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Some considerations about weed risk assessment in France and Spain

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Introduction

Every year thousands of seeds from exotic species are accidentally introduced into new regions (Crawley, 1986; Jauzein, 1998). A few of them will be able to develop populations that may then naturalize. Invasive plants are those species that colonize and proliferate in any ecosystem, whether naturally, semi-naturally or through the actions of man. From a survey, Weber (1997) estimated that exotic species represent five percent of all European flora. In France, most exotic species are found in "disturbed" areas such as crop fields, roadsides, sand dunes and riverbanks (Maillet, 1997), which seem more prone to invasion, while only a few establish in stable natural vegetation that may be more resistant to invasion (Fox & Fox, 1986). Although a few species are a major threat to natural areas, we do nothing to stop sudden infestations taking place in agricultural crops or various environments, with the consequent build-up of problems for farmers, stockbreeders, gardeners or nurserymen, or invasions occur in valuable natural environments (parks, wetlands and islands) that pose a threat to the native biodiversity. In the face of such problems, we cannot talk about official prevention or management and they only become a public concern when the problem is already irreversible (Jauzein, 1998).

With regard to the method of their introduction, various "points of entry" of invasive plants can be distinguished:

- Intentional introductions for agricultural, horticultural, forestry, revegetalization or soil conservation purposes, and also for research.
- Accidental introductions.
- As contaminants of seeds, grain feed, wood or soil deliberately introduced by man.
- As "stowaways" on various means of transport (boat, car, man or animals).

In order to develop adequate and efficient measures against invasive processes, it is necessary to distinguish between the above situations that would involve different methods of preventing or limiting such invasions.

I - Existing regulations in France and Spain

1.1 - Intentional introductions

Numerous requests for introduction, especially from horticulturists, are made every year in France as well as in other European countries. They concern grasses, vegetables, flowers, trees, etc. In France, it is considered that 54% of naturalized species of American origin are the result of intentional introduction (Maillet, 1997). Intentional introductions of plants should be subjected to risk assessment procedures by quarantine authorities to determine their weed potential.

However, in Spain as well as in France, officially the problem of invasive weeds is almost non-existent. In Spain, no specific regulation exists except for Royal Decree 2071/1993 (BOE, 1995), based on EU Directive 77/93/EEC (DOCE,1977) and subsequent amendments relating to protective measures against the introduction and spread of noxious organisms within the national territory or the European Union, and export to third countries. In the EPPO book of quarantine organisms (OEPP, 1996) only non-European species of the parasite dwarf mistletoe *Arceuthobium* are listed among many insects, acarians, nematodes, fungi, bacteria and viruses.

In France, the most recent official list of prohibited plants was published in 1998 and concerns cultivated plants likely to introduce pathogens. The only restriction relates to grasses from countries outside Europe. The introduction of any taxon from this family is prohibited, except ornamental species belonging to the Bambusoideae and Panicoideae sub-families and species of *Buchloe, Bouteloua, Calamagrostis, Cortaderia, Glyceria, Hakonechloa, Hystrix, Molinia, Phalaris, Shibalaea, Spartina, Stipa* and *Uniola* genera. However, the reasons for this list are not clear; presumably the tropical behaviour of these latter species is considered a limiting factor for their naturalization. A decree issued in 1993 also prohibits the transport and commercialization of *Caulerpa taxifolia.*

Apart from the fact that there are no official lists of species, it is important to note that even if there were lists they would probably not be sufficient. In particular, risks that are extremely difficult to evaluate are those related to the possibility of outcrossing between introduced and native species, which may result in introgression of genes. An example demonstrated by Lumaret (Toumi & Lumaret, 2001, and personal communication, 2002) is the relationship between *Quercus ilex*, a native species, and the American *Quercus* introduced into Mediterranean islands. The introduction of sub-species or ecotypes of native species can also create problems by producing invasion of new alleles, which should also be considered in order to conserve local biodiversity. This occurs with the introduction of species for restoration of ecosystems. The problem is even more important when herbicide-resistant populations are introduced, as is the case with *Lolium rigidum* "Wimmera", resistant to some "fop" and "dim" herbicides (ALS inhibitors), which is imported as grass seed cover along roadsides.

1.2 - Accidental introductions by contaminant propagules

Many invasive species were probably accidentally introduced with imported crop-seed lots. For example, many tropical hydrophilous weeds soon adapted to Spanish or French summer rice conditions (e.g. *Heteranthera* spp., *Leptochloa fascicularis, Cyperus eragrostis , Lindernia dubia, Eclipta alba).* A particularly difficult problem to solve is red rice (*Oryza sativa* var. *sylvatica*) as contaminant of rice seed.

In France it is well known that many Panicoideae were introduced with maize seeds (*Panicum dichotomoflorum, P. gattingeri, P. capillare*). Soybean is considered as a means of introduction for several *Ambrosia* species.

Many weed species are listed as seed contaminants among other noxious organisms of the quality in the Technical Regulations for Seed and Plant Control and Certification. (BOE, 1986-2000, taken from the EU Directive 66/402 and modifications), but no particular mention is made of invasive exotic species.

1.3 - Accidental introductions by other means

There is no way to exclude accidental introduction of species, and generally invasion is only discovered once a plant has already become naturalized. Land managers need to assess the potential risk of range expansion and learn to predict early on whether the species will become a weed.

II - Means of prevention and control

2.1 - Prevention tasks

The best approach to future weed problems places the emphasis on prevention (Panetta *et al.*, 1995). For new intentional plant introductions, it should be possible at least to develop a weed risk assessment procedure based on the **consultation of lists** of species considered invasive elsewhere. In Europe, Klemm (1996) drew up proposals for restriction based on the concept of biosecurity developed in New Zealand with the establishment of reference lists: **black list** for species well-known to be invasive elsewhere, **grey lists** for potential invasive species. However, such lists have not yet been established.

Commercialization of invasive species occurs not only without any regulation, but also without any information available for the consumer or for horticulturists. So it is possible to find in catalogues of plants for marketing, species such as *Arctotheca calendula*, *Senecio inaequidens*, *Jussiaea* sp., etc. Problematic plants such as *Myriophyllum brasiliense* or *Heracleum mantegazzianum* are recommended in gardening magazines. Few scientists defend the globalization concept for plants, and claim that preventing introduction (except for plants dangerous to man) is a conservative approach (Clement, 2002). However, local initiatives exist in France to inform the public, particularly regarding species presenting risks for human health (*Ambrosia artemisifolia, Heracleum mantegazzianum*) or for natural habitats (*Senecio inaequidens, Reynoutria japonica*). However, these actions are on a regional basis and very often small-scale in comparison with what is being done in the USA or Australia.

The Spanish Weed Science Society and other Institutions on many occasions have expressed their concerns about the need to draw up a list of quarantine species (Gómez de Barreda, 1997; Sobrino *et al.*, 1999). In France the national Botanical Academies, which are recognized by the Ministry of the Environment, have already submitted preliminary lists.

In the future, **weed risk assessment** (WRA) processes might be proposed, such as those developed in Australia (Pheloung, 1995) and the USA (Westbrooks & Eplee, 1996), in order to reject, accept or retain new introductions for evaluation. According to Reichard, Pheloung's WRA gives better results than the Hierarchical Tree Decisional System (HTD) (Reichard & Hamilton, 1997) and the Alien Plant Expert System (APES) (Tucker and Richardson, 1995). This WRA system has been adopted in various countries such as Hawaii, New Zealand, the Galapagos Islands and Australia.

These schemes generally use five criteria: history of invasiveness elsewhere; relatedness to species that show invasive behaviour; climatic match between original range and proposed area of introduction; noxious and undesirable traits; biological attributes of the species. However, even with risk assessment, Westbrooks (1991) considers that these procedures are inefficient. Although the quarantine system and risk assessment process

in Australia are more elaborate, Smith *et al.* (1998) showed that they are not completely effective. This relative lack of success (Perrins *et al,* 1992; Smith *et al,* 1998) may be due to the fact that the most general and basic form of the assessment focuses on the biological characteristics of the plant. The ability of a species to become a weed, however, is a combined function of the attributes of the plant, the ecological properties of the recipient land, the natural disturbances or the management practices the land undergoes (MacIntyre *et al.*, 1995) and the way the plant is introduced into the new environment (Smith *et al.*, 1998).

2.2 - Surveys and control

For invasive weeds introduced accidentally, the main objective should be early detection. Controlling a weed infestation early will minimize the damage and significantly reduce control costs. Money spent on surveys is less than the resultant savings in control costs.

Some areas must be explored as a priority. Valuable sites (those with high biodiversity values) and vulnerable sites (those where weeds are most likely to invade: harbours, silos, along roadsides, railways and channels, places with "disturbed" vegetation, summer irrigated crops, tree nurseries, garden dumps) are often the first sites to be colonized by new weeds (Braithwaite & Timmins, 1999). The survey must be performed in an orderly fashion and programmed by specialists or trained staff, but fortuitous observations are also of great value. The advantage of early detection is only maximized if the new weed incursion is managed promptly. A network of botanists participate in this research in France, but not as part of an official body.

The weed risk assessment system already mentioned may also be used to determine whether new introduced species, or species that are already naturalized but not yet invasive, are potential invaders.

Timely integrated weed management strategies might be developed against species identified as potential invaders in order to prevent their spread. Unfortunately, control is usually only promoted once the species is already problematic and difficult to eradicate.

III - Criteria to define a plant as a possible invasive weed

There are two ways to examine plants for possible invasiveness: the first concerns species present in Spain and is based on expert opinion integrating several characteristics of the species. The second compares the characteristics of invasive American species, present (or not) in crops in France, in order to find common features that might explain their success in agroecosystems and how to use the eventual characteristics to predict risks of new introductions.

3.1 - Drawing up a list for Spain

What are the reasons for including a species in a quarantine list? Key elements of risk analysis include: (1) the probability of an adverse event, (2) the magnitude of the consequences of the adverse event, and (3) the uncertainty associated with the information used for assessment (Griffin, 2000). In a globalized world, where many useful plant species are the subject of intense free trade for food, fibre, forage, pharmacy, aromatic and ornamental purposes and can become invasive weeds depending on circumstances, it is a basic to define the risks involved.

The simplest criteria established for parasites and pests in a number of countries are as follows:

a) Not widespread in the country or area to be protected;
b) Dangerous due to its growth rate, spreading capability or its noxiousness in a particular crop or environment, its toxicity for humans or cattle, the likelihood of its causing ecological damage, and these effects demonstrated elsewhere in the world;
c) Problematic to manage or control.

A preliminary Spanish list

With the aim of presenting a draft according to the classification of the Directive 77/93/CEE of the European Commission for pests and diseases, the more frequent exotic species quoted in the bibliography are included (García Torres, 1993; Jauzein, 1998; Recasens & Conesa, 1998; Del Monte & Martinez, 1999; Weber & Gut, 1999; Sanz *et al.*, 2001) in different sections. Alien species naturalized for more than 100 years and others not fitting criteria b) or c) have been eliminated from the lists. Some invasive native species are included in Section II. The great climatic and ecosystemic diversity of Spain, together with the changes in climate, must be taken into account to explain why some tropical plants could be considered a threat in irrigated lands, especially near the Mediterranean and the South of the Iberian Peninsula.

Part A: Noxious species whose introduction and spread must be controlled in Spain.

Section I: Noxious species whose presence has not been registered but whose effects are important (* mainly agricultural weeds)

**Ambrosia gigantea*
Amorpha fruticosa
**Asclepias syriaca*
Cyclachaena xanthiifolia
Heracleum mantegazzianum
**Hypericum calycinum*
**Impatiens glandulifera*
**Impatiens parviflora*
Orobanche minor
Parthenium histerophorus
**Reynoutria sachalinensis*
**Rottboellia cochinchinensis*
**Salvinia molesta*
**Sicyos angulatus*
**Solanum eleagnifolium*
Solanum viarum
Solidago gigantea
**Striga asiatica*
**Verbesina encelioides*
**Zantedeschia aethiopica*

Section II: Noxious species whose presence is already registered and whose effects are important (should be controlled on a regional scale).

**Abutilon theophrasti*
Achillea filipendulina
Achiranthes sicula
Albizia distachia (Canary Isl.)
**Amaranthus albus*
**Amaranthus powellii*
**Ambrosia artemisifolia*
Ammannia aegyptiaca
Ammannia coccinea
**Amsinckia calycina*
**Amsinckia lycopsoides*
Apium leptophyllum
**Apium nodiflorum*
**Araujia sericifera*
Asclepias curassavica
Baldellia ranunculoides

**Bergia capensis*
**Bidens aurea*
**Bidens subalternans*
**Centaurea diluta*
**Conyza blackei*
Cortaderia selloana
**Cyperus eragrostis*
Chamaesyce humifusa
Chamaesyce maculata
Chamaesyce nutans
Chamaesyce polygonifolia
**Chamaesyce prostrata*
**Chamaesyce serpens*
**Chloris gayana*
**Cuscuta campestris*
**Cuscuta epithymum*
**Datura inoxia*
**Datura stramonium*
Echinochloa oryzicola (E. phyllopogon)
Eclipta prostrata
Eichornia crassipes
**Eleusine indica*
Eschscholzia californica (Canary Isl.)
**Euphorbia polygalifolia*
Fallopia baldshuanica
Glyceria fluitans
Heliotropium curassavicum
**Heteranthera limosa*
**Heteranthera reniformis*
**Heteranthera rotundifolia*
Imperata cylindrica
**Ipomea purpurea*
**Leersia oryzoides*
**Leptochloa fascicularis*
**Leptochloa uninervia*
**Lindernia dubia*
**Najas gracilisima*
**Nicotiana glauca*
Oenothera biennis
**Orobanche cernua*
**Orobanche crenata*
**Orobanche ramosa*
**Oxalis latifolia*
**Paspalum dilatatum*
**Panicum capillare*
**Panicum dichotomiflorum*
**Pennisetum clandestinum*
Pennisetum setaceum (Canary Isl.)
Phytolaca americana
**Pelargonium capitatum (Canary Isl.)*
**Potamogeton pusillus*
Reynoutria japonica
**Senecio inaequidens*
**Sesbania exaltata*
**Sida spinosa*
**Solanum physalifolium*
**Solanum sarrachoides*
**Solanum sisymbrifolium*
Tropaeolum majus

Part B: Noxious species whose introduction and spread must be controlled in determined protected areas (wetlands, coastal and disturbed habitats, etc.)

Agerantina adenophora
Arctotheca calendula
Artemisia velotiorum
Azolla caroliniana
Azolla filiculoides
Carpobrotus acinaciformis
Carpobrotus edulis
Cortaderia selloana
Heterotheca subaxillaris
Opuntia dillanii
Paspalum vaginatum
Pennisetum setaceum (islands)
Spartina densiflora