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Handroanthus heptaphyllus (*Bignoniaceae*) in Sicily: a new casual alien to Italy and Europe

Abstract

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Handroanthus heptaphyllus (*Bignoniaceae*) is an ornamental tree native to different regions of South America (Brazil, Argentina, Bolivia, and Paraguay). Here we report from Sicily the first case of natural regeneration in Europe.

Key words: non-native plants, Mediterranean, naturalization.

Introduction

Invasive alien plants (IAP) are increasingly considered one of the main threats for biodiversity conservation, human health and activities, as well as ecosystem services (Pimentel & al. 2001; Vilà & al. 2011). Furthermore, climate change is strongly expected to exacerbate the spread and impacts of IAP in the next decades, both in natural ecosystems and agricultural areas (Gritti & al. 2006). This may occur because IAP are generally characterized by high ecological plasticity, notable tolerance to sub-optimal conditions, and, definitely, they should much more suited to cope with rapid changes of environmental conditions than native counterparts (Porté & al. 2011). Future global scenarios also showed that the biodiversity of Mediterranean ecosystems could be more negatively affected by invasive taxa than any other biogeographical region in the next century (Sala & al. 2000). For these reasons, the proliferation of invasive species has attained increasing concern in the overall strategies of biodiversity conservation and preservation of native habitats worldwide (Tilman & al. 2017).

The observation of the early signs of natural reproduction by alien plants plays a very important role for the invasive management and study at least for two reasons. From an ecological point of view, it allows to assess the rapidity of the passage from a stage to the subsequent along the introduction-naturalization-invasion process. The second aspect concerns the invasive management, the cost of which is widely known to be strictly connected to the stage of the naturalization process attained by the species. The crucial importance of

early detection and prompt responses to tackle invasive alien species has recently been highlighted within the Regulation (EU) No 1143/2014 of the European Parliament and of the Council (available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R1143&from=en). Among different possible pathways, the introduction for ornamental purposes, in gardening or horticulture, is by far the most relevant for the entry of invasive alien plants (Mayer & al. 2017). For instance, such category accounts for about 94% of all the introduced plants in Australia (Groves & al. 2005). Hence, the investigations on plants introduced for such purposes are important. Artificial areas may be considered the nursery areas where alien taxa experience familiarity with the abiotic characters of the introduced range, as well as starting the integration within local biotic communities (Badalamenti & al. 2015).

In the last few years, the number of reports about woody species found as casual or naturalized species in Sicily has constantly increased (Villari & Zaccone 1999; Raimondo & Domina 2007; Pasta & al. 2012, 2016; Domina & al. 2013; Cambria & al. 2015; Badalamenti & al. 2018) along with studies about the main reasons for their natural spread (Badalamenti & al. 2014). As part of specific surveys on regional alien flora, the first records of natural regeneration of *Handroanthus heptaphyllus* (Vell.) Mattos in Sicily are here reported, also representing the first known case throughout Europe.

Material and methods

Periodic observations of cultivated mature individuals were carried out randomly in the last 5 years in many green areas of Palermo city (parks and gardens). Only individuals originating from seed were considered. Systematics and nomenclature of *Handroanthus* and *Tabebuia* follow Grose & Olmstead (2007). For the morphological description and the characterization of the species see Venturella & al. (1990) and Gentry (1992).

Results

Field surveys

We found natural regeneration by *Handroanthus heptaphyllus* in green areas within the campus of University of Palermo). The survey area is represented by a row of street trees about 50 m long, exclusively composed of mature *Handroanthus heptaphyllus* individuals, and their surroundings. Natural regeneration from seed has been regularly observed since 29 July 2013 until November 2018. More than 50 seedlings were found growing at the base of sidewalks, whereas 3 individuals were found growing inside manholes (Fig. 1). As soon as a little amount of plant litter is released, an abundant seedling emergence is observed, with a density higher than 1.5 seedling/m^2. The protection from direct sunlight and as well as water and nutrient accumulation provided by litter seem to play a key role in early phases of life. The farthest individual is found inside a manhole at about 15 m of distance from mother plants; it is well developed and it can be considered definitely established. Such evidence clearly shows the high water requirements of this species. Regeneration by root sprouts has also been observed.

Fig. 1. *Handroanthus heptaphyllus* individual coming out from a manhole in the campus of University of Palermo (Photo by E. Badalamenti).

Nomenclature and specimina visa

Handroanthus heptaphyllus (Vell.) Mattos ≡ *Bignonia heptaphylla* Vell. ≡ *Tabebuia heptaphylla* (Vell.) Toledo ≡ *Tecoma heptaphylla* (Vell.) Mart. (Fam. *Bignoniaceae*)

= *Tecoma ipe* K. Schum. ≡ *Tabebuia ipe* (K. Schum.) Standl.

ITALY (SIC): Palermo, Campus of University (WGS84 38°06'19.06"N, 13°21'01.93"E), 42 m a.s.l., sidewalks and manholes, 29 Jul 2013, *E. Badalamenti* (SAF).

Native range

Handroanthus heptaphyllus is a tree species native to sub-tropical and tropical areas of different states of South America (Brazil, Argentina, Bolivia, and Paraguay), where it colonizes notable wet Atlantic forest stands in coastal and low-altitude areas, from 130 to less than 800-1,000 m a.s.l. (Gentry 1992; Lozano & Zapater 2008). The climate of native regions is tropical warm, considerably wetter than Sicilian sites, with annual rainfall of 800-1,500 mm, mild winters and not too hot summers due to the positive effect of frequent precipitation (Lozano & Zapater 2008). *Handroanthus* is insect-pollinated and with wind-dispersed seeds (Sanchez-Azofeifa & al. 2013; Mori & al. 2015).

Handroanthus is a plant species of high conservation value for the Atlantic forest and it is used for the good characteristics of wood and the reforestation for ecological purposes to re-establish complex forest stands (Mori & al. 2015). For these reasons, specific strategies for *ex-situ* conservation have been developed, including micropropagation (Duarte & al. 2016) and cryopreservation of seeds, which are orthodox, yet they are characterized by short viability, not lasting more than 2 months in natural conditions (Higa & al. 2011). Several studies have also been carried out on the genetic variability of *Handroanthus* and on the effects of climate change on its future distribution and on the possibilities of effective future conservation of the different native populations (Mori & al. 2015; Scarante & al. 2017).

Handroanthus heptaphyllus *as an alien species*

Handroanthus heptaphyllus does not have reached a considerable spread outside cultivation all around the world, suggesting our observations are not frequent and the invasive potential of the species is currently low (Randall 2017). For instance, in Florida *Handroanthus* is included among the possible non-native species alternatives to well-known invasive species (Knox & al. 2013). However Hodel & al. (2017) for California state: "…*liberate great quantities of seeds, many of which germinate in the landscape and become weeds*". This could be a quite recent process as the species lacks in recent databases of the same area (Cal-IPC 2006). In Europe, nor *Tabebuia* sp. or *Handroanthus* sp. are listed in the most recent database of alien species (DAISIE 2009) as well as in Euro+Med (2006+) database. In Italy, since the second half of the 19th century, some *Tabebuia* or *Handroanthus* sp. were introduced, including *Tabebuia rosea* (Bertol.) DC. and *Handroanthus serratifolius* (Vahl) S.O.Grose (≡ *Tabebuia s.* (Vahl) G. Nicholson) (Maniero 2000). However, no species has been reported hitherto as casual or naturalized species, neither in the most updated checklist of the Italian alien vascular flora (Galasso & al. 2018; Domina & al. 2018). Seven species belonging to *Bignoniaceae* are naturalized or casual alien plants in Italy, including three lianas: *Campsis radicans* (L.) Bureau, *Catalpa bignonioides* Walter, *C. ovata* G. Don and *C. speciosa* Teas, *Dolichandra unguis-cati* (L.) L.G. Lohmann, *Jacaranda mimosifolia* D. Don, and *Tecomaria capensis* (Thunb.) Spach. Interestingly, the occurrence of this plant family in the Italian alien flora has more than doubled in the last forty years (Viegi & al. 1974; Galasso & al. 2018).

The introduction history in Sicily

In the Sicilian flora, until recently *Bignoniaceae* was only represented by *Jacaranda mimosifolia* and *Tecomaria capensis*, both considered as casual species (Raimondo & al. 2010). Then, *Dolichandra unguis-cati* (sub *Macfadyena unguis-cati* (L.) A. H. Gentry) and *Campsis radicans* were also observed in the wild in Palermo city (Stinca & al. 2012) and Linosa island (Pasta & al. 2017), respectively. *Handroanthus heptaphyllus* is commonly cultivated as ornamental species in the urban streets of Palermo (Giardina & al. 2007), whereas its distribution in the region seems to be quite limited as it lacks in many parks and public gardens (Bazan & al. 2005), as well as in all the circum-sicilian islands (Domina & Mazzola 2008). It is used as ornamental species especially for its beautiful and impressive flowering which occurs from mid-April to mid-May, before the emission of new leaves. It has been recently introduced in Sicily so that the historical account of its occurrence here is extremely precise and detailed, different from other alien woody

species. Such information is very valuable to evaluate the rapidity of the invasion process and hence to understand the invasive potential of the species. In 1982, the first seeds, coming from the province of Corrientes (NE Argentina), were introduced by Prof. Francesco Maria Raimondo at the Palermo Botanical Garden (Venturella & al. 1990). After the germination and the storage in a cold greenhouse the following year, in 1985 nine individuals were planted outside. From 1986 onward, some experimental trials were carried out in the open field in several municipalities in Sicily, at altitudes ranging from 15 and to 1,000 m a.s.l., in different ecological contexts (Venturella & al. 1990; Ilardi & Mazzola 1992). The species proved to be well suited to the use in coastal habitats and hilly areas, lower than 250 m a.s.l., such as the green areas within the Palermo Botanical Garden. As far as propagation is concerned, sowing gave bad results, whereas the vegetative reproduction via woody cuttings was excellent (Venturella & al. 1990). Subsequently, the first flowering was observed in 7 years old individuals and the first fruiting the next year (Ilardi & Mazzola 1992). The germination trial showed that seedling emergence was more than >70% but with rapid loss of germinating power. Furthermore, some individual exhibited a good growth rate, exceeding 5 meters in height and reaching 60 cm of trunk circumference in full sunlight 8 years after planting. Despite a rapid adaptation to local climate conditions, no sign of natural regeneration had been observed up to now in Sicily.

Conclusions

Our observations suggest that *Handroanthus heptaphyllus* has to be considered as a casual alien species in Sicily. In effect, the natural regeneration is still not so abundant and widespread to consider the species as fully naturalized and capable of establishing long-lasting populations without human assistance. However, it should be emphasized that the naturalization process started no more than 10 years after the planting of the mother plants, a rather short time for a tree species. However, the very limited occurrence of wild individuals elsewhere strongly complicates the chance to forecast the evolution and future spread of this species in Sicily and in the Mediterranean basin.

Definitely, the species does not seem bound to invade semi-natural or natural formations of particular interest in the next future. However, the abundance of regeneration indicates that it has found ideal conditions for reproduction in a relatively short time frame. Therefore, *Handroanthus heptaphyllus* could be included among the alien plant species cultivated in green ornamental areas that may spread and be fully naturalized establish in urban environments, such as gardens or villas, as in the cases of other non-native species like *Koelreuteria paniculata* Laxm. (Raimondo & Spadaro 2006).

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