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USEFUL BUT POTENTIALLY INVASIVE PLANTS IN THE MEDITERRANEAN REGION: WHAT RESTRICTIONS SHOULD BE PLACED ON THEIR USE IN GARDENS?

Gardens and other amenity plantings are expanding rapidly throughout the Mediterranean region - a simple protocol, based on relevant information, may help determine which plants should be used, and which should be avoided.

Introduction

In the Mediterranean region as a whole, rising standards of living and expanding urbanisation are leading to rapid extension of land areas devoted to gardens and other planting areas. This entails complex environmental and cultural consequences that should be studied carefully since gardens and other amenity planting areas have both environmental and cultural functions. Whereas they are perceived by the general public as places of 'Nature', they can be seriously harmful for the environment because of their heavy consumption of water and the widespread application of pesticides, fertilisers, and weed killers. They can also be the starting point for the dissemination of exotic invasive plants involving risks for human health, and economies, as well as for native fauna, flora, biotic communities, and ecosystems. Decisions regarding the choice of plant material to be used in gardens and amenity areas are therefore a growing cause for concern. Consideration of both the positive and the negative aspects of the various plant species that can be used horticulturally is required.

*Figure 1: An Ice plant (*Carpobrotus *spp.) invasion on a coastal dune in Corsica (O. Filippi).*

What is an invasive plant?

According to Richardson *et al*. (2000), invasive species are exotic species that overcome successive barriers limiting their reproduction, naturalization, and dispersal, allowing them to spread in their new area of introduction. However, the term itself of invasive species is confusing: a species can never be invasive in and of itself; only *a population* of a species can be invasive, in a given place and at a given time (Colautti & MacIsaac, 2004). For some plants deemed invasive, there may also be uncertainty, at the local level, regarding the status of species or subspecies considered "native" (Beisel & Lévêque, 2009), especially in the context of the Mediterranean Basin with its complex history of intermingling flora and fauna, much influenced and mediated by human choices and activities. This sometimes hinders conservationists and ecologists seeking to dialogue with gardeners, horticultural professionals and landscapers in order to define which invasive plants to avoid when planting.

Indeed, in order to limit the spread of noxious invasive plants, such as Ice plant (*Carpobrotus* spp., Aizoaceae; Figure 1), many lists of species have been created in different countries of southern Europe.

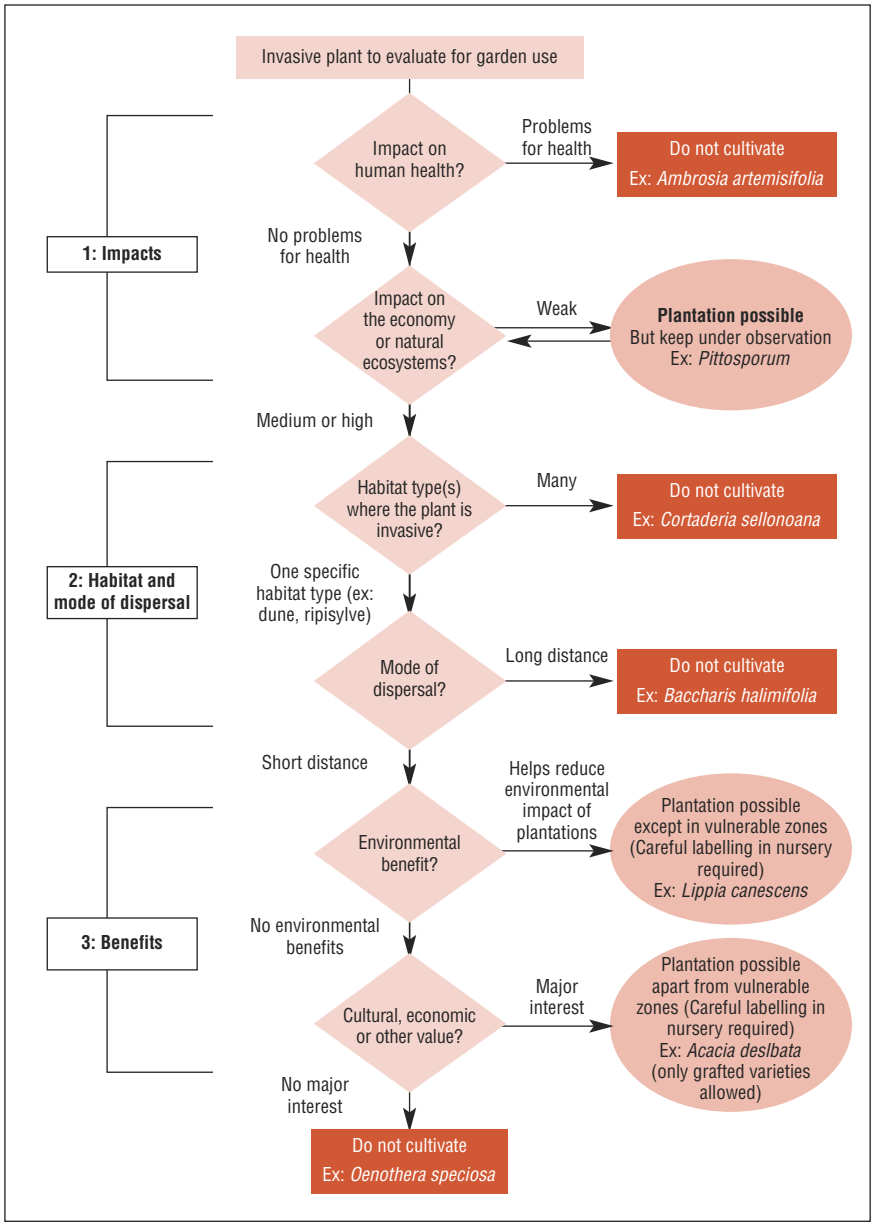

Figure 2: A decision-making protocol to help determine which types of restriction to impose for any given non-indigenous species under consideration for use in gardens or amenity plantings.

> *"Gardens and amenity plantings can be the starting point for dissemination of exotic invasive plants."*

Unfortunately, many of these lists, even those created by official environmental protection agencies, are based on inconsistent criteria (Heywood & Brunel, 2009), thereby contributing to confusion and preventing well-meaning recommendations from being implemented. Moreover, these lists are often elaborated at different spatial scales, e.g. national or regional, which may generate conflicting recommendations. The confusion of species genuinely noxious and those that have as their main defect that they are not considered "native" (Gould, 1997), may inflate the lists of unwanted or forbidden plants in gardens and amenity plantings and unleash negative reactions from horticulture and landscape professionals. To progress on these sensitive issues – which are sometimes strongly marked by emotional and subjective dimensions (Webb, 1985; Wilcove *et al*., 1998) – particular attention should be paid to the choice of targeted species and how decisions are made (Ewel *et al*., 1999; Parker *et al.*, 1999). In the following section, a protocol is described to aid in decision-making regarding which plant species to use freely - or to avoid at all costs - in gardens and amenity plantings across a range of situations.

Decision-making protocol

To classify invasive plants for use or not to use in gardens and amenity plantings, we offer a decision-making protocol (Figure 2) with the following steps: a candidate species' potential negative impacts in the introduction zone are studied followed by an assessment of the risk of the species spreading outside of the planting site; then the species' potential positive aspects in a horticultural setting are also considered. For each candidate species, answers to these successive questions can result in three types of decisions: 1) use of the plant should be proscribed regardless of the planting site (dark grey in Figure 1); 2) the species can be grown in any zone, but the plant should remain under observation in case conditions change (e.g. due to global warming) and lead to a revision in status (light grey); 3) the species can be grown only outside of the zones at risk defined for this species (white).

1) Evaluation criteria of invasive plants

Invasive plants can have several types of negative impacts (Heywood & Brunel, 2009), including those impinging directly on human health, those affecting economic activities and those affecting native biodiversity and the functionality of natural or semi-natural ecosystems. Albeit no tool has yet been internationally recognized for the assessment of the negative impact of invasive species on native biodiversity and ecosystems, several approaches have been suggested (Vitousek *et al*., 1987; Hulme *et al*., 2007; Parker *et al*., 1999). Here we adopt the Belgian protocol for measuring the impact of invasive plants (ISEIA, 2007) (see Figures 3 and 4).

> *"When evaluating invasive plants, we suggest focusing on the positive and negative aspects of the species rather than on place of origin."*

In which cases should a potentially invasive plant species be subject to complete, or partial, proscription? In case of partial proscription, which uses can be allowed, without entailing any environmental risk? In order to evaluate

the risk of invasion by a cultivated plant that might 'escape' from the site where it is intentionally planted, we first consider in what type of environment the plant is potentially invasive. In other words, is it a "generalist invasive" or a "specialist invasive" (Barbault & Teyssèdre, 2009)? A generalist invasive species is able to colonize many different environments, including natural, semi-natural, or human-dominated (e.g. Uruguayan Pampas grass, *Cortaderia sellowiana* (Schult. & Schult. f.) Asch. & Graebn. (Müller, 2004). A specialist invasive by contrast only colonizes one particular type of ecosystem, such as coastal dunes or riparian forests – both of which are in fact among the most sensitive ecosystems to invasive plants in the Mediterranean region (Chytry *et al*., 2009; Vilà *et al*., 2008).

If it is, or suspected to be, noxious, the planting of a generalist invasive plant should be proscribed in all cases, since all – or almost all - gardens constitute zones at risk from which such invasive species can escape. In contrast, for specialist invasive plants, the definition of zones at risk where the planting should be proscribed depends on the ecological connectivity between the planting site and the environment where the plant is potentially invasive. This notion of ecological connectivity, which can be structural and/or functional (Metzger & Décamps, 1997; Tichendorf & Fahrig, 2000), refers to the likelihood that a species with invasive potential may succeed in migrating from one ecosystem type to another within a given landscape (Taylor *et al*., 2006) (Figure 5).

Figure 3: Hyparrhenia hirta*, which is considered native in France, is deemed exotic and potentially invasive in Spain (O. Filippi).*

Regarding the positive aspects of a horticultural plant, whether it is native or exotic, our protocol calls for analyzing how best to use the plant in order to take advantage of its attributes in order to reduce the ecological footprint of traditional gardens and amenity plantings where the plant may be used. This can be done according to three parameters, namely water consumption, chemical inputs required (fertilizers, weed killers, insecticides, and fungicides, etc.), and fuel consumption related to maintenance operations requiring engine tools: mowers, hedge-trimmers, brush cutters, waste removal, etc.

Figure 4: Medicago arborea*, a highly ornamental but colonizing Mediterranean shrub, is expanding its range from east to west and is now considered a* planta non grata *by some conservationists in southern France (O. Filippi).*

2) Bibliographic database on plant species

Another tool is required for using this decision-making protocol to help identify and gather the necessary information in one standardized evaluation document, consisting of a database on the risks and advantages of invasive, or potentially invasive, plants used in gardens and amenity plantings. In order to reduce the risk of errors related to an overly narrow perception (Pyšek *et al*., 2009), we suggest that the database should be established by an interprofessional group including scientists and landscape professionals. This database should identify its different sources (bibliographies, experts' interviews or authors' personal observations). The European Botanic Gardens Consortium for example, could and should play a major role in developing, updating, and implementing this database. Head gardeners,

Figure 5: Pennisetum villosum *and* Oxalis pes-caprae *have long distance propagation modes, enabling them to escape readily from planting sites (O. Filippi).*

horticulturists, and botanists of botanic garden staff are perhaps the most knowledgeable experts anywhere and should participate in all collective efforts undertaken to evaluate potentially invasive species in an holistic fashion (Figure 6).

"As the ecological footprint of amenity planting is increasing rapidly in the Mediterranean region, the choice of well-adapted exotics can be very useful."

Discussion

Following test application on twenty exotic species used horticulturally in the Mediterranean region (Filippi & Aronson, 2010), our decision-making protocol clearly allows candidate species to be classified according to which of the three types of use restrictions to recommend. However, the reliability of this protocol should be validated with many more examples. The decision-making protocol can establish, at least for some specialist invasive plants with a short-distance spreading mode, the possibility of planting in low-risk areas. The process of demarcating the areas where planting these species might be possible should be given special attention, in order to avoid the plants at issue spreading into areas or ecosystems where they may become noxious.

Conclusions

Prevention and precaution remain vital to help limit the environmental risk related to the introduction of invasive plants (Ewel *et al.*, 1999; Hulme *et al*., 2007; Gasso *et al*., 2009). We hope that the new tool we offer will contribute to the debate on the issue of holistic assessment of invasive plants, some of which may be valuable for Mediterranean horticulture. We assert that a comprehensive analysis is required to lead to collective decisions, based on a consistent method. Only in this way will it be possible to bring together gardeners, nurserymen, landscape planners and botanic gardens, rarely consulted in this regard and yet key players, in search of a consistent policy aimed at limiting the spread of noxious invasive plants. We emphasize that there is a real risk of seeing these players reject outright any recommendations – or even legislation – which may seem arbitrary or lacking in a robust scientific basis.

Concurrently, the protocol we propose has potential use in the broader context of ecosystem management, conservation ecology, and restoration ecology. Happily, botanical gardens around the world are getting much more active in these areas (Hardwick *et al*., 2011) and the new list of Targets of the Global Strategy for Plant Conservation (http://www.cbd.int/gspc/targets.shtml) also suggests that the development of a holistic, decision-making protocol concerning invasive and potentially invasive plants is timely.

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Figure 6: Phyla canescens *is a cosmopolitan ground-cover species that is considered exotic in France. However, the use of this plant allows savings in irrigation water, herbicides and mowing (O. Filippi).*

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