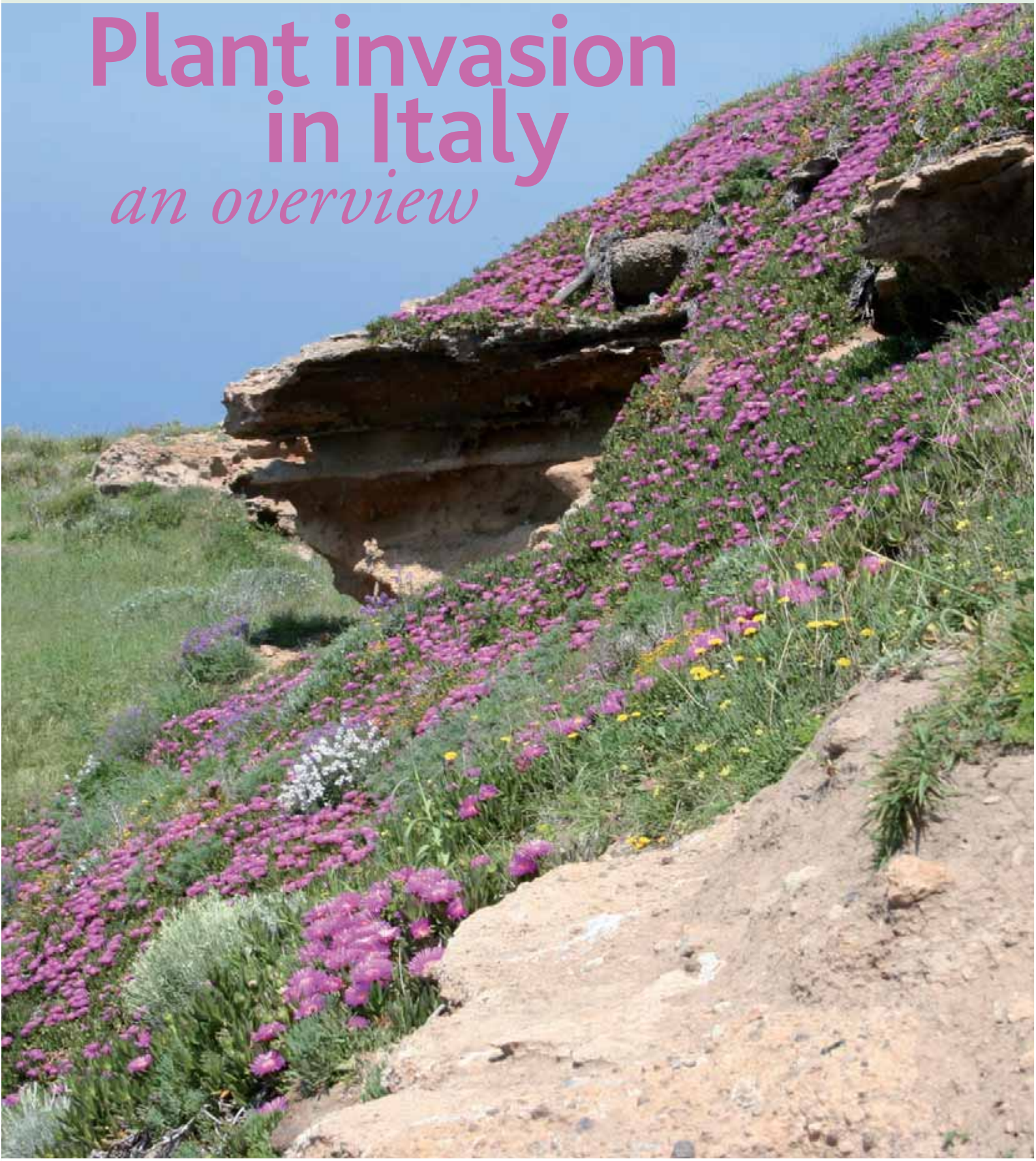
A thematic contribution to the

National Biodiversity Strategy

Plant invasion in Italy

an overview



Ministero dell'Ambiente e della Tutela del Territorio e del Mare

Centro di Ricerca Interuniversitario Biodiversità Fitosociologia ed Ecologia del Paesaggio

Sapienza Università di Roma

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Plant invasion in Italy *an overview*

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Carporbotus acinaciformis. PHOTO: E. Carli

Attached CD-ROM: Non-native flora of Italy

The *project* on the non-native flora of Italy

The uncontrolled spread of species from other geographical areas, introduced either intentionally or accidentally by man, is considered to pose one of the most serious threats to the conservation of biodiversity on a global scale, and has significant socio-economic and health repercussions. Inventories of non-native species compiled on a national scale thus represent a fundamental scientific tool for the correct management of invasions of such species.

The project "A survey of the non-native flora of Italy", promoted by the Nature Protection Directorate in collaboration with the "Biodiversity, Plant sociology and Landscape ecology" Inter-university Centre of the 'Sapienza' University of Rome, and completed in two phases between 2005 and 2008, was aimed at gathering, using a standardized system, information on the non-native vascular flora growing spontaneously in Italy and at identifying, among the high number of plant species present, the few that may, owing to their invasiveness or negative impact potential, pose a threat to the environment, human health or economy.

The overall situation in Italy is not particularly critical insofar as our country is characterised by a marked environmental heterogeneity and by a relatively high state of conservation, both of which tend to hamper major invasive events. Nevertheless, there are some seriously critical situations, and in general the phenomenon of plant invasion has progressed quickly recently; the natural systems, weakened most by the leading anthropic transformations within the environment, might no longer be able to endure the impact of man-made changes induced at ever-increasing speed and intensity such as the introduction of new species.

A database that may be used in a national strategy aimed at preventing the spread of harmful invasive species was prepared for each administrative region. A nationwide network of experts, set up to collect the data, identified 1,023 species. Among them 163 species are considered invasive, i.e. capable of spreading fast, and 203 species have been reported to exert some kind of negative impact in Italy, on the environment, human health or the economy. Invasive species that have an ecological impact were analysed in more detail.

Although invasive plants are concentrated above all in areas of intense human activity, such as man-made and agricultural areas, there are several natural environmental contexts in which the introduction of invasive species can pose a threat to the conservation of biodiversity and to ecosystem health e.g. wetlands, riparian areas, hygrophilous woods and coastal areas.

The attached CD containing the database testifies to the extraordinary knowledge available on a regional scale. This wealth of information is obviously essential for the definition of national strategies and action plans aimed at counteracting the spread of particularly invasive plant species.

In the near future, the Ministry plans to make the most of the work carried out so far by implementing a plan aimed at carefully monitoring the spread of those species that pose the greatest risk to human health, the environment and agriculture.

Stefania Prestigiacomo
Minister of Environment, Land and Sea Protection

Senecio inaequidens.
Photo P. Ferrari

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Biological invasion: *pet to pest* in three generations

Biotic invasions are becoming an increasingly widespread problem that affects species belonging to all the main taxonomic groups as well as all types of habitat, whether aquatic or terrestrial, natural or artificial. In his travels to new lands, man has always taken a large number of species, both intentionally, to surround himself with organisms he was used to in his homeland, such as domesticated animals and crop plants, and accidentally, such as most weeds, pathogens and parasites. Once they reached the new land, however, only a small proportion of these species reproduced spontaneously and spread in the wild, becoming totally independent of man.

As regards plants, species that escape from cultivation remain in the vicinity of the sources of seeds, e.g. in parks and gardens, not growing beyond the seedling state in most cases; in some cases, they reproduce for a few generations, without forming established populations. Very few of the introduced species do establish, and hence become part of the local flora. If the naturalization process were to stop at this point, it would enrich the local flora through the addition of a group of new species. In what is usually a very small proportion of species, this process instead leads to the alarming, uncontrolled spread already observed by Darwin, and later described by Elton (1958) in the first book dedicated to biotic invasions, causing the well-known phenomena of loss of biodiversity and "globalization" of the earth biota, as well as serious economic damage and threats to human health. The reason for why some species become invasive pests has, in recent years, become the object of intense research, with many hypotheses being proposed. Although multiple factors are involved in most cases and the history of each invasion is different from that of others, some features are common to all events leading to the invasion of a species, such as man's responsibility in transporting them beyond major natural biogeographical barriers (e.g. oceans), and in making the recipient habitat more vulnerable.

Xanthium orientale subsp. *italicum* and *Cycloloma atriplicifolium* on sandy soil in the bed of the Po river. Photo L. Gariboldi

Short history of *plant introduction* in Italy

In the Mediterranean Basin, human-mediated dispersal, resulting in plants being transported much further than they would have been by natural means (e.g. by wind), was already very intense in ancient times. One such example are the great civilizations that promoted intense maritime trade all along the Mediterranean coasts. From as far back as the 10th century BC, first the Phoenicians, then the Greeks, established cities and colonies long distances from their homeland, with which they maintained constant exchanges. Subsequently, the Romans, with their expansive culture and the building of a network of roads that paved the way for the dispersal of plants via land, became chiefly responsible for the spread of species in extensive areas of Europe, North Africa and Western Asia. The appearance of "exotic" plant species has always aroused considerable interest in Italy. After the importation phase into the colonies of Magna Graecia spread along the coasts of Southern Italy, the Etruscans are also believed to have contributed to the introduction of several useful species from the Eastern Mediterranean, and subsequently to their dispersal in the central area of the Peninsula. It was, however, in Roman times that a real explosion in the importation of non-native species occurred. The Roman Imperial era witnessed a passion for exotic plants, expressed mainly in gardens, where new species from the coasts of Africa and Asia, such as palms, were used to embellish the patrician villas, or to enrich the banquets and impress the guests with unusual dishes at mealtime. In Medieval times, the monks used the new plants for their healing properties, recording them in precious illustrated miniatures, and cultivating them in the medicinal herb gardens, which subsequently evolved into the famous botanical gardens in Renaissance Italy. The Botanical Garden of Padua for instance, founded in 1545 for medicinal purposes, became an important centre for the importation and exchange of seeds and plants from throughout the world; indeed, many species were introduced for the first time in Italy, or even in Europe, in this garden. Other information has been passed down to us thanks to the art of herbarium-making, whose birth is attributed to the

Ricinus communis, an archaeophyte introduced in Roman times. Photo F. Pretto

This picture taken in 1899 documents the first record of giant hogweed (*Heracleum mantegazzianum*) in Italy. Standing under the large umbels is Emil Levier, the Swiss doctor who brought seeds of this plant back from a botanical trip to the Caucasus mountains he had undertaken with Stephan Sommier in 1890. They described the plant upon their return to Florence, dedicating it to their friend Paolo Mantegazza. They subsequently donated the giant hogweed's seeds to several botanical gardens, but it soon escaped from cultivation and is now one of the major invasive species in Europe.

Italian botanist Luca Ghini, and which had spread all over Europe by the mid 16th century.

Jutting out as it does into the centre of the Mediterranean, from the Alps down towards the coasts of Africa, Italy has always been exposed to a considerable exchange of biota, and has always integrated a large proportion of these new species into the local culture, using them for a wide range of purposes (e.g. food, ornamental, healing, forestry, windbreaker, to consolidate road embankments, to build utensils), many becoming so integrated as to form part of the country's tradition (tomato), or to be adopted as the symbol of a region or a local landscape, such as the cypress in Tuscany, and prickly pears, which now invariably appear on postcards from Sicily.

Until some decades ago, the situation regarding plant invasions in Italy was not particularly critical on account of several factors that limited, particularly in natural habitats, the large monospecific invasions that have occurred elsewhere in the world. These factors include: the great environmental heterogeneity; the varied orography of the territory, most of which is covered by mountains or hills; the presence of extensive areas at high altitude in the two main mountain chains, i.e. the Alps, which span Italy's northern border, and the Apennines, that run south along the entire length of the peninsula; the persistence of traditional forms of agriculture and grazing; the historical exposure of resident species to other biota (Rejmánek *et al.* 2005); lastly, the long-lasting association with humans, which means numerous species of the local Mediterranean flora are well adapted to human disturbance and easily thrive in man-made habitats.

However, an awareness of the damage invasive species can inflict upon the natural habitat, as well as on agriculture and human health, has grown following the development of intensive agriculture, industrialization and urbanization, particularly in the Po Plain in northern Italy, and of increasingly extensive trade and travel; indeed, in as far back as 1905 the botanist Saccardo observed that some exotic plants, such as *Erigeron canadensis,* were rapidly becoming "the worst invasive weeds in Italy".

This phenomenon has progressed far more quickly recently, particularly since the 1950s following an increase in the rate of introduction of new species, changes in land use throughout Italy, and synergy with other drivers of global change. The increased pollinosis induced by *Ambrosia artemisiifolia*, the growing size of monospecific populations of species belonging to the genera *Reynoutria* in riparian habitats and *Carpobrotus* in the fragile island ecosystems, are only some examples indicating that the situation has changed. Indeed, these findings suggest that the natural systems, weakened most by the leading anthropic transformations within the environment, might no longer be able to endure the impact of man-made changes induced at ever-increasing speed and intensity, and that one such impact, which has worldwide repercussions, is the spread of invasive species.

Nelumbo nucifera, an ornamental plant, has become invasive in freshwater habitats. Photo E. Carli

The *project* on the non-native flora of Italy

It is this context that led to the research project "A survey of the non-native flora of Italy", developed in the years 2005-2008 and promoted by the Nature Protection Directorate of the Italian Ministry for the Environment, Land and Sea Protection. The main aim of the project was to provide an overall picture of the non-native vascular flora in Italy and to identify, among the high number of species present, the few that may, owing to their invasiveness or negative impact potential, pose a threat to the environment, human health or economy. The wealth of information obtained from the vast, historical Italian botanical tradition, which proved to be dispersed in innumerable sources in the specialised literature, in museums and herbaria, was gathered using a standardized approach by a nationwide network of botanists. The data were then inserted into an integrated regional and national database, which thus constitutes the state of the art on the non-native vascular flora of Italy and provides the scientific basis for the development of plant invasion research and management in the country.
While more detailed information can be found in the literature (e.g. Celesti-Grapow *et al*. 2009a,b,c), in this work (booklet and CD-ROM) we present a synthetic overview of the main results on the composition, structure, distribution and impact of the non-native flora of Italy, as well as some information on the species recorded.

Solidago gigantea. Like the congeneric *S. canadensis*, it is widespread throughout northern Italy. Photo P. Ferrari

The *non-native flora* of Italy

Species diversity and structure

The non-native vascular flora of Italy numbers 1,023 entities, including species and subspecies and thus accounts for 13.4% of all the Italian flora, which currently comprises approximately 7,600 entities. This richness of the non-native flora may be ascribed to the marked geographic heterogeneity within the country; there are, besides species widely found throughout Italy, consisting largely of urban and agricultural weeds, many other species that are found in only one sector of the country, with 205 species being present exclusively in the Mediterranean region, which follows all the coastline and covers southern Italy and the islands, 193 in the Continental region, which covers northern Italy and runs down the Apennines, while a further 57 are limited to the Alps.

Ancient and recent introductions

The non-native flora of Italy is composed of 103 archaeophytes and 920 neophytes. Archaeophytes are plant species that were introduced very early on, i.e. before the discovery of America by European colonizers. They consist above all of agricultural weeds in the oldest crops, such as cereals, which are nowadays widespread. Archaeophytes, with the exception of agricultural weeds, are not usually included in lists of species that need to be kept under control; moreover, following the introduction of new agricultural techniques, several archaeophytes that are associated with traditional agricultural techniques are already in decline.

Neophytes are species that have been introduced since the discovery of America. Although the distinction between archaeophytes and neophytes in the literature is often made by rounding the year off to 1500, important plants had already been introduced in Europe by Columbus when he returned from his first voyage in 1493, e.g. corn (*Zea mays*), whose presence in Italy is documented from 1495. The first spontaneously-growing neophyte reported in Italy is *Amaranthus retroflexus*. A dried sample of this species, conserved in the Biblioteca Angelica in Rome, Gherardo Cibo's herbarium, testifies to the fact that this annual herb already grew spontaneously in 1532; owing to the speed at which it spreads, it has since become one of the most harmful agricultural weeds in Italy.

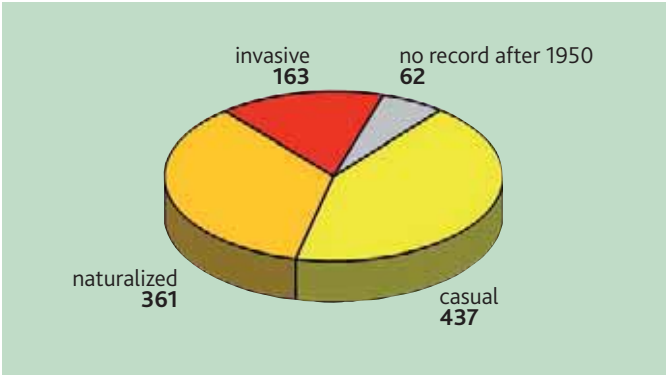
The spontaneous spreading of several other neophytes, such as *Impatiens parviflora*, is documented from the mid 16th century in numerous sources. Nowadays, while archaeophytes are found prevalently in agricultural systems, neophytes are mostly typical of urban and industrial areas, wasteland, and along railways and road verges.

A dried specimen of *Amaranthus retroflexus* (photo) in Cibo's ancient herbarium (1532) is the first record of a spontaneously-growing neophyte in Italy. Photo D. Bouvet

The archaeophyte *Abutilon theophrasti* is a widespread agricultural weed. Photo L. Ghillani

Impatiens parviflora. Photo P. Ferrari

Bletilla striata is the only representative of the orchid family in the non-native flora of Italy. Photo A. Alessandrini



Casual, naturalized, invasive species

Casuals (i.e. non-established species, see page 10 for definitions) currently make up the most numerous group in the non-native flora of Italy. They consist prevalently of ornamental or edible species that have escaped from cultivation and grow in areas close to parental plants.

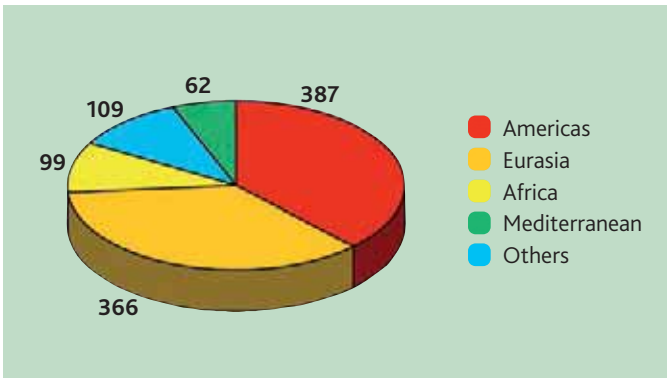
As many as 524 species have become established entities in the Italian flora. They include 163 invasive taxa (i.e. taxa that spread very rapidly, even long distances from where they were originally introduced; see page 10 for definitions), and thus account for approximately 16% of the overall non-native flora. It should be borne in mind that not all the invasive species are spread throughout the country; indeed, some are confined to a very small area. Twelve invasive taxa are currently restricted to a small number of sites and are referred to as local invasive. Monitoring of these species is particularly relevant for management purposes, as some are renowned major invaders elsewhere and might be in the initial stages of a potentially harmful invasion process.

Polanisia trachysperma is naturalized in riparian habitats. Photo P. Ferrari

Polanisia trachysperma. Photo P. Ferrari

Where have they come from?

The majority of the non-native species have been introduced into Italy from the Americas and Eurasia, followed by species of African origin and those that have been introduced from other regions in the Mediterranean Basin. The provenance of the remaining species varies considerably, ranging from tropical areas to Australasia, though the native range of many species introduced in ancient times could not be defined. A group of 19 entities, which includes major invaders such as species of the genera *Reynoutria* and *Oenothera*, results from hybridization.



Apios americana, a species from North America that grows in riparian habitats. Photo M. Adorni

Sicyos angulatus, a climber that spreads above all in riparian habitats. Photo A. Alessandrini

Definitions of terms used in the project

In the project "A survey of the non-native flora of Italy", we adopted the terminology proposed by Richardson *et al.* (2000) and elaborated by Pyšek *et al.* (2004); the following definitions have been modified from Celesti-Grapow *et al.* (2009b).

Non-native plants - (synonyms: alien, introduced, non-indigenous, exotic) plant species whose presence is due to intentional or unintentional human involvement.

Not recorded since 1950 - plant species that lack recent records, i.e. that have not been reported since the year 1950.

Casual plants - (synonym: not established) non-native plants that may flourish and even reproduce occasionally outside cultivation, but that eventually die out because they do not form self-replacing populations, and rely on repeated introductions for their persistence.

Naturalized plants - non-native plants that sustain self-replacing populations without the direct intervention of people.

Invasive plants - a subset of naturalized plants that produce reproductive offspring, often in very large numbers and at considerable distances from the parent plants, and thus have the potential to spread over a large area.

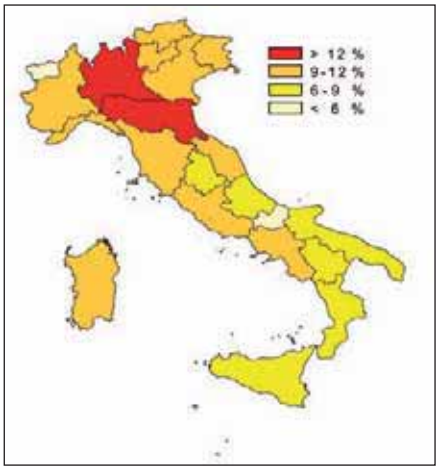
Local invasive plants - non-native plants that have been found to be invasive in only one or two locations.

Archaeophytes - non-native plant species introduced before the year 1492, i.e. before the discovery of America by European colonizers. This date is conventionally rounded off to 1500.

Neophytes - non-native plant species introduced after the year 1492. This date is conventionally rounded off to 1500.

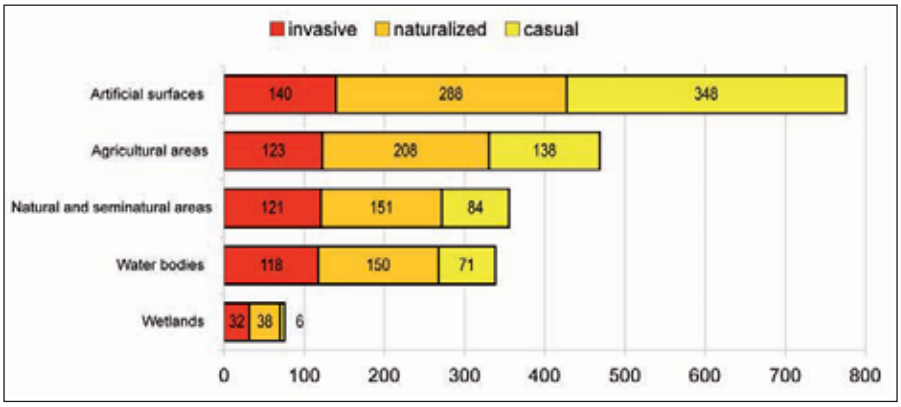
Artemisia verlotiorum. Photo M. Adorni

Species *distribution* across the country



The number and density (i.e. number of recorded species in relation to the area of the region) of non-native plant species, as well as the proportion of non-native species in the flora varies considerably from region to region and increases in relation to the size of the human population. The highest values are reported in the largest, most densely populated regions in northern Italy, such as Lombardy and Emilia-Romagna, which comprise a large part of the heavily cultivated and industrialized Po Plain. Smaller, less densely inhabited regions, by contrast, have the lowest values.

The number of non-native plant species is greatest in man-made habitats (e.g. urban and industrial areas, wasteland, along railways and road verges), with the majority of the non-native flora being confined to these markedly disturbed sites. By far the highest number of introduced species in any land use type is recorded in urban areas, followed by industrial sites and



Chamaesyce nutans spreads above all along railway tracks.
Photo A. Alessandrini

communication routes. The effect of human disturbance on non-native species and the concentration of such species in man-made habitats, particularly in urban habitats, are renowned patterns. Besides disturbance, intense propagule (i.e. seeds or vegetative parts capable of rooting) movement also contributes to the patterns we observed. Artificial habitats, particularly cities, act as centres in which non-native species are first introduced, whether deliberately or accidentally, and are further spread by man e.g. through planting, mainly for ornamental purposes, in parks and gardens. Indeed, the number of casual species in the flora is highest in regions such as Lombardy, Veneto, Tuscany, Liguria and Lazio, where large cities (respectively Milan, Venice, Florence, Genoa and Rome) are major tourist destinations in Italy, as well as centres of intense trade exchanges.

Communication routes, such as road and railway networks, also afford excellent opportunities for secondary dispersal of invasive species. Indeed, some species are known to have spread quickly and extensively along roadside verges: the rapid spread of *Senecio inaequidens*, along major Italian motorways, for instance, has been recorded since the 50s, while *Chamaesyce nutans* is known to typically spread along railways.

Top: Percentages of non-native species in the flora of each region

Bottom: Distribution and status of non-native species in 5 main land use types. (Some species are found in more than one type)

Although most non-native species are found in artificial and agricultural areas, as many as 461 species occur in terrestrial and freshwater natural or semi-natural habitats. If compared with artificial and agricultural sites, the non-native flora in natural habitats is numerically lower, but proportionally harbours more invasive than casual species. Freshwater habitats tend to be among those invaded most; although they do not usually contain as high a number of species as artificial or agricultural sites, their non-native flora generally harbours a high proportion of invasive species, some of which are widespread, while others are confined to smaller areas but sometimes display a high degree of aggressiveness, even within single locations. The twelve species described as local invasive include 6 aquatic plants that are worthy of mention: *Azolla filiculoides, Hydrocotyle ranunculoides, Lagarosiphon major, Ludwigia peploides* subsp. *montevidensis, Salvinia molesta* and *Spartina ×towsendii*. Although they are still highly localized, they are spreading rapidly, and may become major pests in the future.

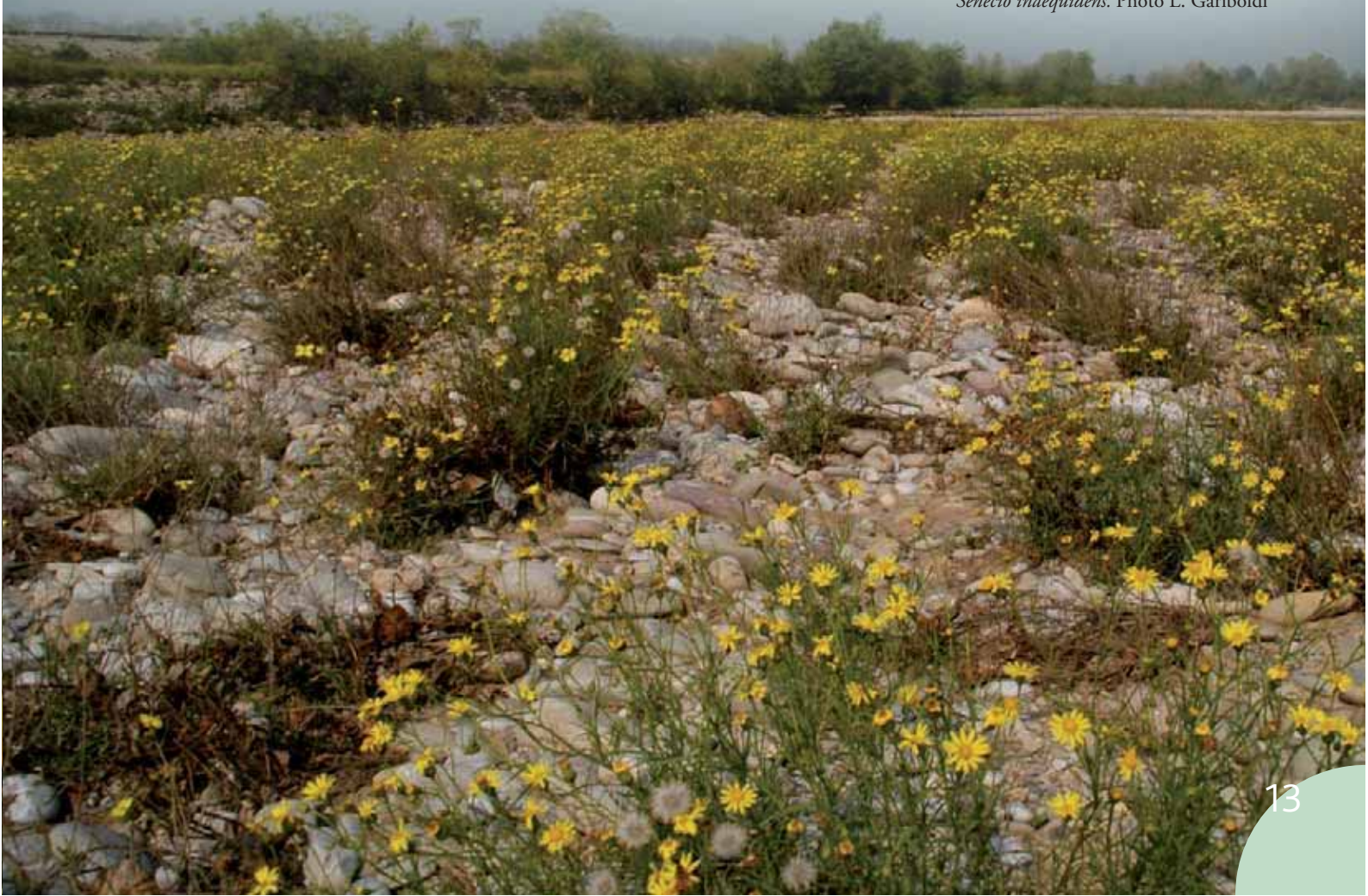
Hydrocotyle ranunculoides, a freshwater plant that is local invasive in Sardinia.
Photo G. Brundu

Helianthus tuberosus is a representative of the Asteraceae, the most numerous family (112 species) in the non-native flora of Italy.
Photo L. Ghillani

Lombardy, the Italian region invaded most

Gabriele Galasso & Enrico Banfi

Lombardy is the Italian region with the highest number of non-native species (545 out of a total of 3,220 spontaneous vascular plant species, but the number is growing) and of invasive species (84). This is due not only to the considerable size and heterogeneity of the territory, but also to agriculture, urbanization, industrialization, freight traffic and people flow, all of which are particularly intense in this region. The areas affected most by invasive species are: the Insubrian area, whose woods are invaded by evergreen species such as *Trachycarpus fortunei* and *Ligustrum lucidum;* the Po plain, which harbours many agricultural weeds and plants that modify the structure of residual woods, such as *Robinia pseudoacacia*, *Prunus serotina*, *Quercus rubra*, *Spiraea japonica*, *Parthenocissus quinquefolia* and *Vitis* sp.pl.; riparian habitats, where we find, among others, *Reynoutria* sp.pl., *Amorpha fruticosa*, *Humulus japonicus* and *Sicyos angulatus;* lastly, areas that are heavily urbanized or routes of communication and railways, which are almost always lined by *Erigeron canadensis*, *E. sumatrensis* and *Senecio inaequidens*. In the Alpine sector of the region, which is the least invaded area, worthy of note is *Elodea nuttallii*, which is one of the species that grows at highest altitudes (up to 1,890 m). The main threat to human health is posed by *Ambrosia artemisiifolia*, which is responsible for late-summer, autumn pollinosis, a constantly increasing phenomenon. The aim of the project "The non-native flora of Lombardy" ("La flora esotica lombarda") launched in 2008 by the Lombardy Region and the Natural History Museum of Milan, is to compile a database and botanical manual on the non-native flora of the region with the collaboration of numerous professional and keen amateur botanists.



Senecio inaequidens. Photo L. Gariboldi

Are the Alps really threatened by non-native plant invasion?

Elena Barni & Consolata Siniscalco

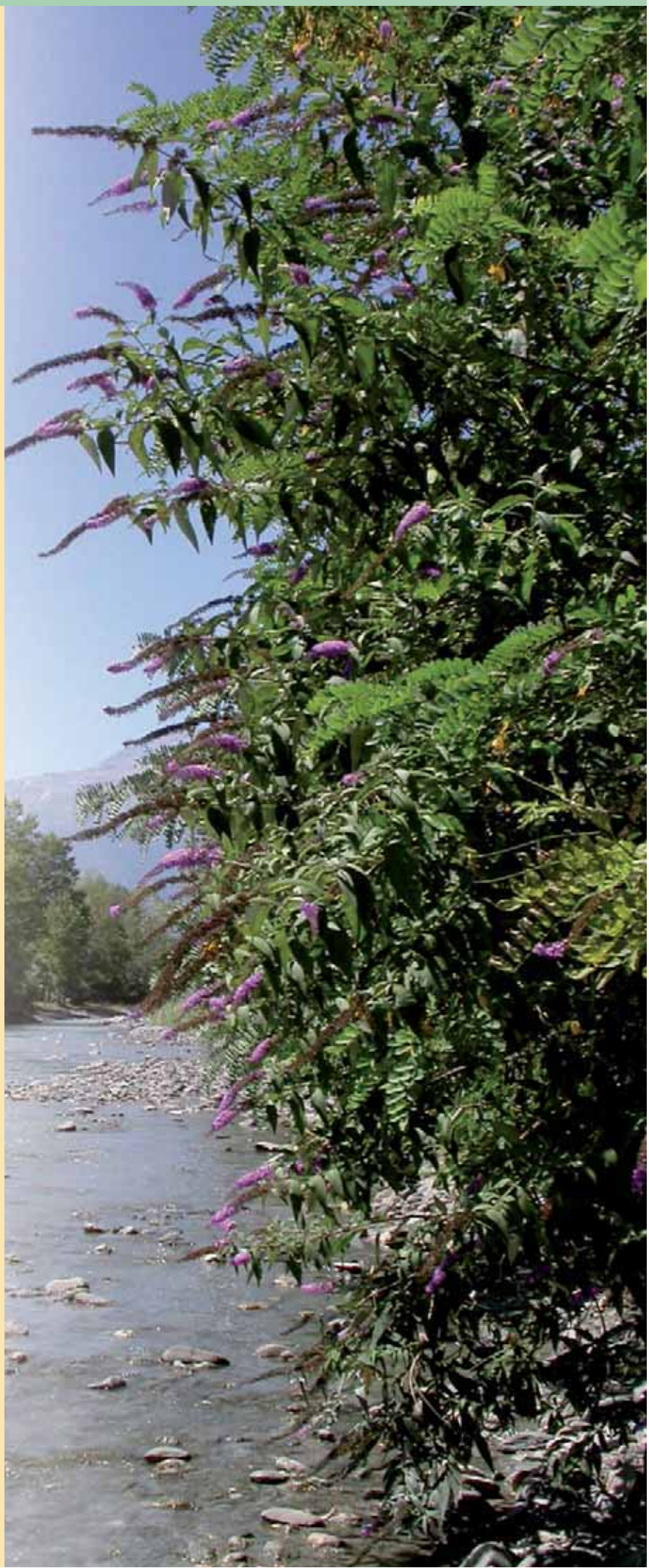
Mountain regions, widely recognized as important biodiversity hot spots with rich, distinct floras, are increasingly threatened by invasive non-native plants as a consequence of anthropogenic changes.

The Department of Plant Biology of the University of Turin conducted a study in the Western Italian Alps aimed at assessing the current distribution of non-native plants in the Alpine valleys in which man's presence is most marked, and to determine what elevation these plants reach. There is a significant degree of non-native plant invasion up to 400-500 m a.s.l., mainly along rivers and roads, which act as corridors for propagule dispersal. As the elevation gradient increases, there is an exponential decrease in non-native plant species richness, with a low presence of non-native species in areas above the timberline.

Three factors are believed to be the main drivers of this distribution pattern: harsh climatic conditions, decreasing anthropogenic disturbance and propagule pressure at increasing elevation. Consequently, higher mountain regions should, in theory, be less threatened by non-native plant invasions; there is, however, evidence, yielded by studies conducted in the Swiss Alps, that several species have spread higher in recent decades, probably as a result of global warming, the increasing use of land for tourism and rapid adaptive evolution.

The non-native flora recorded in the Italian Alps is composed mainly of invasive species that are widespread in the lowlands throughout Europe. The degree of pre-adaptation to mountain conditions of non-native species in their native range may determine their invasive capacity at higher elevations elsewhere. Consequently, some non-native plants, such as *Reynoutria japonica, Erigeron canadensis* and *Buddleja davidii*, are frequent at medium elevations (1,100-1,400 m), while a few species, such as *Impatiens glandulifera* and *Impatiens parviflora,* which are native to the Himalayas, tend to occur at higher elevations. Indeed, particular attention should be paid to the introduction of cold-adapted plants from other mountain systems.

The Italian Alps are thus threatened by non-native plants, though the invasion process is still in its early stages and appears to be proceeding relatively slowly, at least at higher elevation. This situation offers a unique opportunity to counteract the threat of invasion by taking preventive measures to conserve native biodiversity, avoiding the introduction of non-native species, controlling those that have been introduced deliberately (i.e. for cultivation purposes) or accidentally, and eradicating isolated populations as soon as they appear.



Buddleja davidii. Photo E. Barni

Solidago gigantea.
Photo L. Ghillani

Plant invasion in riparian habitats in northern Italy

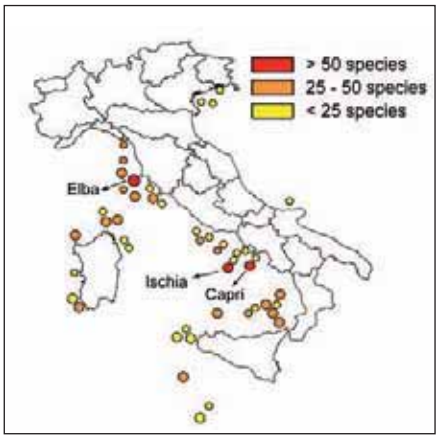
Silvia Assini, Francesco Bracco & Francesco Sartori

Riparian habitats, especially in northern Italy, are amongst those invaded most in the country. The vegetation in the upper courses of rivers is usually composed of well-preserved natural communities that prevent invasive plants from spreading, whereas the invasion process along medium-low courses is more active, particularly in the alluvial plains. The flora in the river beds in northern Italy is rather monotonous owing to the widespread presence of invasive species. The *Polygonum-Persicaria* communities in the Po Plain are often dominated by *Bidens frondosa* and *Xanthium orientale* subsp. *italicum*. Other invasive species include *Lindernia dubia*, *Erigeron canandensis*, *Humulus japonicus, Lepidium virginicum* and, locally, *Ambrosia artemisiifolia, Corispermum marschallii* and *Eragrostis pectinacea*.
The environmental conditions and state of conservation of riparian woods may influence the invasion of non-native species; a strong structure and considerable floristic variety can repel aggressive invasive species, confining them to the wood's edge. One such example is the oak-elm wood of the Bosco Siro Negri Natural Reserve, where *Robinia pseudoacacia* is now receding and no new non-native invasive species are growing. *Amorpha fruticosa* is the only invading species in willow woods (*Salix alba*) along the eastern Apennine tributaries characterized by drought conditions. A similar situation is observed in the willow-poplar woods (*Salix eleagnos-Populus nigra)* along the Piave river in the Venetian Plain. By contrast, in the eastern Po Plain, the herbaceous layer of high cover willow-poplar woods along the Brenta river is often invaded by several non-native species of the genus *Impatiens*. The presence of invasive plants in the weakly-structured, fragmented white willow woods of the central course of the Po is very high, the most aggressive species being *Sicyos angulatus, Solidago gigantea* and *Bidens frondosa*. As the white willow woods along the Ticino river and the western course of the Po river are more mature and their structure and composition stronger, the non-native species in this area are less invasive, the only exception being *Solidago gigantea.*

Bidens frondosa.
Photo P. Ferrari

Plant invasion on Italian *islands*

Island ecosystems, which tend to be generally simplified and to contain lower numbers of plant communities that have evolved in less competitive conditions than those found on the mainland they lie off, are particularly vulnerable to perturbances, including the impact of invasive species. Moreover, the flora and fauna on islands often include endemisms that have a high conservation value. On the islands in the Mediterranean Basin, non-native plants have accompanied the presence of humans for millennia and, since the mid 20th century, the invasion process has increased in parallel with the sudden marked changes in land use caused by the abandonment of traditional agricultural methods and the development of tourism. The latter, mainly concentrated during the summer months, has, by fostering the introduction of propagules, led to an increase in the number of non-native species.
In the project on the non-native flora of Italy, particular attention was paid to the distribution and invasive status of non-native plant species on the numerous small islands and archipelagos that surround Italy, so as to provide a general overview of the composition and structure of their non-native flora and to highlight the main threats.

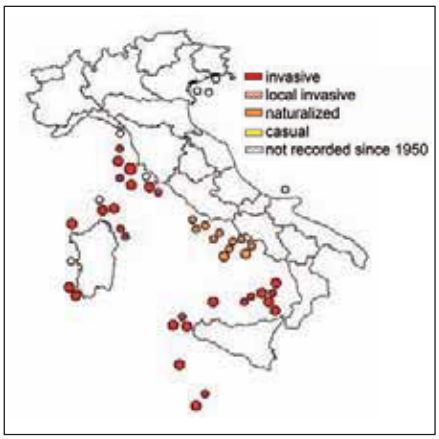


Number of non-native species in 47 small islands


The prickly pear cactus (*Opuntia ficus-indica*) in Sardinia. *Opuntia* is one of most numerous genera (19 species) in the non-native flora of Italy, largely because of its popularity among collectors of succulent plants. Photo G. Brundu


Opuntia engelmannii in Sicily. Photo G. Domina

Besides Sicily and Sardinia, which are the largest islands in the Mediterranean and are regions into themselves, the project recorded the distribution and status of the Italian flora in a significant sample of 47 smaller islands. The highest numbers of non-native species were recorded on Elba, Ischia and Capri, which are among the most densely populated of these 47 islands. The figure shows the distribution and invasion status of one of the most typical species found on these islands, *Opuntia ficus-indica,* more commonly known as the prickly pear cactus.



Opuntia ficus-indica in 47 small islands

Plant invasion along the Italian *coasts*

Number of non-native species in rocky or sandy shores

Opuntia ficus-indica and *O. dillenii* on the island of Capraia, Tuscan Archipelago. Photo B. Foggi

Carpobrotus acinaciformis along the coasts

Human action has deeply transformed the coastal landscape throughout Italy, and coastal habitats are currently among those threatened most by anthropogenic activities. Drainage of wetlands, e.g. in the Tuscan Maremma and the Pontina floodplain along the Tyrrhenian coast, changes in land use, the building of settlements and seaside facilities, as well as tourist activities, have wiped out most of the natural vegetation, changed the physical environment and promoted the spread of non-native invasive species. Indeed, invasive species have, in recent years, become the latest expression of human impact.

There are two main, quite distinct, types of coastal landscape in Italy: rocky coasts, which are unstable environments on account of the erosion processes they are subjected to by the sea, and sandy shores with dunes, which suffer the most serious human impact, such as urbanization and seaside tourism. The non-native flora found in these rocky and sand dune coastal habitats is currently composed of about 260 species (considering neophytes alone, i.e. plant species introduced after the year 1500). Of these, 54 are invasive, while a further 87 are naturalized species that do not display any invading tendency. The remaining species are generally ephemeral escapees from cultivations, particularly ornamentals, that do not establish in the local flora. The coastal areas that have been subjected most to invasion processes are located in the Italian regions that attract the highest number of tourists (e.g. Liguria, Tuscany, Emilia-Romagna, Calabria, Sicily and Sardinia).

The most striking feature of the Italian coastal non-native flora is the presence of a high number of succulent species. It may, indeed, be this particular trait (i.e. succulence), an adaptation of plants to resist drought not common in the native flora, that has allowed these species, which originate in the Americas and southern Africa, to establish so successfully in these new areas in Italy. They are cultivated extensively and are used locally for a wide range of purposes e.g. as ornamentals, as windbreakers, for soil stabilisation, for fencing, and as food (e.g. the edible fruits of the prickly pear).

Some of these succulent species have spread spontaneously from the sites in which they were first introduced, and are, in some cases, becoming a serious threat to the conservation of biodiversity in coastal habitats, on both a local and global scale, owing to the presence of rare and endemic taxa, particularly on small islands. Typical examples are the species belonging to the genera *Carpobrotus*, more commonly known as the Hottentot, and the prickly pear cactus *Opuntia*.

However, besides their ability to colonise rapidly and occupy space, and consequently compete for water and light, little else is known about the impact of these species, nor have detailed analyses and quantitative assessments been conducted to assess how seriously they threaten the habitat. Given the intensification of these phenomena in recent years and the high number of newcomers, a deeper insight into the ecology of invasive species and their distribution along the coasts is urgently needed, as are studies on their impact, to be able to plan appropriate management interventions and set priorities for control aimed at conserving biodiversity.

Agave americana, a succulent species, on the island of Ventotene, Pontine Archipelago. Photo E. Carli

Impacts and *threats*

The information available on the impact of non-native species collected during the Italian project proved that general knowledge is somewhat scarce and fragmentary, it being based in many cases on unverified observations. Indeed, experimental studies and further research aimed at verifying and evaluating the impact of all these species are urgently needed. On the basis of this survey, whose nature is merely preliminary, we found records of 203 species that have been reported to exert some kind of negative impact in Italy.

The tendency of non-native species to gravitate around human activities is also reflected in their impact: the majority of the species reported to have a negative impact are agricultural weeds, which cause problems such as production losses and higher production costs due to the use of herbicides. Several studies indicate that the incidence of non-native species among such weeds has increased in the last forty years.

Owing to the wealth of historical monuments and archaeological remains, a particularly relevant issue in Italy is the damage inflicted by invasive plants on the country's historical heritage. Although the number of non-native species was found to be particularly low in the flora of archaeological sites, some can be particularly detrimental owing to the mechanical and chemical damage caused by their roots. A few, fast-growing woody species, such as *Ailanthus altissima, Ligustrum lucidum* and *Acer negundo,* have recently spread extensively on important remains, mostly in central and southern Italy; the fact that these species are dispersed by either wind or birds means that their seeds are easily transported onto the tops of monuments; this renders any measures taken to control them (usually limited to mowing) particularly difficult and expensive.

A preliminary survey of the sources available found 42 species that have detrimental effects on human health, consisting above all of toxic or allergenic species.

Ailanthus altissima, whose roots inflict serious damage on man-made constructions. Photo J. Grapow

Datura stramonium, parts of the plant are toxic to humans and animals. Photo P. Ferrari

Datura stramonium, fruit and seeds. Photo P. Ferrari

The spread of *Carporbotus edulis* threatens the survival of residual populations of *Limonium sommierianum*, endemic to the islands of Giglio, Montecristo and Giannutri in the Tuscan Archipelago.
Photo J. Grapow

Most of the 88 species reported to have an ecological impact are either believed to directly threaten the conservation of biodiversity or alter ecosystem properties. It is noteworthy that all those species that have been classified as local invasive are included in this group and have, despite being highly localised, been shown to pose a threat to local biodiversity. The aquatic plant *Lagarosiphon major*, for instance, can build dense floating mats that prevent light from reaching the layers below, thus competing with other species and threatening the survival of aquatic invertebrates.

The widespread invasion of this species in one area of the Garda Lake is believed to have been the main cause of the disappearance of *Ranunculus circinnatus* from the only surviving location in Trentino, where it was present until 1992 (Prosser, in Celesti- Grapow *et al.* 2009c).

The most striking example of a threat to the conservation of biodiversity is probably the species of the genus *Carpobrotus*. They are spreading on the steep sea cliffs of the Italian islands, in habitats that had previously been conserved on account of their inaccessibility to man, and are seriously threatening the survival of rare and endemic entities.

The studies undertaken so far indicate that riparian plant communities, wetlands and coastal habitats are those threatened most by non-native species. We illustrate some of these species in the next chapter.

Italian legislation on invasive plants

Giuseppe Brundu

Ipomea acuminata. Photo F. Pretto

Biological invasions are processes that should be tackled with adequate tools of international environmental legislation, as has been done for other global issues, such as climate change, marine pollution, biodiversity loss and desertification. Legislation tools have so far mainly consisted of "soft laws", i.e. international non-bonding resolutions, declarations and agreed principles, such as "polluter pays", or the commitment to nature conservation resulting from the Stockholm Declaration, signed in 1972. However, a significant body of environmental legislation, either directly or indirectly related to biological invasions, has more recently been passed in a relatively short period of time. One example of such legislation is the Bern Convention. The Convention on Biological Diversity (CBD), ratified by Italy (L. n. 124/1994), calls for the parties to prevent, eradicate and control those non-native species that threaten ecosystems, habitats and other species. The CBD has been adopted within many European and national regulations, such as the Italian DPR no. 357/1997 which has led to the implementation in Italy of the Council Directive no. 92/43/EEC. Italy has recently modified the text of its Constitutional Law (*ex* L.C. n. 3/2001) to introduce the term "ecosystem and habitat conservation" [117.2.s] as a national government priority. Nevertheless, the regions can pass ad hoc legislation on invasive alien species (IAS), [117.3] in a variety of fields closely related to biological invasions (e.g. human health, land management, conservation of cultural and environmental heritage, production, transfer and distribution of energy). Italian regions also have legislative powers [117.4] regarding "agriculture, forestry, hunting and fishing". As regards invasive species in particular, Italy has not adopted tools such as the "environmental damage" and "environmental liability" principles, which may help tackle the problems related to the invasion of such species. No action has been taken either to update Italian legislation or to adopt international strategies such as the European Strategy on IAS, signed in 2003, or the "code of conduct on horticulture and invasive alien plants", drawn up by EPPO. Only at a regional level do we find specific legislation on the regulation and control of IAS (e.g. the Lombardy law no. 10 dated 31/03/2008, the Sardinian regional landscape plan). Although non-native species are mentioned in several texts, somewhat contrasting terms are often used.

Oxalis pes-caprae. Photo E. Carli

10 of the major plant *invaders*

The following fact sheets illustrate ten key examples of invasive species in Italy; they represent a wide range of invaded environments and have different forms of impact. Although these species are among the most harmful invasive plant species in the country, they are not necessarily the "top 10". All the species described briefly here are neophytes (i.e. introduced after the year 1500), invasive (i.e. spreading fast), and are reported to have a significant negative impact somewhere in Italy. They are otherwise markedly different: some are widespread throughout the country (e.g. *Ailanthus altissima*), others are common at the regional level (e.g. *Impatiens glandulifera* in the north of Italy), yet others are highly localized; some are invasive in only a few sites, or even in one site alone, but are rapidly expanding (e.g. *Heracleum mantegazzianum*).

The examples provided are typical of the main natural environments that have been invaded, such as wooded (*Prunus serotina*) and riparian (*Amorpha fruticosa*) habitats, and include both terrestrial and aquatic plants. Besides species that pose a threat to natural systems, either by altering the abiotic environment (*Robinia pseudoacacia*) or by directly threatening biodiversity, both on a local (*Reynoutria japonica*) and global scale (*Carpobrotus* sp.pl.), we have also included one example of species that pose other types of threat, e.g. to human health (*Ambrosia artemisiifolia*).

The presence of the majority of these 10 species has long been known in Italy, and some have been included among the main threats to biodiversity and subjected to control measures within LIFE Natura projects (http://ec.europa.eu/environment/life/index.htm). We have, however, also included one example of a species that is still little known in Italy (*Ludwigia peploides* subsp. *montevidensis*), but has been reported to have a very harmful impact in other countries (e.g. http://www.eppo.org/QUARANTINE/quarantine.htm). It is essential that such species be highlighted because it is in these species that countermeasures aimed at controlling and preventing further spreading may, given their limited presence, be effective.

As the examples selected are all renowned invasive species in Europe or worldwide, in the following fact sheets we provide some information on their invasion history and threats specifically in Italy; more general information may be obtained by consulting the numerous studies (e.g. Weber 2003, Galasso *et al.* 2008, DAISIE 2009) and internet sites dedicated to such species (e.g. http://www.issg.org/; http://www.daisie.ceh.ac.uk/; http://www.nobanis.org/; http://www.eppo.org/; http://ias.biodiversity.be/ias/; http://www.cps-skew.ch/english/info_invasive_plants.htm; http://www1.ci.uc.pt/invasoras/index.php).

Ailanthus altissima (Mill.) Swingle

Tree of heaven

Growth form: tree
Family: Simaroubaceae
Native range: China
Introduction: ornamental

This deciduous tree is one of the most common invasive plant species in Italy, it being found ubiquitously in urban and ruderal areas. Introduced in the country in 1760, through Padua's Botanical Garden, it was originally cultivated in order to breed the ailanthus silkmoth, which came from China, like the tree, fed itself on the foliage of this species and was supposed to replace the local silkworm. *Ailanthus altissima* was subsequently widely cultivated as a garden ornamental plant and as a street tree, especially in cities, thanks to its robustness and capacity to grow in poor soils. It was already known to spread spontaneously in the mid 19th century, and has since extended its range in the country rapidly and efficiently owing to the huge number of seeds produced by the female trees (male and female flowers are on different trees), to the vigorous vegetative reproduction of its root suckers and to its rapid growth. It tends to establish itself in disturbed sites, such as along roads and railways, highway medians and wastelands, though it is also found in open woods and riparian habitats, where it displaces other species by forming dense thickets and by releasing a toxin that inhibits the growth of other plants (Kowarik, Säumel 2007).
Its tolerance to drought and rocky conditions is such that tall vigorous trees can germinate and develop out of cracks in the pavement, in roofs, or even in vertical walls. This may cause serious problems due to the mechanical and chemical damage its extensive root system inflicts upon man-made constructions, such as buildings and infrastructures, and particularly to the historical heritage, i.e. ancient monuments and archaeological remains. The occurrence of this tree in important remains has in recent decades grown substantially; moreover, as its winged, wind dispersed seeds are easily blown upwards (e.g. on top of the Roman Colosseum, 50 metres above ground level), control measures, such as mowing, can be both difficult and costly.

Photo J. Grapow

Photo J. Grapow

Ambrosia artemisiifolia L.

Common ragweed

Growth form: **annual herb**
Family: **Asteraceae**
Native range: **Canada & USA**
Introduction: **unintentional**

This species is best known for its highly allergenic pollen, which is produced in copious amounts by the male flowers and becomes a stable component in the air in late summer in many areas in north-western Italy, particularly in Lombardy. Since it was first reported in Italy in 1902, it has spread rapidly, and became, by the 60s, widespread throughout northern Italy, especially in the Po Plain. Its range continues to expand, thanks to its enormous seed production and marked dispersal potential. Its preferred habitats are human-disturbed areas such as ruderal or waste sites (e.g. roadsides, railways, gravel pits, construction sites), though it also grows along riverbanks. Besides its allergy-related impact on human health, it is also a significant agricultural pest, reducing the yield in many crops.

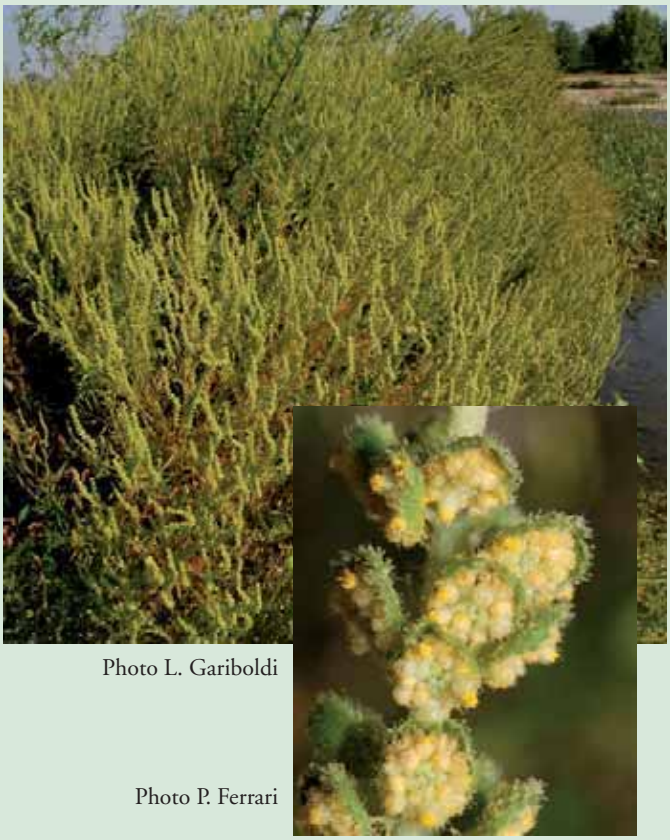


Photo L. Gariboldi

Photo P. Ferrari

Amorpha fruticosa L.

False indigo

Growth form: **shrub**
Family: **Fabaceae**
Native range: **North America**
Introduction: **ornamental**

This shrub spreads mostly in riparian habitats, particularly in northern Italy. Introduced in the country in the late 18th century as an ornamental for its eye-catching flowers, it subsequently spread following its use for hedges and bank stabilization. Its presence in the wild was first reported in the mid 19th century, and it has since spread extensively along stream and river corridors thanks to its efficient vegetative reproduction. It has now become widespread, particularly in the north, where it is found in the beds and along the banks of rivers in the Po Plain and the neighbouring valleys. Although it is also found in ruderal sites, it inflicts most damage upon riparian vegetation, in which it tends to become dominant, altering ecosystem properties, displacing other species and, consequently, reducing local biodiversity. It is one of the few species that have been targeted by specific management strategies at the regional level: in Lombardy it is included in the list of invasive species threatening biodiversity, while in Tuscany a regional law forbids its use for reforesting, green area maintenance and consolidation purposes. Removal actions have been promoted in retrodunal systems in this region.

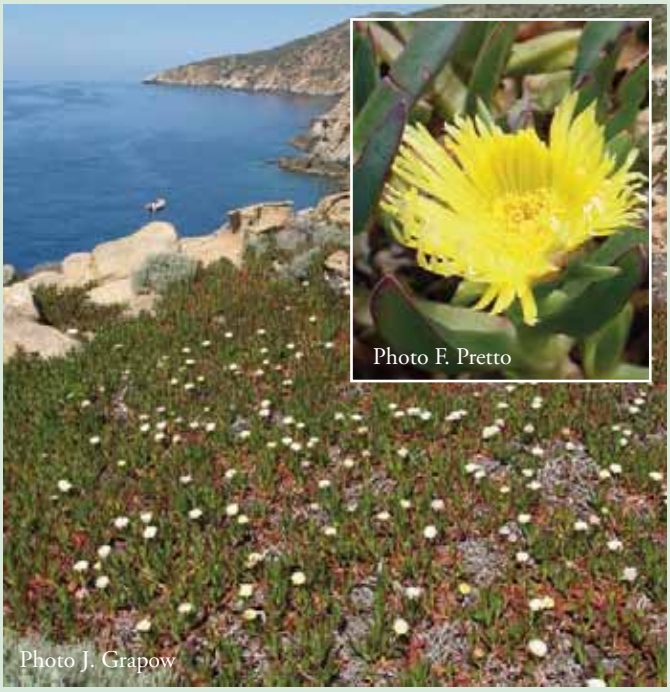
Photo M. Adorni

Carpobrotus sp.pl.

Hottentot fig

Growth form: **shrub**
Family: **Aizoaceae**
Native range: **South Africa (Cape Province)**
Introduction: **ornamental**

The importance of the species belonging to this genus consists in the fact that they tend to spread in one of the most vulnerable systems, i.e. on small islands, and in one of the few habitats that are still relatively untouched by man, i.e. steep sea cliffs, both of which still contain important endemisms. Although they are highly ornamental and have very striking flowers, the expansion of these succulent, crawling species probably poses one of the most serious threats to biodiversity in Italy, and certainly the worst posed by a plant. Indeed, it threatens not only diversity on a local scale, but the survival itself of rare and endemic taxa, such as *Centaurea horrida* in Sardinia and some endemic *Limonium* species in the Tuscan Archipelago (in Elba, Giglio and Capraia, B.Foggi, (pers. comm.) and the Pontine Islands (in Ventotene).
Carpobrotus species form large, dense mats that outcompete the pre-existing vegetation. They can modify soil properties such as nutrient contents and pH. Their presence all along the coastline is due both to interventions aimed at stabilising the dunes and to its widespread cultivation by the management of seaside facilities and private owners on account of their attractive flowers and easy propagation. The invasion of these species continues to this day, because they are widely available commercially and because they may be spread by means of even very small fragments that root at nodes.
Several entities belonging to the *Carpobrotus* genus, including hybrids, probably exist in Italy.
In local botanical studies, however, two main entities have been treated distinctly, *C. edulis* and *C. acinaciformis*, with information on their distribution and history of introduction being collected separately. It was agreed that this distinction be maintained in the present work until the taxonomy of this group of plants is revised.
The establishment of *C. acinaciformis* (top photo and map) was first recorded in 1856 on the island of Ischia, off the coast of Naples. It is currently invasive in many areas in central and southern Italy; it spreads mainly by vegetative means, competing with the native species, even at the root level, for water and nutrients. Strategies aimed at containing its spread and removal actions have been implemented in Sardinia, while in Tuscany a regional law forbids its use for green area maintenance and consolidation purposes.



C. edulis (bottom photo and map) reproduces mainly by means of seeds, dispersed above all by small mammals. In contrast to what has been observed in the rest of the Mediterranean, in Italy *C. edulis* is less widespread than *C. acinaciformis*, even though they are used equally frequently in gardens and beach facilities.

Heracleum mantegazzianum Sommier & Levier

Giant hogweed

Growth form: **perennial herb**
Family: **Apiaceae**
Native range: **Caucasus**
Introduction: **ornamental**


Photo J. Grapow

Following the observation of some spontaneous, flowering samples at 2,173m on the slopes of the Mont Blanc (see photo), giant hogweed is reported to be the non-native species found at highest altitude in Italy. The first record of this plant in the country, though cultivated, is provided by the photo taken in 1899 by Emil Levier, who had introduced it in Europe, via Florence, in 1890, on his return from a botanical trip to the Caucasus mountains. It has since been cultivated as a botanical curiosity, on account of its height (despite being a grass species, it can grow to a height of 5 metres) and the size of its inflorescences (umbels), which may exceed 50 cm in diameter. This species has escaped from cultivation and established in Alpine valleys in several areas, though in only one region is it considered to be invasive. It has rapidly expanding populations, which first developed in a wasteland and then spread along the banks of the Dora river, an affluent of the Po. The origin of this plant in the Caucasus mountains renders it particularly resistant to the environmental conditions in the Alps and it has considerable potential to spread and establish in extensive areas in northern Italy. Moreover, if we consider that it is one of the most significant invasive species in Europe, and that its water-dispersed seeds may spread downstream along the entire course of the Po, the longest river in Italy, which flows eastwards for more than 600 kilometres, it becomes clear that the management of these populations, which have resisted numerous attempts over the years to control them, is of utmost importance. The threat posed by this species is related above all to health issues, insofar as it causes serious skin burns, in the presence of UV radiation, when human skin come into contact with the phytotoxic sap contained inside the plant, which may seep out of broken or damaged leaves and branches. Besides, this species is highly competitive and forms dense stands, and its large leaves shade the surrounding area and inhibit the growth of other species, thereby reducing species diversity (Pyšek *et al.* 2007).

Impatiens glandulifera Royle

Himalayan balsam

Growth form: **annual herb**
Family: **Balsaminaceae**
Native range: **Indian Subcontinent**
Introduction: **ornamental**


Photo P. Ferrari

Widely, but still rather patchily distributed throughout northern Italy, this species, whose flowers are very striking, is becoming one of the main invaders of freshwater wetlands, and is widely reported to be spreading rapidly. Imported as an ornamental from the Himalayan region, it was recorded in Italy for the first time in the early 20th century. It establishes in natural riparian habitats, along stream and river banks, the shores of lakes and edges of ponds, where it progressively displaces other vegetation, creating dense populations over extensive areas. The speed at which it spreads and the ease with which it colonises new sites, thanks to its efficient dispersal of seeds, which are ejected from the fruits at considerable distances, have a highly negative impact on biodiversity. In the Alps it is one of the few species that spread at high elevations, adapting to the extreme conditions in the mountains, which probably resemble those found in the area it comes from in the Himalayas. Other species of the same genus have been reported in Italy; these include *I. balfourii* and *I. parviflora*, which are also invasive, but are less widespread in riparian habitats.

Ludwigia peploides (Kunth) P.H.Raven subsp. montevidensis (Spreng.) P.H. Raven

Water primrose

Growth form: perennial herb
Family: Onagraceae
Native range: N, C & S America
Introduction: ornamental

Photo M. Adorni

Reports of the spontaneous occurrence of this species in Italy are very recent, it having been observed for the first time in Lombardy in 1998. It has, since then, spread rapidly to other provinces within the same region, and to the neighbouring Emilia-Romagna. It is an aquatic plant that develops dense populations and consequently displaces the pre-existing vegetation. In other countries, the considerable amount of plant biomass produced by this species has been shown to result in less oxygen being dissolved in water, increased water acidity, eutrophication and increased sedimentation, all of which alter the overall function of the ecosystem (see e.g. http://www.eppo.org/QUARANTINE/quarantine.htm). Besides its ecological impact, the rapid spread of this plant hampers some human activities, such as those related to navigation and irrigation. It invades canals, where it flourishes in the summer and autumn. In Italy, it is thus still relatively rare, but given the rate at which it spreads, the high number of environments it could invade and its marked invasiveness, which has rendered this species one of the most harmful to the conservation of biodiversity in natural freshwater habitats elsewhere, it may constitute a very serious threat in the future. This species, and other even more localised species, should thus be monitored closely, since prevention and early response are, to date, still the most effective control strategies.

Photo M. Adorni

Prunus serotina Ehrh.

Black cherry

Growth form: **tree**
Family: **Rosaceae**
Native range: **N & C America**
Introduction: **ornamental**


Photo G. Ceffali

Originally introduced as an ornamental, the use of this species for plantation forestry and reforestation has favoured its spread in natural areas in northern Italy, turning it into one of the most invasive plant species in the Po Plain in recent decades. It invades forest understorey, wood clearings, coppices and wetlands. It reproduces rapidly both by means of bird-dispersed seeds and root sprouts. It can survive for long periods of time in the lower layers of woods, enduring both the shade and competition. As soon as there is a break in the canopy, due to felling or fallen trees, it rapidly prevails over all other species. The invasion of this species is accompanied by an overall change in the ecosystem and a marked impoverishment in the quality of the woods (see e.g. Starfinger *et al.* 2003). Several initiatives aimed at eradicating this species have been promoted in Italy within the context of the various LIFE Natura projects (http://ec.europa.eu/environment/life/index.htm).

Reynoutria japonica Houtt.

Japanese knotweed

Growth form: **perennial herb**
Family: **Polygonaceae**
Native range: **China & E Asia**
Introduction: **ornamental**


Photo L. Ghillani

Listed among the worst 100 invasive species in the world (www.issg.org) and in Europe (www.daisie.eu), *Reynoutria japonica* is, along with other species and hybrids of the same genus (such as *R.* ×*bohemica)*, currently one of the most invasive species in the non-native flora even in Italy. It was introduced in the Padua Botanical Garden in the mid 19th century as an ornamental, and was subsequently cultivated, even outside parks and gardens, to consolidate soil. Reports of its spontaneous occurrence date back to at least 1875, following which it has spread at an alarming rate. It is now found throughout northern Italy, even at high elevations in the Alps. Its favourite environments are the sides of roads and railways, waste areas and river banks; it spreads along the banks of rivers thanks to the water, which carries fragments of its rhizomes downstream. Although it prevails in disturbed environments, it also tends to invade natural areas, where it forms dense clonal stands that oppress and outcompete other species, thereby preventing their survival. Thus, when the epigeal parts fall in autumn, large areas are deprived of vegetation and are consequently easily eroded. The seeds are dispersed by the wind, though male flowers appear to be rare in invasive populations, most of the seeds being generated by the pollen of other, related species such as *R. sachalinensis*.
The invasiveness of this species is due above all to its vigorous vegetative growth, starting from even very small fragments of rhizome. Its spread is thus fostered by various forms of both natural and anthropic disturbance, such as erosion of river banks, extraction of materials from rivers and soil movements. The persistence and regenerative capacity of the abundant root sprouts from the rhizomes explains why keeping this species under control is a particularly challenging task (see e.g. Child, Wade 2000). Nevertheless, an effort must be made to prevent it from spreading in natural areas, at least in isolated populations, such as those at high elevations in the Alpine valleys.

Robinia pseudoacacia L.

Black locust

Growth form: **tree**
Family: **Fabaceae**
Native range: **USA**
Introduction: **ornamental**

The black locust, which is the most common invasive tree in Italy, abounds throughout the country. It was introduced as a garden ornamental and was already present in 1662 in the Padua Botanical Garden. It was immediately appreciated for the beauty of its flowers and foliage, as well as for its rapid growth and vigorous root system, composed of strong, resistant, underground rhizomes. It was thus cultivated in urban parks and as a street tree, and was subsequently spread extensively by farmers and foresters to produce firewood and for the consolidation of banks, erosion control and reforestation purposes. It is a fast growing, extremely prolific, deciduous tree that reproduces very efficiently, mainly by producing shoots from its root system. It spreads spontaneously in a wide range of habitats, owing to its tolerance to a variety of environmental conditions. It is an early successional species that colonises wasteland, rapidly growing into large, dense thickets that displace other vegetation, change the structure and composition of the invaded habitat, and modify the chemical composition of the understorey by nitrogen fixation. Although it spreads in riparian habitats and open woods, particularly in central and northern Italy, its favourite environments are disturbed habitats, where, once established, it is difficult to control, owing above all to its extensive rhizome system.

Photo L. Ghillani

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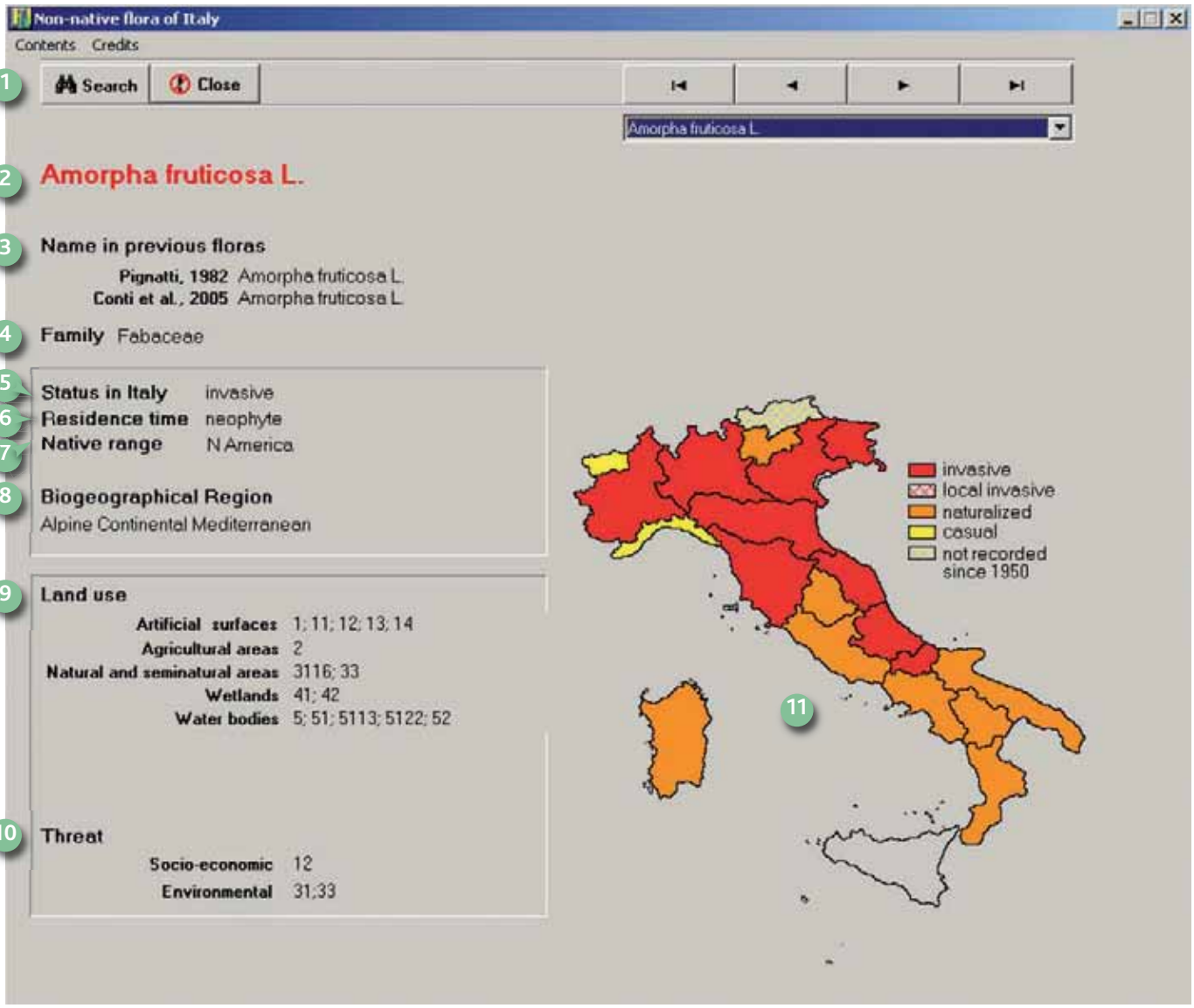
Non-native flora of Italy

Celesti-Grapow L., Pretto F., Carli E. & Blasi C. (Eds.) 2009



database E. Dominici

Supports Windows 98SE/Me/2000/Xp only

Non-native flora of Italy

For each of the 1,023 species of the non-native vascular flora of Italy, the attached CD-ROM contains the following information:

1 **Search** – to search for a species, click on the button and type the name. If the name has changed, the current name will appear.

2 **Name** – each species or subspecies is identified by its scientific name, according to the botanical nomenclature adopted by Celesti-Grapow *et al.* 2009b.

3 **Name in previous floras –** the name as it is found in the most recent Italian Flora (Pignatti 1982) and in the most recent checklist of the Italian flora (Conti *et al.* 2005) is listed under the current one.

4 **Family –** the attribution of each species to a family follows Celesti-Grapow *et al.* 2009b.

5 **Status in Italy –** it refers to the invasion status of the species in Italy, i.e. whether the species is casual, naturalized, local invasive, invasive, or has not been recorded since 1950.

6 **Residence time –** whether the species is an archaeophyte or neophyte.

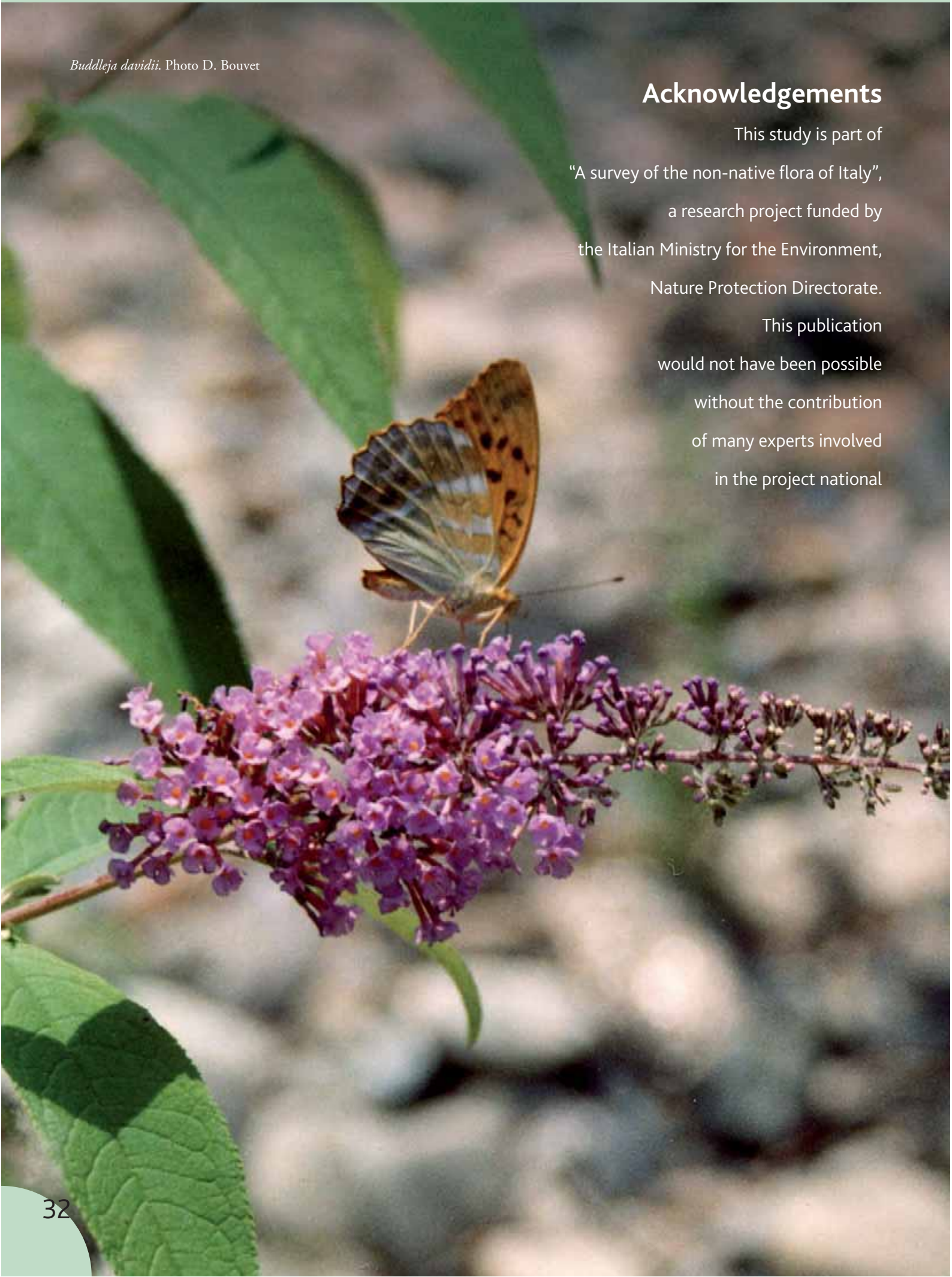
7 **Native range –** identifies the geographical provenance of each species. Besides the main categories, e.g. Europe, North America, South America (including Central America) and Australasia, we used intercontinental groups, such as Mediterranean (i.e. the Mediterranean Basin), Eurasia and Tropics, and "wide distribution" to refer to those species with extensive native distribution ranges across different continents, or whose provenance cannot be determined more accurately. Moreover, we referred to as "uncertain" those species whose geographical origin is unknown or uncertain, and as "hybrid" species resulting from hybridization. (Medit.=Mediterranean; Temp.=Temperate; Trop.=Tropical).

8 **Biogeographical Region –** we adopted the classification of the "Map of the Biogeographical Regions of Europe" (European Environmental Agency, http:/www.eea.europa.eu), according to which Italy comprises three regions: Alpine, Continental and Mediterranean. However, as regards the boundary between the Continental and the Mediterranean regions that runs down the Peninsula, we adapted the map so as to provide greater detail on a national scale by following the boundary of the Mediterranean region proposed in the "Biogeographic Map of Europe" of Rivas-Martinez et al. (2001); nd or empty=no data available.

9 **Land use –** the distribution of each species in land use types was recorded using the CORINE Land Cover classification system, a standard land cover classification of the data for Europe (http://www.apat.gov.it/site/it-IT/) structured hierarchically in five levels. The occurrence of the species in Land Cover types was assessed, at the most detailed level possible, by experts in each regional group; when the information was transferred from the regional level onto a national scale, the data were often simplified to level 1 or to level 2.

10 **Threat –** the information available on the threats that the species pose was integrated into a simple unified system comprising two broad categories, i.e. socio-economic and environmental, each of which was subdivided into several classes to obtain the following preliminary scheme:
Socio-economic threat – including: agricultural weeds, e.g. that cause losses in production or additional, control-related costs in arable land (crops), pastures, nurseries, greenhouses, plantations and water management; species that damage man-made constructions (e.g. buildings, infrastructures, monuments and archaeological remains); species that threaten livestock (e.g. toxic to farm animals); species that threaten human health – e.g. allergenic, toxic or poisonous species; species that cause dermatitis (e.g. urticants).
Environmental threat – including: species that target other biota (e.g. competition for space, nutrients, water and light); hybridization with a related native species or variety generally inducing a loss of genetic diversity in native plants; abiotic changes (e.g. modification of soil chemical-physical properties, nutrient availability, water regime/balance). We assigned each species to one, or several, of the aforementioned classes as long as they were included in specialised studies conducted on Italy.

11 **Map of the distribution in Italy –** The occurrence and status of each species in the 21 regions was compiled by each regional group using data published in the literature, integrated with herbaria records and some unpublished data; an exhaustive field survey aimed at updating the distribution of the species throughout the country was not possible within the framework of this project.



Buddleja davidii. Photo D. Bouvet

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