CHAPTER 10

EXOTIC AND INVASIVE PLANTS OF THE CAATINGAS OF THE SÃO FRANCISCO RIVER

Authors: Juliano Ricardo Fabricante[1];
José Alves de Siqueira Filho[1]

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Calotropis procera plants, besides swift establishment in recently formed areas of the project, mature precociously; fruits and seeds are produced year round and are dispersed by the wind

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Leucaena leucocephala

INTRODUCTION

According to the Convention on Biological Diversity (CBD, 2005), an exotic species is one that is found outside the area of its natural geographic distribution. An invasive exotic species is one that threatens ecosystems, habitats and other species in an area where it did not originate.

Resolution Conabio nº 5 dated October 21, 2009, deals with the strategy to cope with invasive exotic species in Brazil. It defines as exotic or allochthonous a species or lower taxon or interspecific hybrid introduced outside its area of natural distribution, past or present, including individuals in any stage of development or part there of that are able to reproduce. It also defines invasive exotic or allochthonous species as exotic species whose introduction, reintroduction or dispersal represents risks or negative impacts on society, the economy or the environment (MMA, 2009).

In both definitions, the difference between exotic species and invasive exotic species lies in the capacity that certain exotic species have to expand their population and to bring about changes in the new environment where they were introduced. However, this definition generates operational problems due its subjectivity, since it does not establish the level, degree, amount or quality of impact that a species must provoke to be considered invasive.

It is a known fact that any species that is added to an ecosystem will modify it to a greater or lesser extent. The simple presence of a group of individuals can locally change species richness, equitability and diversity, resource availability and energy flow, among other biophysical elements of the habitat. Therefore, various authors have adopted the biogeographic criterion of population growth and dispersal, without explicitly taking into consideration the impact criterion, to define invasive exotic species (Vermeij, 1996; Rejmánek, 1999; Richardson, 2001; Pysek *et al.*, 2004).

THE IMPORTANCE OF THE ISSUE

[1] Centro de Referência para Recuperação de Áreas Degradadas da Caatinga, Universidade Federal do Vale do São Francisco, Petrolina, Pernambuco

Biological invasions are one of the most serious threats to biodiversity on the planet (Williamson, 1996; Meffe & Carroll, 1997; Zenni & Ziller, 2011). The effects of this phenomenon are second only to those of habitat destruction brought about by man's exploitation (Ziller, 2001). However, unlike other environmental problems that decrease over time, biological invasions tend to get worse as time passes (Westbrooks, 1998; Andrade *et al.*, 2010).

According to Parker *et al.* (1999), bioinvasions can cause impacts at various levels, including effects on individuals (morphology, behavior, growth and mortality); genetic effects (alteration of patterns of gene flow, hybridization); effects on population dynamics (abundance, population growth, extinction), communities (richness, diversity, trophic structure) and ecosystem processes (nutrient availability, productivity and disturbance regimes). Therefore, biological invasions interfere with agriculture, cattle raising, human health and the natural environment, provoking serious social and economic harm.

In spite of the lack of official data for most countries that suffer from biological invasions, we estimate that worldwide, losses from bioinvasion are around 1.4 trillion dollars annually, representing about 5% of the global economy (SMA, 2010). In Brazil, these losses would be 42.6 billion dollars (Pimentel *et al.*, 2001). It is important to point out that this figure does not include health costs and those of other sectors of society and, especially, the costs of alteration and loss of natural environments.

Many scientists state emphatically that the translocation of live organisms should be an ultimate, not a primary option to solve econo-

Construction of the Pisf canals facilitates the establishment of invasive exotic species like *Prosopis juliflora* (center) and *Nicotiana glauca* (at left)

mic and/or conservation problems (Magnusson, 2006; Zalba & Ziller, 2007). Still many short-sighted people believe in the potential of these organisms as a source of income or to rectify ecological and environmental problems (GISP, 2005). Experience gathered over the last few years shows that the most efficient and economically viable strategy for facing the problem of biological invasions is to avoid new introductions (Magnusson, 2006; Zalba & Ziller, 2007).

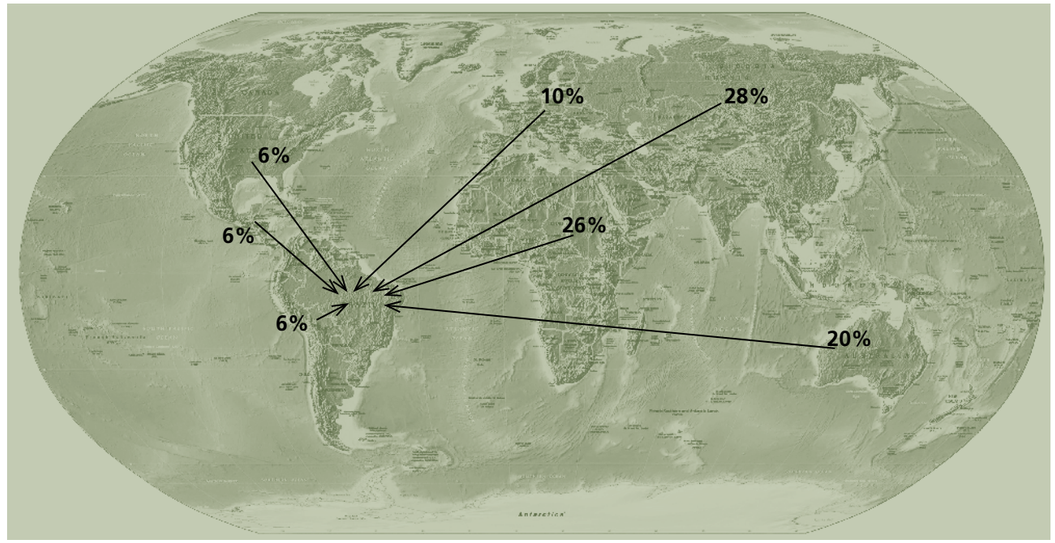
BIOLOGICAL INVASIONS IN BRAZIL

Today, our knowledge is still incipient concerning the problem of biological invasions in the Americas. In light of this and because of the importance of the issue, the Inter-American Biodiversity Information Network (Iabin) was formed, bringing together 18 signatory countries, to note: Argentina, the Bahamas, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Equator, El Salvador, United States, Guatemala, Jamaica, Mexico, Panama, Paraguay, Peru and Uruguay (Iabin, 2009). However, at present, only eight countries have organized an online database that makes available a list of invasive exotic species; Brazil is one of these countries (I3N, 2011a).

Another important measure was the federal government's release of the first document to deal with this issue, on October 21, 2009, Conabio, or Comissão Nacional de Biodiversidade (National Biodiversity Commission, in English) Resolution nº 5, dealing with Brazil's National Strategy on Invasive Exotic Species.

The aim of the Resolution was "to prevent and mitigate the negative impacts of invasive exotic species on the human population, the productive sectors, the environment, and biodiversity by planning and executing measures of prevention, eradication, containment or control of invasive exotic species with joint efforts between the agencies of the federal, state and municipal governments and civil society, including international cooperation".

The Conabio document includes comments on the issue, definitions of terms used, directives, and strategies for implementation of goals. This is an important instrument for the orientation of various spheres of government on the approach to issues relative to invasive exotic species; an important landmark for alteration of the current scenario.



THE STATUS OF OUR KNOWLEDGE ON INVASIVE PLANT SPECIES IN BRAZIL

In Brazil, there are over 100 known plant species that have invaded natural ecosystems (I3N, 2011b; Zenni & Ziller, 2011), and hundreds more infest and cause serious damage and financial loss to agriculture (Aranha *et al.*, 1982; Bacchi *et al.*, 1982; Bacchi *et al.*, 1984; Lorenzi, 1991; Kissmann, 1997; Kissmann & Groth, 1997). It should be mentioned that most of these invasive exotic species are from Asia, Africa and Oceania. However, species from the Americas cause greater problems in natural environments, an example being Pinus taxons that are causing serious impacts along the South-Southeast axis of the country (Ziller & Galvão, 2001; Liesenfeld & Pellegrim, 2004; Zanchetta & Diniz, 2006; Zanchetta & Pinheiro, 2007; Almeida *et al.*, 2010), and *Prosopis juliflora* (Sw.) D.C. in the semi-arid Northeast (Pegado *et al.*, 2006; Andrade *et al.*, 2008; Andrade *et al.*, 2009; Andrade *et al.*, 2010; Fabricante *et al.*, 2010).

As regards the notorious costs of biological invasions, information is still lacking on the true impacts of invasive exotic species on biodiversity and the physical environment. Even the simplest questions have not yet been answered, such as: What is the area of geographic distribution of the main invaders in Brazil? How susceptible are Brazilian ecosystems to invasion by species already recognized as problematic in

Above
Estimated frequency per continent of the main invasive species of natural ecosystems in Brazil. Information taken from the database I3N (2011b)

Next double page spread
Melinis repens, a species cited for the first time as an exotic invader of the Caatinga, forms dense flowering clumps along highway BR232 in Serra Talhada, Pernambuco. "Algarobeiras" (*Prosopis juliflora*) in the background

Page to the right
Nicotiana glauca, cited for the first time as an exotic invader of Brazil. The species advances rapidly along the axes of the Pisf canals, as in Plot 11, Custódia municipality, Pernambuco

other regions of the world with similar biophysical characteristics? And worse yet, there is no consistent list of invasive exotic species, based on scientific evidence, as was drawn up in countries like Australia, United States, Portugal and Spain.

Given these gaps in our knowledge, papers such as this one gain importance for drawing up more consistent lists for the states and the country of Brazil. Therefore, the present study aimed to survey exotic species in the areas of influence of the São Francisco River Integration Project with Hydrographic Basins of Northern Northeast Brazil (Pisf, in Portuguese) and to infer on those with invasive behavior.

THE SITUATION OF EXOTIC AND INVASIVE SPECIES IN AREAS OF PISF

Metodology

The list of species in this chapter was taken from the results of the floristic inventory carried out from July 2008 to January 2012 within the scope of Pisf (see chapter 13). This list contains the exotic species whose classification was based on the occurrence of sub-spontaneous (exotic) species on the *List of Species of the Brazilian Flora* (Flora do Brasil, 2012), except for taxons with insufficiently known or controversial distribution patterns, classified by means of consultation with specialists responsible for the families in this book (see chapter 13).

Categorization of these species as exotic invaders was established by means of observations in the field taking into consideration the experience of the authors. In this study, an exotic species, whether of accidental or intentional origin, was considered invasive if it were capable of expanding populations into areas of influence of Pisf, forming dense, visually mono-dominant populations.

Taxonomic classification is in agreement with APG III (2009). Authors' names of species are in accordance with the *List of Species of the Brazilian Flora* (2012). To illustrate spatial distribution of the exotic species and exotic invaders in the North and East Axes of Pisf a map was drawn based on geo-referencing of the collections. The software used was ArcGIS 9.3.1© (ESRI, 2009).

Cenchrus ciliaris becomes established in areas of conserved Caatinga. This fact supports the idea that exotic invaders can actually replace native species and provoke harmful negative effects on the biota

Results and discussion

A total of 62 species were identified, distributed in 45 genera and 19 families. Six taxons (9,7% of the total) were considered to be exotic invaders (table 1). Three species were listed for the first time for Brazil (see chapter 13): *Azolla pinnata, Physalis pruinosa* and *Enneapogon cenchroides*.

The most species-rich families were Poaceae, with 24 taxons (38.7%), Solanaceae with six (9,7%), Fabaceae with five (8.1%), Convolvulaceae with four (6.7%) and Amaranthaceae and Lamiaceae with three each (5%). Annonaceae, Apocynaceae, Asteraceae, Cactaceae and Nyctaginaceae had two species (3.2%), and the remaining families had only one taxon (1.6%). The most species-rich families were similar to those cited by Sanz-Elorza *et al.* (2010) in their study of exotic plants carried out in six arid zones of Europe, Africa and America.

Three species (*Melinis repens*, *Nicotiana glauca* and *Prosopis pallida*) considered to be invaders in the study area were not cited by Dossiê Pernambuco (Cepan, 2009) as occurring in the state; they also are not listed in *Livro de Espécies Exóticas Invasoras no Nordeste do Brasil* (Leão *et al.*, 2011) nor are they included in the Institute Hórus de Desenvolvimento e Conservação Ambiental database as invasive exotic species in Caatinga (I3N, 2011b).

In this context, an important species is *N. glauca*, native to northern Argentina and Bolivia and widely distributed in the hot, dry climates of tropical America (Nee, 1986). It is recognized as an important invasive exotic species in Spain (Sanz-Elorza *et al.*, 2004), Australia (Florentine & Westbrooke, 2005) and Namibia (Shapaka *et al.*, 2008), and grows spontaneously in arid zones of the Americas, Africa and Europe (Sanz-Elorza *et al.*, 2010). In the study area, N. glauca forms mono-dominant thickets with hundreds to thousands of plants, and is capable of becoming established in a variety of surroundings, mainly those that are more disturbed, such as steep slopes, areas where vegetation has been suppressed due to the work project and the Caatinga-fragment borders.

Parker & Reichard (1997) listed various studies that confirmed a close relationship between the number of invasive exotic species and the degree of disturbance of the invaded community. Also, low richness and biodiversity have been cited as facilitators for the establishment of bioinvasion processes (Vermeij, 1996; Tillman, 1997; Simberloff & Von Holle, 1999; Pujadas, 2001; Woitke & Dietz, 2002).

Another species, *Calotropis procera* is worth mentioning because of its widespread distribution (Zenni & Ziller, 2011) and tolerance range for edaphic and climatic fators. According to Oliveira *et al.* (2009), it is very resistant to drought, but also grows in wetter habitats, and can invade different types of soil. According to speciesLink (Cria, 2011), this taxon

Table 1
List of exotic species (E) and exotic invaders (I) taken from the results of the floristic survey carried out from 2008 to 2012 by the Projeto de Integração do Rio São Francisco com Bacias Hidrográficas do Nordeste Setentrional (Pisf)

FAMILY/SPECIES	SITUATION
AGAVACEAE	
Agave sisalana Perrine *ex* Engelm.	E
AMARANTHACEAE	
Amaranthus viridis L.	E
Amaranthus blitum L.	E
Amaranthus spinosus L.	E
ANNONACEAE	
Annona reticulata L.	E
Annona squamosa L.	E
APOCYNACEAE	
Calotropis procera (Aiton) W.T. Aiton	I
Cryptostegia grandiflora R. Br.	E
ASTERACEAE	
Artemisia vulgaris L.	E
Bidens pilosa L.	E
CACTACEAE	
Opuntia dillenii (Ker Gawl.) Haw.	E
Opuntia ficus-indica (L.) Mill.	E
CONVOLVULACEAE	
Ipomoea batatas (L.) Lam.	E
Ipomoea triloba L.	E
Ipomoea wrightii A. Gray	E
Jacquemontia tamnifolia (L.) Griseb.	E
CUCURBITACEAE	
Mormodica charantia L.	E
EUPHORBIACEAE	
Ricinus communis L.	E
FABACEAE	
Clitoria ternatea L.	E
Leucaena leucocephala (Lam.) de Wit	E
Prosopis juliflora (Sw.) DC.	I
Prosopis pallida (Humb. & Bonpl. *ex* Willd.) Kunth	I
Tamarindus indica L.	E
LAMIACEAE	
Leonotis nepetifolia (L.) R. Br.	E
Leucas martinicensis (Jacq.) R. Br.	E
MELIACEAE	
Azadirachta indica A. Juss.	E
NYCTAGINACEAE	
Boerhavia diffusa L.	E
Mirabilis jalapa L.	E
PAPAVERACEAE	
Argemone mexicana L.	E
PHYTOLACCACEAE	
Petiveria alliacea L.	E
POACEAE	
Andropogon gayanus Kunth	E
Aristida adscensionis L.	E
Cenchrus ciliaris L.	I
Cenchrus echinatus L.	E
Cynodon dactylon (L.) Pers.	E
Dactyloctenium aegyptium (L.) Willd.	E
Digitaria ciliaris (Retz.) Koeler	E
Digitaria insularis (L.) Fedde	E
Digitaria nuda Schumach.	E
Echinochloa colona (L.) Link	E
Eleusine indica (L.) Gaertn.	E
Enneapogon cechroides (Roem. & Schult.) C. E. Hubb.	E
Eragrotis cilianensis (All.) Vignolo *ex* Janch.	E
Eragrostis pilosa (L.) P. Beauv.	E
Eragrostis tenella (L.) P. Beauv. *ex* Roem. & Schult.	E
Megathyrsus maximus (Jacq.) B. K. Simon & S. W. L. Jacobs	E
Melinis repens (Willd.) Zizka	I
Oryza sativa L.	E
Pennisetum polystachion (L.) Schult.	E
Setaria parviflora (Poir.) Kerguélen	E
Urochloa arrecta (Hack. *ex* T. Durand & Schinz) Morrone & Zuloaga	E
Urochloa decumbens (Stapf) R. D. Webster	E
Urochloa fusca (Sw.) B. F. Hansen & Wuderlin	E
Urochloa mosambicensis (Hack.) Dandy	E
SALVINIACEAE	
Azolla pinnata R. Br.	E
SOLANACEAE	
Datura inoxia Mill.	E
Datura metel L.	E
Nicotiana glauca (L.) Grah.	I
Nicotiana tabacum L.	E
Physalis angulata L.	E
Physalis pruinosa L.	E
SPHENOCLEACEAE	
Sphenoclea zeylanica Gaertn.	E

occurs in various states of Brazil. It is originally from arid and semi-arid regions in Asia and Africa (Lindley, 1985) and, today, it is widely distributed in the Cerrado and Caatinga domains. According to the risk analysis for invasive plants of the Instituto Hórus (I3N, 2011b), it has "high risk" status.

In Pisf areas, *C. procera* is sympatric with *N. glauca* and invades the same environments. Preliminary studies carried out *in loco* indicate that these species have attributes that reflect negatively on invaded habitats (J.R. Fabricante, unpublished data).

Two other taxons stand out in the study area: *Cenchrus ciliares* and *M. repens*. In contrast to other species that are opportunists and mainly invade disturbed sites, *C. ciliaris* and *M. repens* (especially) also occur in well-preserved Caatinga, taking advantage of specific sites such as those with shallow soils, as well as cracks and depressions in rocky outcrops.

One of the invasive exotic species in Pisf areas is already a well-known threat to the biodiversity of the Caatinga: *Prosopis juliflora* (Pegado *et al.*, 2006; Andrade *et al.*, 2008; Andrade *et al.*, 2009; Andrade *et al.*, 2010; Fabricante *et al.*, 2010). It is very aggressive, is easily dispersed in man-made environments and is capable of interfering with the

Page to the left
Prosopis pallida is confused many times with *P. juliflora*, due to similarity of the habitat

Below
Datura inoxia is subspontaneous in Pisf areas; it has not yet overcome environmental barriers to assume the role of invader

Page to the right
Argemone mexicana, originally from Central America, is widespread today in many dry regions of the globe. The species is becoming more common every day in Pisf areas

resilience of ecosystems that it invades (Andrade *et al*., 2010). According to Fabricante *et al*. (2010), the difference in the number of native species between areas with and without *P. juliflora* can be as great as 90%, and the reduction in abundance of native species at the invaded sites is over 80%. It is estimated that, today, the extent of the area invaded by this species is around one million hectares (Andrade *et al*., 2010). In Pisf areas, *P. juliflora* is quite common, appearing mainly at sites where riverine forests would usually occur, in patches of Fluvial Neosols and on sedimentary lowlands.

Another species of *Prosopis* was found in the study area: *P. pallida*. This suggests that the semi-arid Northeast is being invaded by more than one species of this genus. The differentiation of the two taxons mentioned in this chapter is very subtle in terms of morphology, so this may have caused a sweeping identification of the species as *P. juliflora*. The description of both species, as well as detailed information on how to differentiate *P. juliflora* and *P. pallida*, is found in the studies of Pasiecznik *et al*. (2001), Harris *et al*. (2003), Pasiecznik *et al*. (2004), Landeras *et al*. (2006) and Gallaher & Merlin (2010).

According to Pasiecznik *et al.* (2001), most species of *Prosopis* can survive in areas with low rainfall and long dry periods that facilitate the establishment and dissemination of this species in regions such as the one under study. Several species of *Prosopis* are regarded as being extremely aggressive while others are seen as true invaders (NAS, 1980). It should be remembered that, in the 1980s, Embrapa Semiárido carried out experiments with other species of *Prosopis* (Lima, 2005) and, given the high capacity of adaptation and dispersal of these taxons, the existence of other species in the region is very likely.

A special case must be examined very carefully, and that is the differences in opinion between authors on the origin of Parkinsonia aculeata. For Martius *et al.* (1870), Rizzini (1963) and Lorenzi (2008), the species occurs naturally in Brazil. But, this species is cited as subspontaneous on the *List of Species of the Brazilian Flora* (2012).

Information provided in a compilation of studies by Fabricante & Feitosa (2010) indicates that *P. aculeata* occurs naturally in most of Central and South America, including Brazil, in two separate regions: sub-humid and semi-arid Northeast and the southern extremity of Rio Grande do Sul. The authors, however, argue that populations of *P. aculeata* exhibit behavior different from that of other species of the Caatinga. In these plant formations, *P. aculeata* grows in seasonally flooded habitats, with characteristics similar to those shown in other regions of the globe, where it is causing serious economic and environmental problems (Fabricante *et al.*, 2009).

Page to the left
The grass, *Enneapogon cenchroides*, a native of Africa, is one of the species cited for the first time in Brazil

The aquatic macrophyte, *A. pinnata*, is originally from Asia and Africa (Hasan & Chakrabarti, 2009). It was found in the main channel of the São Francisco River in the municipality of Cabrobó, Pernambuco, in an area considered to be of extreme importance for biodiversity conservation (MMA, 2007). It may have been introduced accidentally through piscicultural tecniques in the 1970s by the former Companhia de Desenvolvimento do Vale do São Francisco (Codevasf) but was only now recorded in Brazil, as were *P. pruinosa* and *E. cenchroides*.

Physalis pruinosa on the other hand, is originally from Mexico (Martínez, 1993) and is classified as an invasive species in other countries like India (Reddy, 2008) and Japan (Mito & Uesugi, 2004). *E. cenchroides* was collected near the perimeter irrigation canals in Petrolina, Pernambuco, and Juazeiro, Bahia. It was observed for the first time in the Americas in the state of Arizona (USA) in 2006 (McClaran & Nafus, 2007).

In view of the situation described in this chapter, we present here one of the directives of Resolution Conabio nº5 (21/10/2009): *Mitigation of impacts – Once an established invasive exotic species is detected, the states, alone or in cooperation, should adopt appropriate measures, such as eradication, containment and control, to mitigate adverse effects*.

Although the impacts have not been checked in this study, it is not speculation to affirm that regional diversity and habitat resilience are being greatly affected in Pisf areas of influence, due to the large number of exotic species and to the abundance of plants of invasive exotic species. It is pertinent to remember that the Pisf work project crosses areas considered by MMA (2007) as priority for biodiversity conservation. Some are still insufficiently known, thus increasing the need and the urgency for mitigative action.

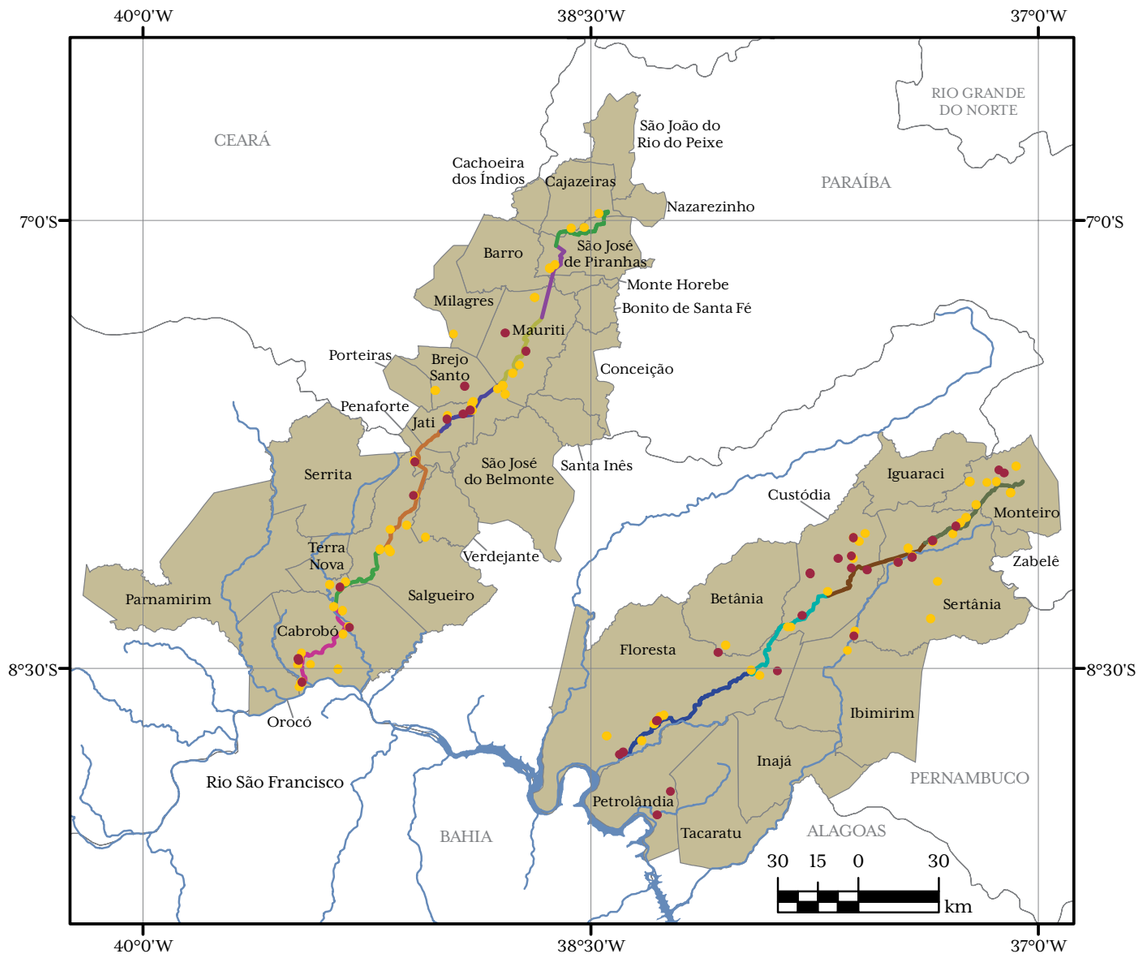
Until now, the other species have small populations established in one or a few points of Pisf areas, and are therefore considered exotic. According to Williamson (1996), about 10% of the introduced species become naturalized, and only 10% actually become harmful. These numbers coincide with those found in the present study, where 10% of the observed exotic species showed invasive behavior.

In the literature, some intrinsic characteristics of these species are mentioned as traits that may contribute to plants becoming invaders: the production of large quantities of small seeds, precocious maturation, efficient soil seed-bank formation, effective asexual and sexual reproduction, seeds with dormancy that guarantees periodic germination when conditions are favorable, dispersal by animals or wind, biological toxin production that blocks establishment and/or growth of other plants (allelopathy), capacity as parasites, long periods of bud-

Opuntia ficus-indica is a widespread forage species in the semi-arid and sub-humid regions of the Northeast

ding and fruiting, lack of specific requirements for germination, fast growth, efficient dispersal and self-fertilization mechanisms are some examples (Burke & Grime, 1996; Randall & Marinelli, 1996; Binggeli *et al.*, 1998; Westbrooks, 1998; Alpert *et al.*, 2000; Elfadl & Luukkanen, 2006; Shiferaw *et al.*, 2004; El-Keblawy & Al-Rawai, 2007; Lawes & Grice, 2007; Leal *et al.*, 2012; Reaser *et al.*, 2007; Richardson *et al.*, 2007; Santana & Encinas, 2008; Andrade *et al.*, 2008). On the other hand, Mack *et al.* (2000) suggested that these species survive and become established in the new environment not because they have differentiated morpho-physiological traits, but because they have been dispersed to where they have competitive advantages, because they are free of their competitors, predators, parasites and pathogens.

It is clear, however, that some of the species thought to be exotic in this study are admittedly invaders at other sites (*Azadirachta indica*, *Cryptostegia grandiflora*, *Leucaena leucocephala*, *Mormodica charantia*, *Physalis pruinosa*, *Ricinus*



Map of Exotic and Invasive Species in the Pisf Area
Distribution of the collections of exotic and invasive plants for the North and East Axes of the Projeto de Integração do Rio São Francisco com Bacias do Nordeste Setentrional (Pisf)
Source: Brasil (2004, 2006, 2010) with alterations

Legends
- Exotic
- Exotic Invasive
- Hydrography
- AID
- ADA

North Axis
- Plot 1
- Plot 2
- Plot 3
- Plot 4
- Plot 5
- Plot 6
- Plot 7

East Axis
- Plot 9
- Plot 10
- Plot 11
- Plot 12

communis and almost all the Poaceae), which suggests that a change in this situation may be only a question of time. Many plants have a phase of relatively long latency, during which their number is more or less constant (Le Floc'h, 1991). Degraded habitats such as the ones analyzed here may favor the survival of exotic species, until new conditions make expansion possible and they become true invaders.

Given the above, immediate intervention aimed at excluding these species would be a way to prevent new cases of biological invasion. This measure fits within the "The Precautionary Principle", Principle 15 of the Declaration of the Rio 92 Conference on Environment and Development (Cnumad, 1992), according to which the lack of clear scientific proof does not have to be presented as a reason for not adopting measures that aim to prevent environmental degradation.

In practically the entire extent of Pisf canals exotic species and invading exotic species were collected. It is pertinent to mention that the distribution of points on the following map greatly underestimate the reality observed in field. Many of the species were sampled only once due to lack of fertile material at times or because it was not necessary to make new collections of some taxons.

FINAL CONSIDERATIONS

Exotic species represent a little over 5% of the flora of Pisf areas. Although this suggests low representation, these numbers cannot be ignored, considering the effects (impacts) that they may have on the physical environment and on native species.

A little over half a century ago, the subject of biological invasion began to gain prominence in the scientific community, and the subject also began to interest the public due to the economic harm that bioinvasion can cause. It is well-known that habitats degraded and/or modified by man offer conditions that facilitate the establishment of biological invasion processes. The construction of Pisf canals and reservoirs, besides degrading the Caatingas, created hundreds of kilometers of empty niches, where exotic species are capable of becoming established and reproducing without difficulty. It has already been proven in Pisf areas of influence the existence of dense mono-dominant populations of exotic species, indubitably characterizing processes of biological invasion.

This study is a pioneer initiative for the semi-arid Northeast and reveals a problem that is quietly growing each day with serious the social and environmental consequences. The situation must be monitored, public policies elaborated and strategies adopted for the control or management of these species by competent public agencies and these measures are urgent and of utmost importance.

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