., *Celtis australis* L., *Osyris alba* L., *Spartium junceum* L., *Rosa canina* L., *R. sempervirens* L., *Smilax aspera* L., *Rubus* sp., *Ampelodesmos mauritanicus* (Poir.) T. Durand & Schinz, etc.

Distribution (Fig. 4). – *C. zichichii* is distributed in northwestern Sicily, particularly in the province of Trapani. Frequent from Castellammare del Golfo to Custunaci, Valderice, Erice, Trapani, Paceco, Marsala, Castelvetrano and Campobello di Mazara. Its primary dispersal center is the ancient Punic Epicracy of Erice (Caruso 2019). Heterotopic, to date, is the presence close to the inhabitated area of Marineo in the province of Palermo.

Affinities. – A species of the sect. *Crataegus*, it is closely related to *C. laevigata* than to other species and subspecies of the same section. It differs from the latter taxon in its arborescent habit, larger and markedly lobed leaves; lobes not rounded at the margins but acutely toothed; those of the macroblasts endowed with broad, irregularly incised or toothed stipules (Fig. 7c). The fruits are also significantly larger (Fig. 7f), and typically contain 2(-3) seeds.

Conservation status. – Due to its small population size and the location of its distribution area, which is highly susceptible to anthropogenic disturbance, *C. zichichii* should be classified as *"Vulnerable"* (VU), as it meets the D2 criterion of the IUCN Red List categories and criteria (2001).

Valorisation of Sicilian hawthorns

Generality on pharmacognostic aspects:

Ethnobotanical uses

Hawthorn (*Crataegus* sp. pl.) holds significant cultural and economic value, with a long tradition of medicinal use. Dioscorides recommended consuming its fruits to treat dysentery and heavy menstrual bleeding. In folk medicine, a poultice made from fresh, pounded roots was used externally to extract thorns and arrows embedded in tissues, while a poultice of fresh leaves was used to heal wounds and ulcers. Hawthorn flower infusion was consumed as a sedative and antispasmodic, and a decoction of flowers and leaves was used as a digestive. The enolite of flowers and leaves was employed as a cardiac tonic (Peroni 2012). Various ethnobotanical studies have also reported the traditional use of common hawthorn (*C. monogyna*) flowers infusion as a sedative, heart regulator, and hypotensive (Leporatti & Ivancheva 2003; Cornara & al. 2009).

Biological activities

Currently, extracts of *Crataegus* sp. pl. are primarily used for the treatment of mild congestive heart failure according to New York Heart Association (NYHA) functional class II (Veveris & al. 2004). The effectiveness of hawthorn in the treatment and prevention of cardiovascular diseases is related to its cardioprotective (Weihmayr & Ernst 1996; Wang & al. 2013) antioxidant (Škerget & al. 2005; Cui & al. 2006) and antihypertensive activities (Chang & al., 2002; Olcay & Kültür 2020), mainly attributed to proanthocyanidins and flavonoid glycosides, compounds found in the leaves, flowers, and fruits of hawthorn. These compounds may also benefit various inflammatory diseases (Ahumada & al. 1997; Taleghani & al. 2024).

Extracts of *C. oxyacantha* leaf, stem, bark, and fruit, due to their content of polyphenols, flavonoids, and tannins, may be useful for treating various diseases because of their anti-inflammatory, gastroprotective, antimicrobial, lipid-lowering, immunomodulatory, antioxidant, and cardioprotective properties (Ali & al. 2017; Aguilera-Rodríguez & al. 2021).

Nutritional health benefits

Several studies suggest that incorporating hawthorn into the diet can help prevent chronic diseases linked to oxidative stress (Zhang & al. 2001; Güven & al. 2006). In addition to its pleasant taste, hawthorn fruit is valued for its antioxidant content (Gurlen & al. 2020; Alirezalu & al. 2020). Some studies have shown that hawthorn fruits improve heart health, regulating arrhythmias, relieving spasms, and lowering blood pressure, as well as having laxative, diuretic, and antitumor properties (Gundogdu & al. 2014). In Sicily, *C.*

monogyna subsp. *monogyna* and *C. azarolus* are used raw in salads and their fruits are eaten fresh, dried, or in jam (Lentini & Venza 2007).

Biological activity of some Sicilian hawthorn populations

In the context of the health-promoting properties of hawthorn, it is pertinent to highlight the results of recent phytochemical studies, involving some of the present authors, conducted on several Sicilian populations of hawthorn. These studies have identified new natural sources of bioactive molecules.

Specifically, a recent phytochemical investigation on *Crataegus laciniata*, a species growing wild in western Sicily, showed that the extract of its flowers, could be a potential source of bioactive compounds, useful for the treatment of metabolic disorders and skin hyperpigmentation (Mirabile & al. 2024).

Additionally, similar biological activities are also confirmed by the findings of another recent study, currently in publication. This study analyzed fruits collected from wild *Crataegus* plants in different provinces of western Sicily, namely *C. laciniata*, *C. azarolus* var. *aronia*, and *C. laevigata*. The results indicate that most of the fruits examined are a rich source of antioxidants, suggesting their potential use in managing diabetes by mitigating postprandial hyperglycemia (Cacciola & al. 2024).

While flowers and fruits of various *Crataegus* species - including *C. azarolus* var. *aronia* coexisting with the new species *C. zichichii* - are sources of medicinal and nutraceutical products, the same species are also of fundamental ecological value in natural and semi-natural ecosystems, as a source of food for wildlife. In this regard, the importance of *Rosaceae* in general – thus also of plants of the genus *Crataegus* – in diversifying the forest topsoil has recently been highlighted. For this reason, hawthorns constitute plants to be valorised in reforestation plans, with the primary objective of supporting wildlife feeding in phytobiologically poor areas (Campisi & Raimondo 2023). In this perspective, the first form of valorisation of these species is therefore nursery gardening aimed at supporting the new direction of urban, peri-urban and extra-urban forestation (Blasi 2023), which also has the objective of bringing nature back into the city (Capotorti & al. 2020). Relative to one of the two species described here, namely *C. zichichii*, the copious spring flowering, but especially the showy autumn fruiting that is kept alive on the plant until mid-January, give the species a considerable decorative value, and this makes it economically interesting in nursery and therefore commercially, because it is not only suitable for animating green spaces of all kinds but can be cultivated to obtain branches to use in the preparation of Christmas decorations, just like other wild species such as holly (*Ilex aquifolium* L.).

Discussion and conclusion

Based on the conclusions of the taxonomic study performed by the classical method of analysis phenetic, biological, ecological, and phytogeographic features, the diversity of the genus *Crataegus* in Sicily is enriched by two new species of a great interest: *C. zichichii* is linked to applications in forestry and decorative fields, *C. drepanensis* is primarily of bio-ecological and phytogeographic interest. In any case, the description of the two new species

not only enriches the diversity of Sicilian dendroflora but also offers new potential sources of bioactive molecules of pharmaceutical, nutraceutical, and cosmeceutical interest.

The greater diversity highlighted by the study is not found throughout the rest of the western and central Mediterranean region. For the genus *Crataegus,* this makes Sicily a biodiversity hotspot. In this regard, concerns arise from both the urban expansion of the seaside town of San Vito Lo Capo and the recurrence of fires that in recent years have compromised, sometimes irreversibly damaging, the population of *C. drepanensis* in particular, which has so far been little considered by all directives aimed at conserving European biodiversity, as it is not known and therefore not protected as an extremely localized endemic species.

This study, therefore, serves as a basis for initiating awareness actions aimed at ensuring greater protection of the distribution area of the new species and the conservation of its fragile natural habitat.

Regarding *C. drepanensis* – the more endangered of the two new species – there is concern about what happened last summer in the eastern coastal area of San Vito Lo Capo, where the highest concentration of its population is found. A severe fire scorched several thousand plants (Fig. 10). Of these, only a small portion managed to sprout again from the base after the autumn rains. Therefore, *in situ* conservation measures are urgently needed to help the fire-damaged plants regenerate by promoting resprouting. In this context, there is no better technique than cutting the damaged parts. Simultaneously, given the successful outcome of seed regeneration, experimented in a nursery directly by one of the authors (L. Scuderi) in the family business (Fig. 11), *ex situ* conservation strategies and *in situ* repopulation actions could be successfully implemented.

Fig 10. (a, b) Devastating effects of the recent fire on *Crataegus drepanensis* plants and its phytocoenosis.

Fig. 11. a) *In situ* conservation strategies thanks to the regenerative capacity of compromised *Crataegus drepanensis* plants in the winter months following the fire; b) possibility of *ex situ* and *in situ* conservation through transplanting seedlings obtained from seeds; c) characteristic one year old *C. drepanensis* seedling obtained in a private nursery.

References

Aguilera-Rodríguez, F. R., Zamora-Perez, A. L., Galván-Moreno, C. L., Gutiérrez-Hernández, R., Reyes Estrada, C. A., Esparza-Ibarra, E. L. & Lazalde-Ramos, B. P. 2021: Cytotoxic and Genotoxic Evaluation of the Aqueous and Hydroalcoholic Leaf and Bark Extracts of *Crataegus oxyacantha* in Murine Model. – Plants **10(10):** 2217. https://doi.org/10.3390/plants10102217

Ahumada, C., Sáenz, T., García, D., De La Puerta, R., Fernandez, A. & Martinez, E. 1997: The effects of a triterpene fraction isolated from *Crataegus monogyna* Jacq. on different acute inflammation models in rats and mice. Leucocyte migration and phospholipase A2 inhibition. – Journal of pharmacy and pharmacology **49(3):** 329-331. https://doi.org/10.1111/j.2042-7158.1997.tb06806.x

Ali, M., Muhammad, S., Shah, M. R., Khan, A., Rashid, U., Farooq, U., Ullah, F., Sadiq, A., Ayaz, M., Ali, M., Ahmad, M. & Latif, A. 2017: Neurologically Potent Molecules from *Crataegus oxyacantha*; Isolation, Anticholinesterase Inhibition, and Molecular Docking. – Front. Pharmacol. **8:** 327. https://doi.org/10.3389/fphar.2017.00327

Alirezalu, A., Ahmadi, N., Salehi, P., Sonboli, A., Alirezalu, K., Mousavi Khaneghah, A., Barba, F. J., Munekata, P. E. S. & Lorenzo J. M. 2020: Physicochemical Characterization, Antioxidant Activity, and Phenolic Compounds of Hawthorn (*Crataegus* spp.) Fruits Species for Potential Use in Food Applications. – Foods **9:** 436. https://doi.org/10.3390/foods9040436

Bartolucci, F., Peruzzi, L., Galasso, G., Alessandrini, A., Ardenghi, N. M. G., Bacchetta, G., Banfi, E., Barberis, G., Bernardo, L., Bouvet, D., Bovio, M., Calvia, G., catello, M., Cecchi, L., Del Guacchio, E., Domina, G., Fascetti, S., Gallo, L., Gottschlich, G., Guarino, R., Gubellini, L., Hofmann, N., Iberite, M., Jiménez-Mejías, P., Longo, D., Marchetti, D., Martini, F., Masin, R. R., Medagli, P., Peccenini, S., Prosser, F., Roma-Marzio, F., Rosati, L., Santangelo, A.,

Scoppola, A., Selvaggi, A., Selvi, F., Soldano, A., Stinca, A., Wagensommer, R. P., Wilhalm, T. & Conti, F. 2024: A second update to the checklist of the vascular flora native to Italy. – Pl. Biosyst. **158(2):** 219–296. https://doi.org/10.1080/11263504.2024.2320126

Blasi, C. 2023: PNRR ed indirizzi la forestazione urbana, periurbana ed extraurbana nelle città metropolitane. In: Atti Conferenza Regionale "Forestazione urbana, periurbana es extraurbana in Sicilia" – Quad. Bot. Amb. Appl. **32(2021):** 15-18.

Browicz, K. 1972: *Crataegus* L. (*Rosaceae*). In: Davis P. H. (Ed.) Flora of Turkey and the East Aegean Islands. Edinburgh University Press, Edinburgh, 133-147.

Cacciola, A., D'Angelo, V., Germanò, M. P., Mirabile, S., Raimondo, F. M., Arabi, S. B., Rosa, E., Santoro, V. & De Tommasi, N. 2024: Polyphenolic characterization, antioxidant and antidiabetic activities of *Crataegus* spp. fruit extracts. – In Proceedings of X International Plant Science Conference (IPSC). 119° Congresso della Società Botanica Italiana onlus, Università di Teramo (Abruzzo, Italy), 11th - 13th September 2024.

Campisi, P. & Raimondo, F. M. 2023: Importance of minor native wood species in urban, peri-urban and extra-urban forestation. In: Atti Conferenza Regionale "Forestazione urbana, pariurbana ed extraurbana in Sicilia". – Quad. Bot. Amb. Appl. **32(2021):** 109.

Capotorti, G., Bonacquisti, S., Abis, L., Aloisi, I., Attorre, F., Bacaro, G., Balletto, G., Banfi, E., Barni, E., Bartoli, F., Bazzato E., Beccaccioli, M., Braglia, R., Bretzel, F., Brighetti, M.A., Brundu, G., Burnelli, M., Calfapietra C., Cambria, V. E., Caneva, G., Canini, A., Caronni, S., Castello, M., Catalano, C., Celesti-Grapow, L., Cicinelli, E, Cipriani, L., Citterio, S., Concu, G., Coppi, A., Corona, E., Del Duca, S., Del Vico, E., Di Gristina, E., Domina, G., Faino, L., Fano, E. A., Fares, S., Farris, E., Farris, S., Fornaciari, M., Gaglio M., Galasso, G., Galletti, M., Gargano, M. L., Gentili, R., Giannotta, A. P., Guarino, C., Guarino, R., Iaquinta, G., Iiriti, G., Lallai, A., Lallai, E., Lattanzi, E., Manca, S., Manes, F., Marignani, M., Marinangeli, F., Mariotti, M., Mascia, F., Mazzola, P., Meloni, G., Michelozzi, P., Miraglia, A., Montagnani, C., Mundula, L., Muresan, A. N., Musanti, F., Nardini, A., Nicosia, E., Oddi, L., Orlandi, F., Pace, R., Palumbo, M. E., Palumbo, S., Parrotta, L., Pasta, S., Perini, K., Poldini, L., Postiglione, A., Prigioniero, A., Proietti, R., Raimondo, F. M., Ranfa, A., Redi, E.L., Reverberi, M., Roccotiello, E., Ruga, L., Savo, V., Scarano, P., Schirru, F., Sciarrillo, R., Scuderi F., Sebastiani, A., Siniscalco, C., Sordo, A., Suanno, C., Tartaglia, M., Tilia, A., Toffolo, C., Toselli, E., Travaglini A., Ventura, F., Venturella, G., Vincenzi, F. & Blasi, C. 2020: More nature in the city. – Pl. Biosyst. **154(6):** 1003-1006.

Caruso, E. 2019: Archaeological Landscape of the "Punic Epicracy" of Sicily. – Bocconea **28:** 13-25. https://doi.org/10.7320/10.7320/Bocc.28.001

Chang, Q., Zuo, Z., Harrison, F., Chow, M. S. S. 2002: Hawthorn. – J. Clin. Pharmacol. **42:** 605-612. https://doi.org/10.1177/00970002042006003

Christensen, K. I. 1992: Revision of *Crataegus* Sect. *Crataegus* and Nothosect. *Crataeguineae* (*Rosaceae-Maloideae*) in the old world. – Syst. Bot. Monographs **35:** 1-199. https:/doi.org/10.2307/25027810

— , & Zieliński, J. 2008: Notes on the genus *Crataegus* (*Rosaceae* - *Pyreae*) in southern Europe, the Crimea and western Asia. – Nordic J. Bot. **26(5-6):** 344-360. https://doi.org/10.1111/j.1756-1051.2008.00330.x

Cornara, L., La Rocca, A., Marsili, S. & Mariotti, M. G. 2009: Traditional uses of plants in the Eastern Riviera (Liguria, Italy). – J. Ethnopharmacol. **125(1):** 16-30. https://doi.org/10.1016/j.jep.2009.06.021

Cui, T., Li, J. Z.; Kayahara, H., Ma, L., Wu, L. X. & Nakamura, K. 2006: Quantification of the polyphenols and triterpene acids in Chinese hawthorn fruit by high-performance liquid chromatography. – J. Agric. Food Chem. **54(13):** 4574 - 4581.

Dickinson, T. A. & Campbell, C. S. 1991: Population structure and reproductive ecology in the *Maloideae* (*Rosaceae*). – Syst. Bot. **16(2):** 350-362. https://doi.org/10.2307/2419285

Fichtner, A. & Wissemann, V. 2021: Biological flora of the British Isles: *Crataegus monogyna*. – J. Ecol. **109(1):** 541-571. https://doi.org/10.1111/1365-2745.13554

Gundogdu, M., Ozrenk, K., Ercisli, S., Kan, T., Kodad, O. & Hegedus, A. 2014: Organic acids, sugars, vitamin C content and some pomological characteristics of eleven hawthorn species (*Crataegus* spp.) from Turkey. – Biol. Res. **47:** 1-5.

Gurlen, A., Gundogdu, M., Ozer, G., Ercisli, S. & Duralija, B. 2020: Primary, secondary metabolites and molecular characterization of hawthorn (*Crataegus* spp.) genotypes. – Agronomy **10(11):** 1731. https://doi.org/10.3390/agronomy10111731

Güven, K., Yücel, E. & Cetintaş, F. 2006: Antimicrobial activities of fruits of *Crataegus* and *Pyrus* Species. – Pharm. Biol. **44(2):** 79-83. https://doi.org/10.1080/13880200600591253

IUCN 2001: IUCN Red List Categories and Criteria: Version 3.1. – Gland & Cambridge.

Lentini, F. & Venza, F. 2007: Wild food plants of popular use in Sicily. – J. Ethnobiol. Ethnomed. **3:**1-12. https://doi.org/10.1186/1746-4269-3-15

Leporatti, M. L. & Ivancheva, S. 2003: Preliminary comparative analysis of medicinal plants used in the traditional medicine of Bulgaria and Italy. – J. Ethnopharmacol. **87(2-3):** 123-142. https://doi.org/10.1016/S0378-8741(03)00047-3

Lojacono-Pojero, M. 1891: Flora Sicula, **1(2).** – Palermo. Pp. 202-206.

Mirabile, S., D'Angelo, V., Germanò, M. P., Arabi, S. P., Parisi, V., Raimondo, F. M. & Rosa, E. 2024: Chemical profile and health-promoting activities of *Crataegus laciniata* (*Rosaceae*) flowers. – Plants, **13(1):** 34. https://doi.org/10.3390/plants13010034.

MirAli, N., Al-Odat, M., Haider, N. & Nabulsi, I. 2011: The genus *Crataegus* L.: An ecological and molecular study. – Russ. J. Gen. **47:** 26-34. http://dx.doi.org/10.1134/S1022795410061018

Nazhand, A., Lucarini, M., Durazzo, A, Zaccardelli, M., Cristarella, S., Souto, S. B., Silva, M. A., Severino, P., Souto, B. E. & Santini, A. 2020: Hawthorn (*Crataegus* spp.): An updated overview on its beneficial properties. – Forests **11(5):** 564. https://doi.org/10.3390/f11050564

Oklejewicz, K., Chwastek, E., Szewczyk, M., Bobiec, A. & Mitka, J. 2013: Distribution of *Crataegus* (*Rosaceae*) in SE Poland along a gradient of anthropogenic influence. – Pol. J. Ecol. **61(4):** 683-691.

Olcay, B. & Kültür, Ş. 2020: Medicinal plants used in traditional treatment of hypertension in Turkey. – Int. J. Sci. Technol. Res. **6(3):** 80-95. https://doi.org/10.7176/JSTR/6-03-11

Peroni, G. 2012: Trattato di fitoterapia. Driope ovvero il patto tra l'uomo e la natura. – Palermo.

Pignatti, S. 1982: Flora d'Italia, **1.** – Edagricole, Bologna.

—, 2018: Flora d'Italia (2a ediz.). – Edagricole, Milano.

Raimondo, F. M. 2004: Landscape and floristic features of Sicily. – Bocconea **17:** 63-64.

— 2013: Biodiversità nella dendroflora italiana. L'Italia Forestale e Montana **68(5):** 233-257.

—, Arena, M. P., Marino, P., Spadaro, V. & Zizzo, G. V. 2023: Note tassonomiche, corologiche e fitogeografiche sul genere *Crataegus* (*Rosaceae*) in Sicilia. – Quad. Bot. Amb. Appl. **33(2022):** 113-118.

Škerget, M., Kotnik, P., Hadolin, M., Hraš, A. R., Simonič, M. & Knez, Ž. 2005: Phenols, proanthocyanidins, flavones and flavonols in some plant materials and their antioxidant activities. – Food Chem. **89(2):** 191-198. https://doi.org/10.1016/j.foodchem.2004.02.025

Spadaro, V. & Raimondo, F. M. 2023: Dendrological biodiversity and forestation in Sicily. In: Atti Conferenza Regionale "Forestazione urbana, periurbana ed extraurbana in Sicilia" – Quad. Bot. Amb. Appl. **32(2021):** 111.

Taleghani, A., Eghbali, S., Moghimi, R. & Mokaber-Esfahani, M. 2024: *Crataegus pentagyna* willd. Fruits, leaves and roots: phytochemicals, antioxidant and antimicrobial potentials. – BMC Complementary Medicine and Therapies **24(1):** 126. https://doi.org/10.1186/s12906-024-04430-4

Veveris, M., Koch, E. & Chatterjee, S. S. 2004: *Crataegus* special extract WS[1]1442 improves cardiac function and reduces infarct size in a rat model of prolonged coronary ischemia and reperfusion. – Life Sci. **74:** 1945-1955. https://doi.org/10.1016/j.lfs.2003.09.050

Zhang, Z., Chang, Q., Zhu, M., Huang, Y., Ho, W. K. & Chen, Z. Y. 2001: Characterization of antioxidants present in hawthorn fruits. – J. Nutr. Biochem. **12(3):** 144-152. https://doi.org/10.1016/S0955-2863(00)00137-6

Zohary, M. 1972: *Crataegus* L. in Feinbrun-Dothan, N. – Flora Palaestina 2(Text): 1-489. Israel Academy of Sciences and Humanities.

Wang, J., Xiong, X. & Feng, B. 2013: Effect of *Crataegus* usage in cardiovascular disease prevention: an evidence-based approach. – Evid.-Based Complementary Altern. Med. **2013(1):** 149363. https://doi.org/10.1155/2013/149363

Weihmayr, T. & Ernst, E. 1996: Therapeutic effectiveness of *Crataegus*. – Fortschr. Med. **114(1-2):** 27-29.

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