Point of View

Proposals to prevent and control exotic invasive species[1]

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ABSTRACT. Invasive alien species are currently recognized as the second global cause for the loss of biological diversity in the world. This theme is still little known in Brazil as well as the South American continent where there is a lack of basic information, public policies and legal frameworks, prevention and control programs and academic and corporate perception about the seriousness of the problem. The objective of this article is to propose some bases for the subject involving fundamental concepts established in the Convention on Biological Diversity, basic science issues regarding biological invasions such as propagule pressure, vectors and routes of dispersion and risk analysis, and discuss action priorities.

Key words: biological invasion, biological contamination, routes of dispersion, vectors of dispersion, risk analysis.

INTRODUCTION

Invasive alien species are considered the second leading cause for the loss of biodiversity in the world. They are present in every environment, although their presence and impacts are still little noticed by the public (Baskin, 2002; Vázquez and Aragon 2002; GISP, 2005).

Without a doubt, in the history of the planet's evolution, species have always moved about between different geographic points and different environments. However, the rhythm of this movement was incomparably slow compared to the flow that has been established over recent centuries, and most especially, recent decades, when the means of transportation, commercial and tourism routes were greatly expanded and facilitated. There are invasive species in Brazil such as the African oil palm that entered the country with the slaves, brought by the Portuguese caravels. Today, they have negative impacts on the functioning of ecosystems and on biodiversity, but in many cases they took considerable time to adapt and received human help for such due to their cultivation and the special care they received.

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This more intense movement of species outside their natural distribution areas led to biological invasion processes. Most of the species, between 75 and 85%, which invade terrestrial environments and continental waters, are introduced in an intentional manner for direct or indirect human use (Hayden Reichard & White, 2001). In the case of insect species and other land invertebrates, as well as for marine organisms, this tendency is the opposite. In other words, most of them are introduced accidentally, in ballast water or on ships that cross natural boundaries that had remained constant during millions of years of evolution.

Another relevant factor to consider is the influence of global warming as an ally for biological invasion. Disturbances in the natural distribution of species, caused by weather factors, tend to favor the advance of exotic invasive species that easily adapt to degraded areas are mostly pioneers in prolific reproduction and rapid growth.

These factors made biological invasions one of the main themes discussed in the International Convention on Biological Diversity (CDB, 2006). Article 8h deals with the clauses assumed by the countries that signed on to combat the problem (CDB Article 8h, s.d.). Decision VI/23 includes guidelines for the prevention, introduction and mitigation of impacts by exotic invasive species (CDB Decision VI/23, s.d.) and Decision VII-13 (CDB Decision VII/13, s.d.) brings many considerations and recommendations agreed upon at the COP 8, in 2006.

EXOTIC SPECIES AND EXOTIC INVADERS

According to the Convention on Biological Diversity, the term exotic species refers to a species, subspecies or lower taxon introduced outside its past or present natural distribution area. It includes any part, gamete, seed, egg or propagulum of these species that may survive and subsequently reproduce. Exotic invasive species are the ones whose introduction and/or dispersion threaten biological diversity (CDB Decision VI/23, s.d.).

Therefore, the expression native species refers to species within their natural distribution borders in evolutive terms, in other words, inside environmental and not political borders. Species moved from one ecosystem to another within the same country are as exotic as non-national species and they also have a high potential for risk and damage.

The invasion process

One of the greatest challenges in working with invasive alienspecies is the difficulty in making people understand that the invasion is a dynamic and growing process and not a stable fact (FIGURE 1). When a species overcomes geographical barriers that limit it to its natural distribution area and it is introduced in a new environment, three situations can develop: it does not survive, it establishes itself and only persists locally, or it becomes invasive.

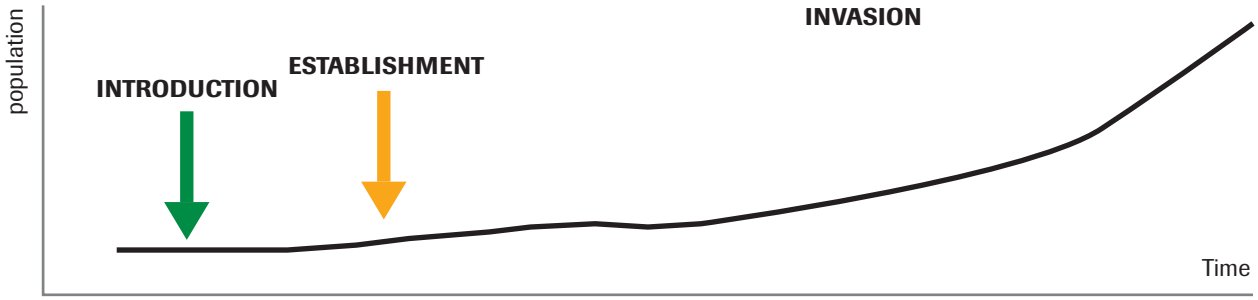

Figure 1: The biological invasion process.

Once introduced, the species need to overcome environmental barriers to survive. These range from climatic and soil conditions to attacks by predators and pathogens. Once these barriers have been overcome, a species is considered established when it begins to form self-regenerative populations, that is, it begins to reproduce locally. This is the second step in the invasion process.

The third barrier the species needs to overcome to become an invader refers to dispersion capacity beyond the point where it was introduced. Once a species finds a manner to propagate to broader areas, whether through physical means such as the wind, by association with another species that function as their dispersers, by human's indirect help (for example, in the case of species that propagate following irrigation canals or the edges of roads or trails) or by their own means, as is the case with animals, it is considered an invasive species.

The time that lapses from the moment the species is introduced and the deflagration of the invasion process is called the lag phase (Mack et al., 2000). This time is unpredictable because it varies for every species in every environmental situation and it depends on factors such as maturing until sexual reproduction, the time necessary to produce large numbers of seeds or descendants, the number of years between favorable climate cycles for their establishment, or a combination of these and other factors. The lag phase also depends on propagule pressure, measured by introduction effort, whether by the number of species individuals introduced, or the number of introduction repetitions. Both of these factors increase the chances for establishment. Invasions comparatively progress faster when the species is introduced in several separate geographic areas than when they are limited to a single point (Mack et al. 2000).This is one of the reasons why species to be used as a crop or for raising should not have invasive potential.

In Germany, it is now known that more than 50% of the exotic species that became invasive took more than 200 years to set off the invasion process (Mack et al. 2000). Mild climates facilitate the process and tend to generate shorter lag phases. The lag phase is followed by an exponential growth phase that continues until the species reaches the spatial limits of its new distribution area and then reduces its population growth (Mack et al. 2000).

It is difficult to distinguish the lag phase of exotic invasive species since this is paradoxically the period when the potential for its successful eradication and control is the greatest (Wittenberg and Cook, 2001). For this reason, the species invasive history is of utmost relevance. It is fundamental to work on preventing problems and eliminating risks before the invasion can be put into effect, seeking the species past history in other parts of the world as a reference. This is still the best indicator of invasion risk, despite the many research efforts directed towards defining clear characteristics to configure species that become problematic (Williamson, 1996). Not acting implies favoring the invasion and missing the opportunity to solve the problem at the outset, often leading to the impossibility for definitive solutions and to living with long-term control processes, whether due to a lack of financial resources or the difficulty in eradication.

When the movement of species between environments was eventual, natural or even random, that is, when people transported them without any notion of the ideal environmental conditions for their establishment, it can be said that most died due to their incapacity to adapt. A hypothesis entitled the Rule of 10 was developed and affirms that only about 10% of the introduced species have conditions to survive and only 10% of those, that is, 1% of the total, has the chance to become an invasive species (Williamson, 1996). These numbers are didactic to explain the process, and in reality, they would be very appropriate if it were not for the technology currently used for climate modeling and comparisons

between environments and soil types, which greatly increases the possibility of establishing these species in new environments and strengthens the creation of exotic invasive species, greatly increasing this percentage, as the authors of this article have observed after over more than a decade of working with invasive species.

After all, the characteristics that are common to many invasive species are the same that are generally wanted for rural and economic development: easy reproduction, rapid growth, competitive vigor, flexibility for adaptation to diverse environments, short juvenile period, abundant production of descendants, capacity for dominance and good dispersion capacity, among others (Rejmánek and Richardson, 1996; Rejmánek, 1996; Mack et al., 2000).

By virtue of the large predominance of intentional introductions, the fact that an exotic species becomes invasive is more a human than a biological process (Baskin, 2002), since the natural movement of the species rarely generate high levels of environmental, social, cultural and economic impact.

Voluntary and accidental introduction

According to statistics calculated from the exotic invasive species database maintained by the Hórus Institute and The Nature Conservancy (www.institutohorus.org.br/trabalhosa_levantamento.htm), almost 75% of the species introduced in land and freshwater ecosystems in Brazil were brought for economic purposes. There are many examples of species that never achieved an established market and due to lack of demand were abandoned whereby they adapted to natural environments and became invasive. The giant African snail, *Achatina fulica,* is probably the most acute example, being present in urban areas throughout the country and expanding its distribution area to natural environments, at least in the Atlantic Forest, in the township of Morretes – PR (Fischer et al., 2006). The species was illegally introduced in 1972 and broadly disseminated for cultivation, even by government agencies, however there was never any prior market survey to verify the initiative's economic feasibility. There was not even any risk analysis prior to introduction, which would have easily shown the damage history in other parts of the world, such as Hawaii and Florida in the United States. (Simberloff et al., 1997)

VECTORS AND ROUTES

Most of the vectors and routes of dispersion for exotic invasive species are associated with the commercial movement of products and tourism. Vectors refer to the physical means by which species are transported, such as ballast water, ship hulls, sand, vehicle tires, agriculture machinery, packages and containers. The dispersion pathways are the tracks over which species travel, whether commercial maritime or air routes, in the transportation of products or passengers, highways, waterways, etc.

The analysis of dispersion pathways is a basic step to evaluate from where the next exotic invasive species tend to come. When allied with climate modeling to verify in which regions of the planet there is greater potential for adapting new species in a country or region, it is possible to optimize inspection at borders and establish norms and practices to reduce the potential for accidentally introducing a species. One example is the definition of norms to transport products in wood packages, being discussed at the World Trade Organization (WTO), which aims at avoiding the entry of insects with any potential for environmental damage or becoming an agricultural pest (WTO, 2000).

RISK ANALYSIS

Risk analysis is a basic preventive measure where the objective is to prevent the voluntary introduction of exotic invasive species. It is a protocol with questions related to species ecology and biology, to its invasion history in other parts of the world and other environmental issues that evaluate the potential for

adaptation and invasion. The best existing protocol was developed by the Australian Quarantine Inspection Service (NWRAS Review Group, 2006a and 2006b), later adapted to other realities such as New Zealand, Hawaii, the United States and the Galapagos Islands in Ecuador.

Evaluations carried out after species introduction show that up to 85% of all current invasive species would have been detected before their introduction by using this system. From the risk analyses carried out in Australia, about 30% of all species whose introduction is requested are rejected, avoiding environmental, social and economic harm (Daehler and Carino, 2000; Mack et al., 2000). In New Zealand, all correspondence handled by the post office is checked by dogs trained to detect biological material when it arrives in the country. This system reduced entry of the fruit fly, which used to cause frequent financial damage to agriculture production. The result of this action alone covers the cost for the entire mail verification system in the country, and it avoids allowing other species to become a problem.

CONCLUSION: A STRATEGY FOR EXOTIC INVASIVE SPECIES

Although several exotic species have their place in the generation of income and jobs, with an established market, it is important to consider the cultural and social aspects involved. It is common for exotic invasive species inserted in the market generate benefits for small private social groups and the damage associated with the invasion process used to be socialized. In other words, they are shared by civil society and are often seen as problems to be solved by the government with public resources.

Appropriate practices need to be incorporated to manage these species in order to attribute control costs to the beneficiaries and those responsible for the introduction. In this case, the polluter-payer principle can be applied, by considering the invasion process as a form of biological pollution and considering total environmental, economic and social costs associated with the species proliferation beyond the point where it was initially introduced.

The legal and political infrastructure for prevention, control and eradication of the exotic invasive species has yet to be developed in most countries. There are many elements to consider, and no doubt there is room for work and responsibilities to establish an efficient system on the part of civil society, the private, government and tertiary sectors. This system is normally called a strategy for exotic invasive species, handled on a national and regional level, containing elements that involve prevention, control, technical training, creation of public policies and legal frameworks, education, research, financing and integrated management between diverse sectors of society and ministries.

Among these fundamental issues, many initiatives are sometimes simple to carry out, requiring more perception and implementation than large sums of funds.

A basic issue is the edition of official lists of exotic invasive species for public reference.

Some examples of actions to be carried out are listed below with the intent of serving as a guide, so diverse groups can contribute to avoid and solve problems related to exotic invasive species.

With regard to cultivation:

- Do not cultivate or commercialize exotic invasive ornamental plants, especially if seed dispersion is carried out by birds or other animals and if use will be in a rural environment or areas near natural environments (see www.institutohorus.org.br/trabalhosa_ornamentais.htm);

- Do not use exotic invasive plants in landscaping projects;

- Incorporate dissemination prevention practices and control routines to the handling of exotic invasive species that are cultivated. If species dispersion is carried out by animals, alternatives must be sought to use other species whose contention is more feasible;

- Do not use exotic species in environmental restoration projects;

With regard to training and education:

- Incorporate the biological invasion theme to school disciplines and stimulate students to carry out research about the theme in order to prepare professionals in the future who can work this issue with scientific knowledge and naturalness.

- Help prepare and train people who work with environmental management and similar areas;

- Be a multiplier and distribute information about exotic invasive species.

With regard to projects for the introduction of new species:

- Before supporting a project to introduce a new species in a specific country or region, evaluate whether there are native or exotic non-invasive species already introduced that may be appropriate to carry out the desired function;

- In introduction projects, promote the complete evaluation of costs, market and projected benefits, including economic, environmental, social and cultural aspects. It is necessary to responsibly evaluate who will receive the benefits and who will suffer the impacts and pay for the costs that result from an invasion process by species in question;

- Prevention plans must be developed to avoid evasions and as well as contingency plans if these occur, especially in the case of nurseries and fish raising projects that use exotic species. It is necessary to be aware that the structures to contain evasions are precarious in general and contention and control measures must be foreseen. The option of working with native species must be appraised. Projects to introduce exotic fish and other aquatic species should not be approved because the potential for invasion is immense and once the invasion occurs, eradication is practically impossible.

With regard to pets:

- Do not release pets into nature. Some are excellent hunters and others establish themselves and occupy the place of native species (see www.institutohorus.org.br/pets.htm).

With regard to research:

- Support research projects that seek to evaluate native species' potential for production, restoration and landscaping;

- Since there is an extreme shortage of information on the topic for Brazilian conditions, applied research must be carried out to help build a framework of good practices and solutions for prevention, eradication, control and management of exotic invasive species, analyses of routes and vectors of dispersion and other themes for immediate application.

With regard to rights:

- Learn about the theme to avoid having denunciations of exotic invasive species be judged as environmental crime, when in reality they are tools for the conservation of biological diversity;

Help create jurisprudence and regulations about the topic, such as official lists of exotic invasive species for public reference, regulations about the use of species with commercial value and risk analyses.

Biological invasions are dynamic processes whose aggravation is not linear in time, but rather exponential while there is sufficient adaptation for the species to undergo population explosion and space occupation processes. There are sufficient cases of impacts on biodiversity as well as the economy, health and cultural values, so there is no doubt about the potential for risk and damage they tend to cause. The increased knowledge and disclosure of information about the theme no doubt helps the public reflect on and review the use of plants, animals and other living beings, and to have better conditions to contribute to the conservation of biodiversity. It also helps technicians and environmental managers to be proactive in treating biological invasions.

It is necessary to avoid excessive care and monitoring recommendations that only favor the growth of biological invasions and result in the loss of opportunity to solve serious problems that require immediate action.

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