

Article

New records for the alien vascular flora of Calabria (S-Italy)

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Abstract: While alien organisms, vascular plants included, are progressively increasing their worldwide impact on habitats, the present research confirms a similar dangerous trend for Calabria, the southernmost and floristically richest region of Italian Peninsula. The set of additional alien taxa here recorded for the vascular flora of Calabria includes: *Acacia melanoxylon*, *Bidens subalternans*, *Buddleja davidii*, *Cucurbita moschata*, *Cyclosporum leptophyllum*, *Erigeron annuus* subsp. *annuus*, *Hesperocyparis glabra*, *Ligustrum ovalifolium*, *Mahonia aquifolium*, *Morus indica*, *Oenothera speciosa*, *Prunus serotina*, *Pyracantha fortuneana*, *Rudbeckia laciniata*, *Solanum nitidibaccatum*, *Sparaxis bulbifera*, *Tradescantia cerinthoides*, *Ulmus pumila*. These additional 18 taxa bring the total number of alien species from 382 to 400. The most represented biological forms are scapose therophyte and scapose phanerophyte with 5 species (27.8% of the total). The most frequent biogeographic origins of the surveyed species are North America (6 species; 33.3%), followed by Asia and South America both with 4 species (22.2%). The most common habitats hosting the recorded alien taxa are roadsides (8 species; 44.4%), although all surveyed plants have been found in deeply anthropized environments. The altitude of occurrence, extending 3 to 1,286 m a.s.l., together with other ecological data provided, demonstrate the ability of aliens to potentially colonize a wide range of environments in the region.

Keywords: Alien species, Biodiversity, Bioinvasion, Exotic plant, Floristic data, Herbarium specimens, Invasiveness, New floristic records, Plant diversity, Southern Italy

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1. Introduction

Human activities deeply altered the Earth biota, producing transformations that modified the ecological equilibria [1, 2]. In the current globalization era, increasing transportation, communications, large scale trading promoted the transfer of a huge amount of plant species outside of their native geographical range, determining a constant erosion of existing biogeographic barriers [3-5]. Several alien species now represent a permanent component of the flora of the countries where have been introduced [6]. Aliens are today considered one of the main threats to the biodiversity conservation [7-9] because they are often able to modify the colonized habitats, where they reproduce and spread, altering the ecosystem services, with heavy consequences on ecological, economic and social order [10-12]. The occurrence of exotic species usually characterizes anthropized areas, especially those where human settlements, farming and industries are concentrated [13]. The destruction of natural environment, urbanization and the anthropic disturb ineluctably promote the propagation of exotic species [14, 15], due to their ability to spread at the expense of native vegetation and substitute it thank to several adaptations [16-19]. Moreover, the human induced climate change is recognized as one of the factors responsible of the competitive advantage of alien species [20, 21]. Although not all the

alien species show the same invasive tendency, every new exotic taxon could negatively affect the native phytocoenoses, and anyway the long-term invasiveness of each taxon in a given area it is not always easy to foresee. The damage of alien species is usually wider in areas expressing highest naturalness, such as native forests, national parks and wetlands, where defending biodiversity is crucial for conservation. The level of mixing of floras with different biogeographical origin in all continents is actually so high and uncontrolled, due to human activities, that physical barriers and even geographical distances among continents are virtually inexistent, and anyway unable to keep biogeographical regions well separated. That's why some scientists believe that biosphere is today experiencing a sort of "Pangea effect", under which unprecedented numbers of vascular plants with any biogeographic origin mix each other determining an increasing biotic homogenization [22], resulting in a dangerous global loss of floristic uniqueness [23] and in inedited combinations, some of which are reversible (hybrid ecosystems) and some irreversible (novel ecosystems) [24] whose medium and long term consequences on biodiversity and ecosystem services are completely unpredictable.

At European level, Italy is one of the countries with the highest number of exotic species, representing about 20% of national flora [25] due to an ancient history of trading among the Mediterranean and European countries, and even the massive industrialization of Northern regions [26, 27]. Massive is also the voluntary introduction of species from North America and SE-Asia, such as *Robinia pseudoacacia* with forestry purpose, *Ailanthus altissima* and *Artemisia annua* respectively for fabric and medicine purposes, *Prunus laurocerasus* and *Parthenocissus quinquefolia* for ornamental use. Calabria as well, has a large contingent of exotic species as part of its vascular flora, showing increasing importance and interest demonstrated by the growing number of new records reported for this territory during recent years [28].

Aim of this research is to report new exotic species found in Calabria during the 2021-2023 investigations, so providing further information about the occurrence of exotic flora in Calabria and in Italy.

2. Materials & methods

2.1. Study area

Calabria is the southernmost continental region of Italy (Figure 1A), surrounded E, W and S by seas (Ionian, Tyrrhenian and Messina Strait), and abruptly separated from the continental Italy by the Pollino massif, whose highest mountain top is Serra Dolcedorme (2,267 m a.s.l.). The complex orography – characterized by Calabrian Apennine mountain ranges (Pollino, Orsomarso, Sila, Catena Costiera, Serre and Aspromonte) quite close to coasts – and the extremely heterogeneous geology are at the basis of a wide climatic diversity and different plant communities [29] occurring in Calabria. The vascular flora native to the region counts about 2,700 taxa [30], part of which are the 60 strictly regional endemics and the 270 national endemics [31], the highest values recorded among Italian continental regions. According to Spampinato *et al.* [28] Calabria flora counts 382 alien taxa, 14% of its total vascular flora.

During 2021-2023, Catanzaro urban area, a few localities surrounding the administrative capital of Calabria, and few areas encompassed in the Sila National Park have been specifically surveyed for exotic flora (Figure 1B).

2.2. Specimen and data collection and manipulation

The surveyed stands and the specimens collected have been georeferenced using a GPS device (Garmin Montana 650t). Each plant has been collected and dried in at least two voucher copies applying the common herbarium techniques. Exsiccata have been stored in the herbarium of Department of Agraria, Mediterranean University of Reggio

Calabria (code REGGIO, according to Thiers [32]). A voucher copy of each specimen is also stored in the Herbarium Capuano (Catanzaro).

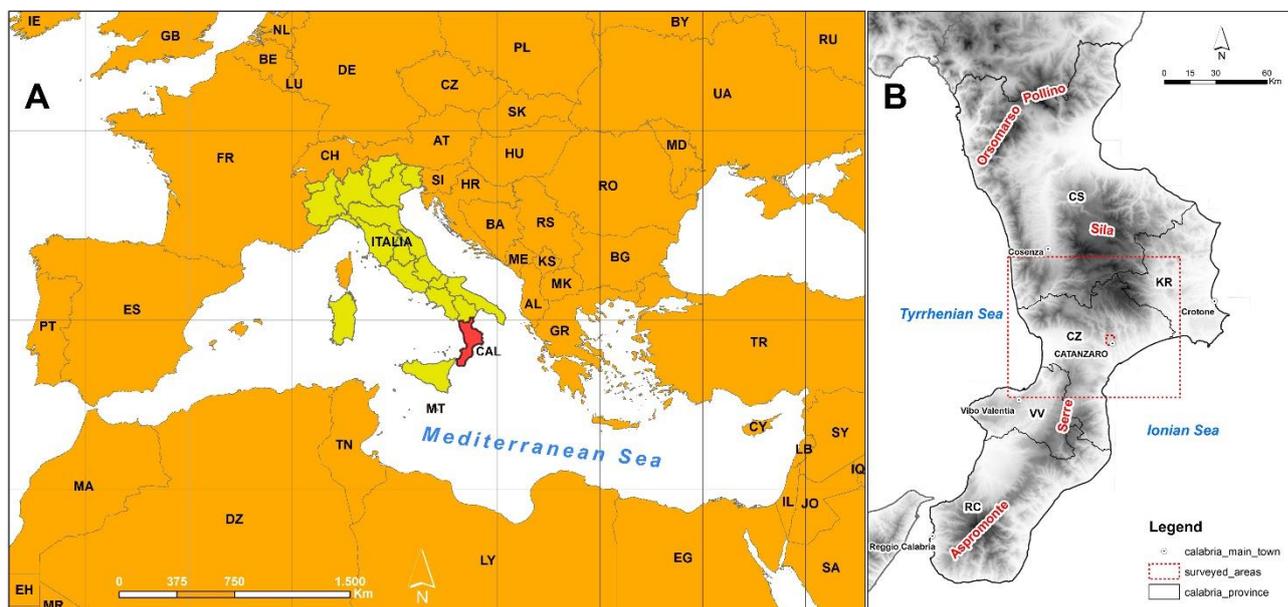


Figure 1. Calabria (red) and other Italian regions (yellow) as part of European continent (orange), right at the center of Mediterranean Sea (A) and map of Calabria region with shaded digital elevation model, province's borders (CZ = Catanzaro; CS = Cosenza; KR = Crotona; RC = Reggio Calabria; VV = Vibo Valentia), administrative chief towns, main mountain chains (red text), surveyed areas (dashed red line polygons) (B).

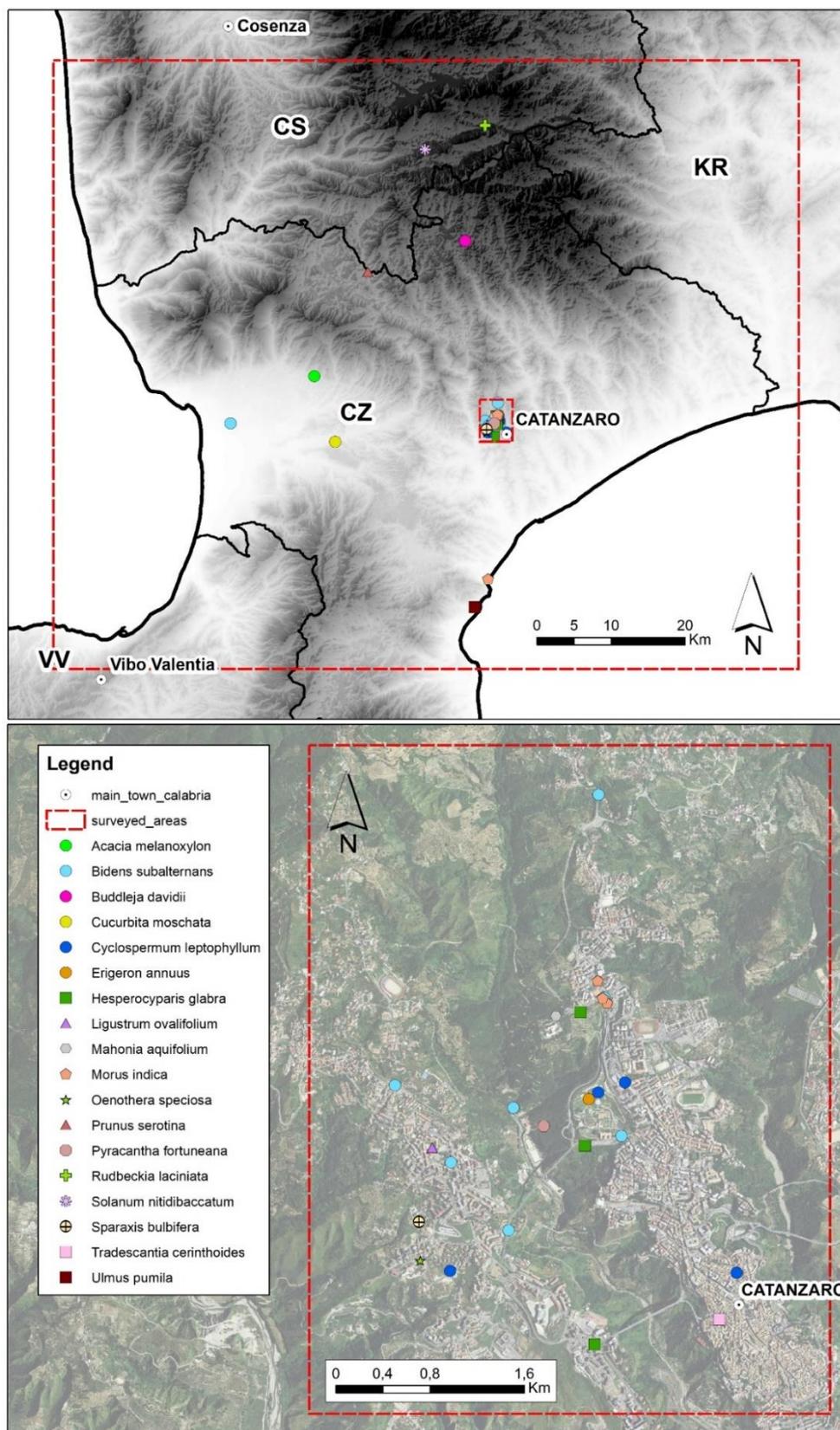


Figure 2. Investigated area (dashed red line) in Catanzaro Province and surrounding areas, and distribution of alien taxa surveyed in this research (A). Detail of the smaller investigated polygon (dashed red line) located across Catanzaro downtown and surroundings on orthophotograph by PCN (2012).

from the Asian biogeographical region, and as many coming from South America (Tab. 1B). According to available data all the recorded species can be considered neophytes.

All species have been found in synanthropic habitats, 8 of which (44.4%) at roadsides, while 2 species (11.1%) both inside flowerbeds and in uncultivated areas (Table 1C).

The recorded species have been found covering an altitude range of 3-1,286 m a.s.l..

4. Discussion

The amount of taxa found, their biogeographical origins, the prevailing ruderal and synanthropic habitats confirm the trend of an increasing pressure of alien plant species at regional and national level, as respectively already proposed by Spampinato *et al.* [28] and Galasso *et al.* [25]. The occurrence of many therophytes in this survey probably testifies the high efficiency of this life form to develop and persist in disturbed habitats, while the high number of phanerophytes is probably due to the past introduction of alien trees in Europe for ornamental or forestry purposes that still continues sometimes nowadays. Many of these plants show specific adaptations to the vegetative reproduction which support surviving and spread along the time. A few peculiar synanthropic ecological niches, such as abandoned fields and urban areas, according to Wagner *et al.* [45], could sometimes represent ecological corridors that promote the spread of these species across natural and seminatural environments. Phanerophytes included in this survey, according to other European sources [46-48] have been confirmed occurring even outside of urban areas, despite most of the findings have been associated to urban or suburban contexts. Most of the reported species have been found in highly anthropized environments, due probably to the ability of alien species to settle on weak ecological niches where most of the native species could not develop permanent colonies. In fact, urban and suburban areas are well known alien species hot spots, also as a result of the amount of exotic species used as ornamentals in private and public spaces, such as parks and gardens, often without any preliminary consideration for the biogeographical origin and the invasive potential of the chosen taxa. Moreover, the wide altitudinal range, along with the diversity of colonized habitat, suggests the huge potential of these taxa to potentially invade many different ecosystems in the investigated territory and the surrounding regions. A high number of taxa coming from American continent confirms data provided by Pyšek *et al.* [49], according which almost 50% of European exotic flora (except alien species of European origin) are from Northern and Southern America. Consistently with Pyšek *et al.* [43], Pyšek *et al.* [49] and Follak *et al.* [50] our data confirms that human modified habitats (e.g. agriculture and industrial zones, park and gardens) host in Europe most of alien species, much more than grasslands and wooded areas.

5. Conclusions

During last years the investigation on bioinvasions attracted increasing interest by scholars, mainly because of negative effects on natural environment and ecosystem services [43, 51]. Recent field survey has shown the increasing number of exotic species new not just to the regional territory, but even to Italy and Europe as well [52-58, 28, 59, 60]. The lacking knowledge about the Calabrian vascular exotic flora, according to Musarella *et al.* [61], was probably due to missing deep territory exploration. Calabria, according to Spampinato *et al.* [28], and also with the additions provided by this work, is a Mediterranean and European region where a high number of exotic plant species has been recorded. The timely identification of exotic species in a territory allows to understand and predict in advance the dynamics of colonization and expansion, so that management plans can be scheduled [62, 63]. Control and eradication, almost always potentially useful to reduce the impact of some invasive aliens, rarely can be applied because of technical difficulties and, above all, reduced resources specifically dedicated to this goal [64, 65], despite in the today scenario of climatic-environmental crisis, the

amount of alien species is tendentially destined to increase, further threatening biodiversity and native ecosystems, and so representing one of the challenges requesting most commitment in the next future [66]. A kind of long term effective approach to the mitigation of effects of bioinvasions would be based on a mixed strategy, including actions such as (1) implementing in the school curricula lab based educative programs addressed to pupils belonging to different age classes, in order to provide them the best possible awareness about risks coming from the introduction of exotic organisms [29] (2) adopting specific legislative barriers (e.g. city green rules) discouraging (e.g. higher taxes) or forbidding the introduction of new exotic species [67], (3) introducing strict limitations to the cultivation of non-native species, especially in the next proximity of rural or natural areas, (4) avoiding the abandonment of areas potentially highly sensible to bioinvasions [68, 69], (5) favoring the spontaneous recover of natural vegetation when possible, (6) recovering degraded habitats when technically (hybrid ecosystems) and financially possible implementing specific eradication plans, (7) mitigating the effect of bioinvasions when eradication is practically impossible (novel ecosystems), (8) monitoring trajectories taken by restoration processes, (9) adjusting trajectories according to realistic target ecosystems when necessary [24].

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Appendix A – List of the recorded taxa in alphabetical order by scientific name.*Acacia melanoxylon* R.Br.

Fabaceae – Neophyte – Australia – Scapose phanerophyte

First record for Calabria (casual)

Specimina: 6th January 2023, external perimeter of Dossi Comuni Park, locality Censi, Lamezia Terme (Catanzaro province), roadside, 38.963058°N-16.358312°E, 245 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. Mature trees planted in the park probably originated the small group of individuals found in the external area by the roadside. Further investigation revealed the presence of several seedlings and young plants in the mixed native-alien species plantation extending across the park, dominated by *Eucalyptus camaldulensis* Dehnh. subsp. *camaldulensis*, *Acacia saligna* (Labill.) H.L. Wendl., *Quercus suber* L. with dense renovation of both native and exotic species such as *Myrtus communis* L., *Laurus nobilis* L., *Viburnum tinus* L., *Quercus pubescens* Willd., *Rubia peregrina* L., *Robinia pseudoacacia* L., *Cercis siliquastrum* L.. *Acacia melanoxylon*, native to the Eastern territories of Australia, has been largely introduced outside its native range for timber production and soil erosion control [70, 71]. Because of its rapid spread it is considered a noxious species which can affect forestry environments, especially in the Mediterranean area [72]. In Italy this species is reported as casual or naturalised alien species for Sicily, Sardinia and the regions by Tyrrhenian Sea [73, 74, 25] except Campania and Basilicata [25].

***Bidens subalternans* DC.**

Asteraceae – Neophyte – Southern America – Scapose therophyte

First record for Calabria (naturalized)

Specimina: 23rd September 2022, along the national road SS 109 just before the Tangenziale nord, Catanzaro, roadside, 38.9118595°N-16.5738392°E, 324 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 1st November 2022, entry road to “Ciaccio” Hospital, Catanzaro, ruderal vegetation under some trees, 38.9257671°N-16.5811130°E, 426 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 1st November 2022, Via Giuseppe Schiavi, under the overpass, Catanzaro, ruderal vegetation by the roadside, 38.9174970°N-16.5824350°E, 379 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 3rd November 2022, Ferrovie Calabro-Lucane Gagliano station, Catanzaro, railway enclosures, 38.9205292°N-16.5651784°E, 408 m a.s.l., *leg.* A. Capuano (REGGIO,

Herbarium Capuano), *det.* A. Capuano, G. Caruso; 3rd November 2022, Viale Tommaso Campanella, Catanzaro, roadside, 38.9159172°N-16.5694501°E, 370 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 4th November 2022, along the national road SS 109 just before Piterà, Catanzaro, roadside, 38.9379023°N-16.5806966°E, 462 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 15th December 2022, Via Zuccherificio, close to Lamezia Terme Centrale railway station, Lamezia Terme (Catanzaro province), roadside, 38.918038°N-16.256820°E, 20 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 5th January 2023, Torrente Fiumarella gorges, Parco della Biodiversità Mediterranea, Catanzaro, along the trail at the side of the watercourse, 38.919180°N-16.574205°E, 252 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. *Bidens subalternans* is often confused with the similar *B. bipinnata*, a neophyte native to Northern America and reported for several Italian regions. It differs mainly for smaller achenes length (0.6-1.4 cm), awns almost perfectly erect, triangular leaf shape and linear-lanceolate lobes [75, 76]. In Italy, *B. subalternans* has been found in almost all Italian regions and it is considered an invasive neophyte [25]. This species also occurs in several European countries as casual or naturalized alien. It occurs mostly in nitrophilous and ruderal communities, especially in disturbed and man-made habitats (e.g. railways, roadsides), but also along rivers and meadows [75]. *Bidens subalternans* can produce up to 6,000 seeds per individual, which are easily dispersed far away from the mother plants due to their sticky bristles [76]. It is also an extremely strong weed noxious to agriculture for its resistance to herbicides [77, 78]. The last localities recorded host several plants still flowering and fruiting on the first days of January. For this species has been proposed the status of naturalized alien according to the high number of stands discovered, the large metapopulation and the occurrence in several different habitats and changing ecological conditions. It could be assumed that *B. subalternans* has been present in Calabria for many years. This species at the moment is expanding its range, affecting more native communities.

***Buddleja davidii* Franch.**

Scrophulariaceae – Neophyte – Eastern Asia – Caespitose phanerophyte

First record for Calabria (casual)

Specimina: 11th September 2022, Racise, Taverna (Catanzaro province), roadside at the edge of a forest, 39.0914894°N-16.5411589°E, 1,252 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. Imported from China at the end of XIX century, *B. davidii* has become a popular ornamental plant in Europe, Northern America, Australia and New Zealand [79]. It is known as “butterfly-bush”

because of its melliferous flowers, which attract a large number of pollinators. *Buddleja davidii* often escapes from gardens and parks, establishing in ruderal, disturbed or semi-natural habitats [80], also due to its tolerance to different environmental conditions. A few flowering specimens have been observed along the roadside, on the edge of *Pinus nigra* J.F. Arnold subsp. *laricio* Palib. ex Maire forest mixed with *Acer pseudoplatanus* L. and *Cytisus scoparius* (L.) Link. *Buddleja davidii* seeds could have been wind-dispersed from nearby villages, where this species is locally cultivated in private gardens.

***Cucurbita moschata* Duchesne**

Cucurbitaceae – Neophyte – Central America – Scapose therophyte

First record for Calabria (casual)

Specimen: 29th November 2022, along the national road SS 19 dir., Maida (Catanzaro province), roadside at the edge of a disturbed scrubland, 38.900551°N-16.383456°E, 74 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. A few well-developed and fruiting plant has been observed. Seeds could have been probably carried through abandoned food wastes. In Italy this species has been recorded in Piedmont, Liguria, Veneto and Campania [81, 25]. *Cucurbita moschata* is similar to *C. maxima*, from which differs mainly for peduncles abruptly expanded at point of fruit attachment and calyx teeth enlarged at the apex [35, 82, 36]. Among *Cucurbita* species, it is widely grown in warm and tropical areas for its resistance to different environmental conditions [83].

***Cyclospermum leptophyllum* (Pers.) Sprague ex Britton & P. Wilson** [\equiv *Apium leptophyllum* (Pers.) F. Muell. ex Benth.; *Pimpinella leptophylla* Pers.]

Apiaceae – Neophyte – Southern America – Scapose therophyte

First record for Calabria (casual)

Specimina: 12th August 2021, Via Biagio Miraglia, Catanzaro, roadside, 38.909432°N-16.569375°E, 295 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 7th September 2022, Vico I Ospedale Civile, Catanzaro, cracks in the sidewalk, 38.909302°N-16.591230°E, 334 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 7th September 2022, Viale Pio X, at the entry of “Pugliese” Hospital, Catanzaro, flowerbed side, 38.920695°N-16.582699°E, 421 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 8th June 2023, Parco della Biodiversità Mediterranea, Catanzaro,

uncultivated flowerbed, 38.920087°N-16.580674°E, 397 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. *Cyclospermum leptophyllum*, formerly included in the *Apium* genus, according to Ronse *et al.* [84], is native to Southern America, but it is widespread as neophyte in several countries of Northern America, Europe and Asia [85-90]. This taxon has been observed in four different localities in Catanzaro, but it could occur in many more stands, maybe even outside of the urban area, because of small size and ephemeral occurrence, making it difficult to be easily detected, especially in disturbed sites where it can assume a prostrate habitus [91]. Its introduction is probably accidental (through nursery substrates or vehicles movement), although Del Guacchio [92] suggests it could have been introduced to Southern Italy (by Naples Botanical Garden) for cultivation purposes.

Erigeron annuus* L. subsp. *annuus

Asteraceae – Neophyte – Northern America – Scapose therophyte

First record for Calabria (casual)

Specimen: 3rd July 2021, Parco della Biodiversità Mediterranea, Catanzaro, uncultivated flowerbed at the edge of a meadow, 38.919697°N-16.579948°E, 394 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. In the recorded stand a few individuals have been found. The introduction of this species in the area is probably accidental, maybe helped by nursery substrates. *Erigeron annuus* is considered one of the most invasive plants of Europe, because of its fast and aggressive growth which can affect meadows communities of native herbaceous species [93-95].

***Hesperocyparis glabra* (Sudw.) Bartel** [≡ *Callitropsis glabra* (Sudw.) D.P. Little; *Cupressus arizonica* Greene subsp. *glabra* (Sudw.) A.E. Murray; *Cupressus arizonica* Greene var. *glabra* (Sudw.) Little; *Cupressus glabra* Sudw.]

Cupressaceae – Neophyte – Northern America – Scapose phanerophyte

First record for Calabria (casual)

Specimina: 17th September 2021, Tangenziale road close to Parco della Biodiversità Mediterranea, Catanzaro, grassland along the roadside, 38.916915°N-16.579657°E, 366 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 19th September 2021, Via Gioacchino da Fiore, Catanzaro, flowerbeds in the roundabout, 38.9050233°N-16.5803989°E, 300 m a.s.l., *leg.*

A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 3rd May 2023, entry road to “Ciaccio” Hospital, Catanzaro, on the edge of an abandoned olive grove, 38.924890°N-16.579331°E, 430 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. While only a few plants occur in the second and third recorded stand, small groups of young individuals have been found in the first stand. All the plants included in the three localities have been apparently originated by adult trees cultivated in the proximity and actively disseminating. *Hesperocyparis glabra*, long considered a *H. arizonica* taxon of subspecific or varietal rank [96, 97], according to different authors, has been reevaluated as an independent species on the basis of molecular survey [98]. Askew and Schoenike [99] and Little [100], as cited in Adams and Bartel [101], distinguished the two taxonomic entities on the base of bark texture (fibrous and not peeling = *H. arizonica*; smooth and peeling in thin plates or strips = *H. glabra*) and resin glands (on <5% of leaves = *H. arizonica*; on >5% of leaves = *H. glabra*). Moreover, in *H. glabra* cones are characterised by erect conic umbos up to 4 mm [102], and reddish bark exfoliates annually in curls [36]. At the moment the surveyed taxon behaves as a casual neophyte in the investigated area.

***Ligustrum ovalifolium* Hassk.**

Oleaceae – Neophyte – Japan – Caespitose phanerophyte

First record for Calabria (casual)

Specimen: 25th April 2023, green area in front of Mater Domini church, Catanzaro, storm drain, 38.916769°N-16.568004°E, 375 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. A few individuals have been found in a storm drain along with *Rhaphiolepis bibas* (Lour.) Galasso & Banfi and *Adiantum capillus-veneris* L., a few metres from the supposed mother plants. Specimens have been identified according to Iwatsuki *et al.* [40] and Pignatti [36]. This taxon, native to Japan and widely used as ornamental [35, 103], is considered invasive [35], also because seeds, similarly to other species belonging to the same genus, are probably successfully dispersed by wind (once fallen on the ground) or animals (birds, ants) [104, 105].

***Mahonia aquifolium* (Pursh) Nutt. [≡ *Berberis aquifolium* Pursh]**

Berberidaceae – Neophyte – Northern America – Caespitose phanerophyte

First record for Calabria (casual)

Specimen: 20th April 2021, Parco della Biodiversità Mediterranea along the trail beneath “Ciaccio” Hospital, Catanzaro, slope in the oakwood, 38.924651°N-16.577442°E, 418 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. The group of observed plants, some of which flowering and fruiting, have been probably originated by plants cultivated about 200 m away from the new spontaneous stand. Seeds from cultivated individuals probably have been dispersed by birds or mammals. *Mahonia aquifolium* is native to the North-Western Pacific Coast between British Columbia and Northern California and it is often planted as ornamental [106]. It is considered an invasive species in several European countries [107] such as Belgium [108], Germany [109] and Slovakia [110], where it can participate to different habitats. In Italy this species has been recorded as casual or naturalised alien across almost all regions [86, 73, 111, 112], but lacking in Southern Italy except of Puglia [113].

***Morus indica* L.**

Moraceae – Neophyte – Eastern Asia – Scapose phanerophyte

First record for Calabria (casual)

Specimina: 26th May 2021, Copanello Lido, Stalettì (Catanzaro province), uncultivated flowerbed close to the beach, 38.767310°N-16.567272°E, 3 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 6th June 2022, Viale Pio X at the north entrance of Parco della Biodiversità Mediterranea, Catanzaro, at the base of the fencing wall, 38.9254408°N-16.5813414°E, 425 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 6th June 2022, entry road to “Ciaccio” Hospital, Catanzaro, uncultivated area beneath some trees, 38.9257366°N-16.5810081°E, 426 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso; 22nd September 2022, Viale Pio X, Catanzaro, roadside, 38.9267659°N-16.5806225°E, 430 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. Just a few individuals belonging to this taxon have been found in each stand. All surveyed stands have been apparently originated by seeds coming from trees cultivated in nearby gardens. It could be speculated that zoochory (birds, mammals), anemochory (wind) and anthropochory (human beings) directly contribute to the dissemination of seeds when these are still on the mother plant or even once fallen from it. Native to Eastern and South-Eastern Asia [114, 40], in Italy *M. indica* is grown for ornamental purposes and it has been increasingly reported as an escaped species in anthropized and semi-natural habitats [115, 116, 117].

***Oenothera speciosa* Nutt.** [= *Hartmannia speciosa* (Nutt.) Small]

Onagraceae – Neophyte – United States, Mexico – Scapose hemicryptophyte

First record for Calabria (casual)

Specimen: 25th May 2023, Via Nicola Calipari, Catanzaro, uncultivated area, 38.910056°N-16.567097°E, 312 m a.s.l., *leg.* A. Scarpino, A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. *Oenothera speciosa* is usually found, also inside its native range, in grasslands, disturbed places, pastures and roadsides, where it can form extensive clonal populations and spread aggressively by vegetative reproduction [118, 119]. In France, Bulgaria, Iraq and Italy it has been reported that the flowers of this species can represent a threat for native moths, since they can be trapped with their proboscis into hypanthium and die or being seriously damaged within a few time [120]. In the surveyed location a small population has been found: seeds or parts of plants could have been dispersed from nearby gardens or through nursery substrates as abandoned wastes.

***Prunus serotina* Ehrh.**

Rosaceae – Neophyte – Northern America – Scapose phanerophyte

First record for Calabria (casual)

Specimina: 3rd September 2022, Locality Castagna, Santa Maria di Corazzo Abbey, Carlopoli (Catanzaro Province), amongst the abbey ruins, in nearby fields and along the roadside, 39.062009°N-16.422812°E, 725 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. Dozens of small individuals have been observed, supposedly originated by two mature trees planted on the left side of the Corazzo Abbey as ornamentals. Most of them are juvenile individuals (20-50 cm tall), but a few plants reach a height of about 2.5 m. However, just a few individuals showed fruitification. *Prunus serotina*, one of the worst invasive species in Europe, has been imported from Northern America to Italy in 1922 for forestry and ornamental purposes [121]. It is an aggressive, fast-developing invader of forests and open habitats. It can tolerate different ecological conditions, like poor and dry soil, drought and frost [122]. A single plant can produce up to 6,000 fruits [123], most of which fall in the vicinity of the mother plant, or are dispersed on long distances by birds and mammals [123-126]. Seedlings are shade tolerant and plants often grow in the understorey and in the shrub layer [122, 126]. In Italy *P. serotina* has been proposed in the national list of

Priority Invasive Alien Species [127]. Rapid eradication of this species is highly recommended, in order to prevent a future colonization of the nearby riparian forests.

***Pyracantha fortuneana* (Maximowicz) H. L. Li**

Rosaceae – Neophyte – Southern-Eastern Asia – Caespitose phanerophyte

First record for Calabria (casual)

Specimen: 17th November 2021, Parco della Biodiversità Mediterranea, along the Rizzitano Trail, at the Fiumarella stables, Catanzaro, slope on the edge of the trail, 38.918091°N- 16.576517°E, 267 m, *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. This species is cultivated both in upper and lower areas of the Park. Seeds could have been probably dispersed by birds or mammals. Despite the most recent checklist of the Italian flora [25] considers *P. fortuneana* a synonym of *Pyracantha crenatoserrata* (Hance) Rehder, here is applied the nomenclature proposed by Lance and Zika [128] and Tsue-Chih and Spongberg [129], according to the morphological features of the specimens collected and the dichotomous key provided by these works. Taxonomic distinctions in this genus are still problematic, also because of several cultivars and garden hybrids, and it is even uncertain if *P. fortuneana* should be attributed to *Photinia* genus [130-133]. Firethorns are very popular in private and public gardens, mostly because of their rich blooming, the abundant production of red fruits and rapid development very useful in creating dense and impenetrable hedges.

***Rudbeckia laciniata* L.**

Asteraceae – Neophyte – Northern America – Bulbose geophyte

First record for Calabria (casual)

Specimen: 3rd September 2022, Caporosa, along the provincial road SP 216, Aprigliano (Cosenza province), on the edge of a cultivated field, 39.200609°N-16.565366°E, 1,286 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. A small group of blooming plants has been observed along the roadside, on the edge of a cultivated field. Seeds or parts of rhizomes could have been accidentally dispersed from nearby gardens. *Rudbeckia laciniata* is considered a noxious weed because of its strong root system, difficult to be eradicated [134, 56]. Moreover, seed bank can persist on the soil for a long time, disturbing native

meadow communities [135]. Different cultivars of this species (e.g. Golden-Glow) are frequently grown as ornamentals in Europe, and can occasionally escape from cultivation [136].

***Solanum nitidibaccatum* Bitter** [= *Solanum physalifolium* Rusby var. *nitidibaccatum* (Bitter) Edmonds]

Solanaceae – Neophyte – Southern America – Scapose therophyte

First record for Calabria (casual)

Specimen: 3rd September 2022, Savuto dam, Parenti (Cosenza province), along the road at the margin of a *Pinus nigra* subsp. *laricio* forest, 39.177969°N-16.492448°E, 1,175 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. *Solanum nitidibaccatum* has a complex taxonomic history, since it was treated both as species or subspecies by different authors. In Italy it was first recorded as *S. physalifolium* Rusby in Veneto, Trentino-Alto Adige and Friuli-Venezia Giulia [25]. Later, Särkinen *et al.* [137] clarified its status excluding *S. physalifolium* from European flora. *Solanum nitidibaccatum*, occurring in several European countries, is considered a weed linked to agricultural activities and disturbed sites. Moreover, a sterile hybrid between *S. nitidibaccatum* and *S. nigrum* has been also reported (*S. ×procurrens* A.C.Leslie) where both species grow together [138, 139]. In this Calabrian stand *S. nitidibaccatum* has been found close to potato fields, along with ruderal species such as *Papaver rhoeas* L., *Veronica persica* Poir., *Erigeron canadensis* L., *Echinochloa crus-galli* (L.) P.Beauv. and *Solanum nigrum* L. This species is showing an increasingly expansion of its range in Italy, since it has been recently reported for Lombardia [140].

***Sparaxis bulbifera* (L.) Ker Gawl.** [= *Ixia bulbifera* L.]

Iridaceae – Neophyte – South Africa – Bulbous geophyte

First record for Calabria (casual)

Specimen: 18th April 2023, Mater Domini close Via Michele Torcia, Catanzaro, on the edge of an uncultivated field and by a construction site, 38.912362°N-16.567020°E, 322 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. The genus *Sparaxis* Ker Gawl. is endemic to the western Cape Province of South Africa and comprises 16 species [141], some of which are cultivated as ornamentals outside of their native range, especially in Mediterranean climate countries e.g. California, Tunisia and Australia, where they have

been found in the wild as garden escapes [142-144]. In Italy the genus is represented by two species: *S. bulbifera*, which has been recorded only in Apulia [25], and *Sparaxis tricolor* (Schneev.) Ker Gawl., found in Sardinia [145]. Our finding represents the second record for Italy of this species and the third for the entire genus. The Calabrian stand here reported hosts a few plants (identified according to [146, 147, 141]) actively reproducing sexually (flowers and fruits) and vegetatively (bulbils). They have been found in a mixed native-alien plant community along with *Trifolium repens* L., *Medicago polymorpha* L., *Lotus ornithopodioides* L., *Vicia bithynica* L., *Dittrichia viscosa* (L.) Greuter subsp. *viscosa*, *Sonchus oleraceus* L., *Urospermum picroides* (L.) Scop. ex F.W.Schmidt, *Tordylium apulum* L., and several other species. Seeds or corms have been probably dispersed from the surrounding gardens or through soil.

***Tradescantia cerinthoides* Kunth**

Commelinaceae – Neophyte – Southern America – Rhizomatous geophyte

First record for Calabria (casual)

Specimen: 23rd September 2022, Via Francesco Burza, Catanzaro downtown, roadside, 38.9065167°N-16.5898855°E, 325 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. *Tradescantia cerinthoides*, a taxon native to Argentina, Brazil and Uruguay, is widely grown as ornamental and occasionally escaped from cultivation [148], although its invasive potential is still unknown [149]. In Italy this species has been recorded for Trentino-Alto Adige [150], Emilia Romagna [151] and Tuscany [25]. A few specimens have been found in this Calabrian stand along with ruderal species such as *Dittrichia viscosa* (L.) Greuter subsp. *viscosa*, *Parietaria judaica* L., *Poa annua* L., *Sonchus oleraceus* L., *Symphytotrichum squamatum* (Spreng.) G.L. Nesom, *Trachelium caeruleum* L. subsp. *caeruleum*.

***Ulmus pumila* L.**

Ulmaceae – Neophyte – Central and Eastern Asia – Scapose phanerophyte

First record for Calabria (casual)

Specimen: 30th December 2021, Locality Calalunga-Pietragrande, Montauro (Catanzaro province), water drainage channel, 38.743250°N-16.552661°E, 26 m a.s.l., *leg.* A. Capuano (REGGIO, Herbarium Capuano), *det.* A. Capuano, G. Caruso.

Note. A small group of young individuals (not taller than 3 metres) has been found along with other non-native species such as *Eucalyptus camaldulensis* Dehnh. subsp. *camaldulensis*, *Ricinus communis* L., *Washingtonia* sp., *Sorghum halepense* (L.) Pers., probably originated by close mature plants, several of which have been planted at the roadside in a residential area. *Ulmus pumila* is native to the semi-arid regions of Mongolia, China, Siberia and Korea, where it grows in dry grasslands, slopes and temporary river [152]. This species has been largely used for its resistance to drought and Dutch elm disease (*Ophiostoma ulmi* Nannf., Ophiostomataceae) in Europe and America, where it is now considered an invasive species [153]. It has been also reported that *U. pumila* can generate fertile offsprings by hybridizing with native elms [154, 155]. This species is similar to the native *U. minor*, from which differs from symmetrical leaf base, distichous and regular leaf arrangement in young shoots, leaves decreasing in size towards the apex of the branch and absence of suberification on young branches [156].

Appendix B – Photographic repertory.



Photo 1 - Young specimen of *Acacia melanoxylon*.



Photo 2 - Detail of *Acacia melanoxylon* fruits.



Photo 3 - *Bidens subalternans* stand amongst railway enclosures of Gagliano station, Catanzaro.



Photo 4 - *Bidens subalternans* achenes.



Photo 5 - *Buddleja davidii* growing along the road near to Racise, Taverna (CZ).



Photo 6 - *Cucurbita moschata* developing on native shrubs.



Photo 7 - Detail of *Cucurbita moschata* fruit.



Photo 8 - Fruits of *Cyclospermum leptophyllum*.



Photo 9 - Detail of flowering stem of *Erigeron annuus* subsp. *annuus*.



Photo 10 – Plants of *Hesperocyparis glabra* close to Parco della Biodiversità Mediterranea, Catanzaro.



Photo 11 – Details of resin glands of *Hesperocyparis glabra*.



Photo 12 – Cones of *Hesperocyparis glabra*.



Photo 13 - *Ligustrum ovalifolium* growing in a storm drain.



Photo 14 - *Mahonia aquifolium* in Parco della Biodiversità Mediterranea, Catanzaro.



Photo 15 - *Morus indica* along Viale Pio X, Catanzaro



Photo 16 - *Oenothera speciosa* flowers.

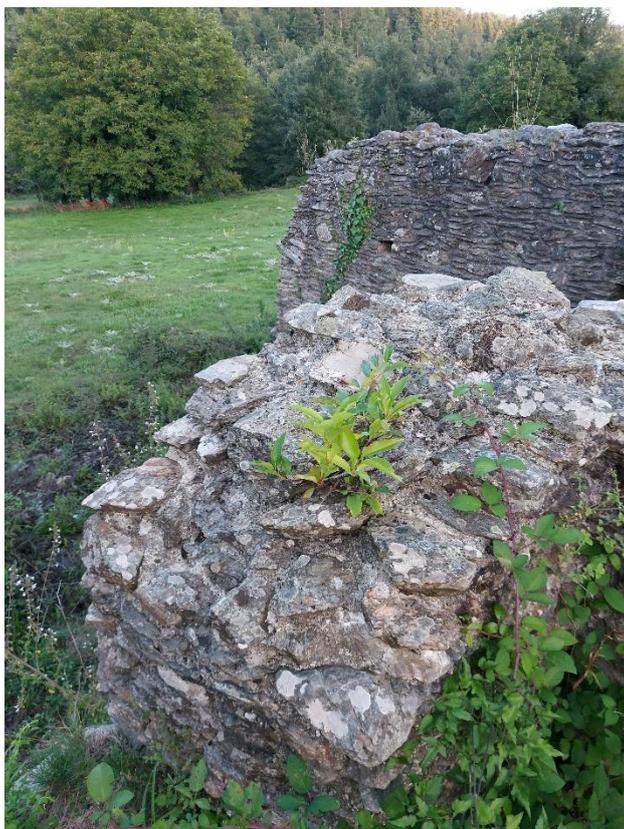


Photo 17 - *Prunus serotina* growing on the ruins of Corazzo Abbey, Carlopoli, Catanzaro.



Photo 18 - *Prunus serotina*, leaves and fruits.



Photo 19 - *Pyracantha fortuneana* along the Rizzitano Trail, Catanzaro.



Photo 20 - *Rudbeckia laciniata* flowers.



Photo 21 - *Solanum nitidibaccatum* flowers.



Photo 22 - *Solanum nitidibaccatum* fruits.



Photo 23 - *Sparaxis bulbifera* flowers.



Photo 24 - *Tradescantia cerinthoides* flowers.



Photo 25 - Leaves and branches of *Ulmus pumila*.

Photo 26 - *Ulmus pumila* fruits.