

# Linking historical ecology and invasion biology: some lessons from European rabbit introductions into the new world before the nineteenth century

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**Abstract** Historical ecology can provide important insight to understand biological invasions, as some of the most transcendent and successful cases of species introductions occurred hundreds or thousands of years ago. However, studies linking historical ecology and invasion biology are still scarce. In this article, we use the history of European rabbit (*Oryctolagus cuniculus*) introduction into America as an informative case study to highlight the important role of historical ecology in the field of invasion biology. Historical documents show that Spaniards often transported European rabbits to America, starting with the first travels in the fifteenth century. This resulted in frequent European rabbit introduction events into wild ecosystems in both

Central and South America. According to these documents, some of these historical introductions were successful, at least temporally, although only a few European wild rabbit populations persisted in the long-term. This suggests that propagule pressure would have been an important complement to the usually recognized colonizer ability of European rabbits, and that some degree of biotic resistance to rabbit invasion could have existed. According to this example and others previously published, historical ecology would be also useful to evaluate the origin of some species whose distributions have been largely altered by humans since long time, to determine when such species were introduced out of their ranges, to prevent future invasions and/or to alert damage caused by

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invasive species. Overall, our article emphasizes the need for incorporating historical information in the study of invasive species introduced long ago.

**Keywords** Biological invasions · Biotic resistance · Hispanic America · Historical ecology · *Oryctolagus cuniculus* · Propagule pressure

## Historical ecology and biological invasions

The effects of human activities on the world ecosystems are pervasive. Historical approaches are increasingly used to better understand the structure and function of contemporary ecosystems and landscapes that have been affected by human activities for centuries or millennia (Swetnam et al. 1999). The discipline that addresses this historical relationship between human beings and the biosphere at different scales is usually known as “historical ecology” (Szabó 2015; but see also Balée 2006). Almost all the definitions of historical ecology emphasize the interconnectedness of humans and nature in the past, as well as the fact that influences and feedback mechanisms are active in both directions (reviewed in Szabó 2015). Therefore, historical ecology encompasses studies that aim either to understand more about human history with the help of nature phenomena or about nature with the help of history (Szabó 2010). Regarding the latter, history matters in ecology because it aids understanding of current patterns and processes in nature, because it fosters better-informed management and policy decisions, and because it places ecology and conservation in a wider interdisciplinary context (Szabó 2010).

Direct or indirect human-mediated transport is an essential stage in most invasion processes. Therefore, historical ecology should provide important insight into the understanding of biological invasions (Willis and Birks 2006). Humans have transported many species to ecosystems out of their native ranges since time immemorial (Crosby 2004; Gippoliti and Amori 2006). Some of the most successful and transcendent cases of species introductions took place as a result of the development of agriculture and the expansion of domesticated animals, thousands of years ago. In the same sense, the arrival of Europeans in the Caribbean in 1492, and subsequent colonization of the Americas, provides many examples of human-mediated

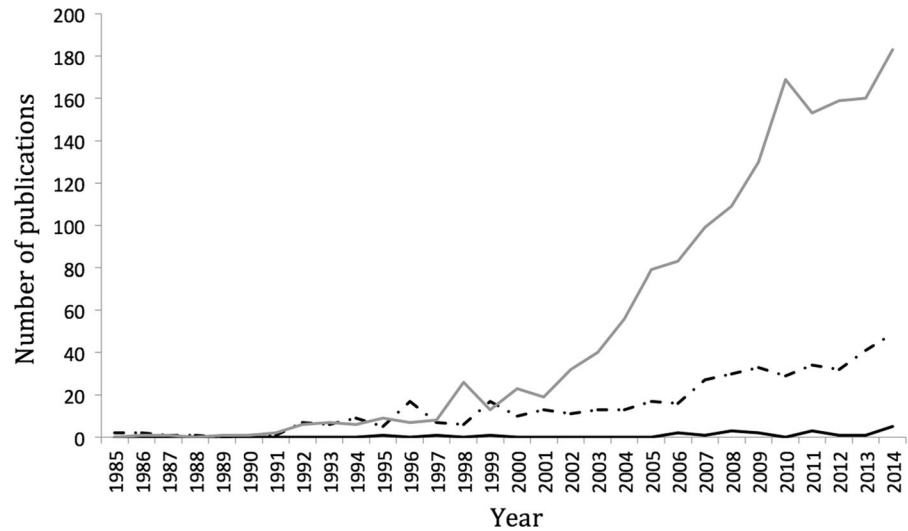
historical introductions. Indeed, the collision of the Old and New Worlds led to a cross-continental movement of dozens of food species (such as potatoes to Europe or the common bean to the New World), domestic animals (such as the cow or pig to the Americas or the turkey to Europe), human commensals (such as the black rat *Rattus rattus* to the Americas), plus accidental transfers (such as many species of worms to North America). All of them contributed to a swift, radical reorganization of life of Earth without precedent, as indicated by Lewis and Maslin (2015). In spite of this, biological invasions that occurred centuries or millennia ago, such as those mentioned above, usually have been ignored in traditional ecological studies (e.g. Clavero 2014; but see Grayson 2001), which have mostly focused on the last decades, when the influence of human activity on the Earth system has increased markedly (Lewis and Maslin 2015).

### A brief bibliometric overview

Both invasion biology and historical ecology are evolving disciplines that have received increasing interest among researchers over the past years, as it shows the increase in the number of publications within both fields (Fig. 1). In spite of this, studies linking both disciplines are still very scarce; for example, only a few articles are published every year including historical ecology and invasion among their topics according the Web of Science (Fig. 1). In the twentieth century, historical ecology for the most part focused on the interactions between humans and vegetation, usually forest (Szabó 2015). However, recently zoologists have also begun to contribute to this field; for example, historical information has been used recently to describe changes in wildlife species' distribution ranges (Clavero and Delibes 2013; Li et al. 2015). Among studies linking historical ecology and invasion biology, those addressing the evolution of vegetation seem also to predominate. In contrast, investigations dealing with historical wildlife invasions are apparently scarcer (Table 1).

The sources of information used in historical ecology studies are highly diverse (Swetnam et al. 1999), and particularly in those dealing with biological invasions (Table 1 and references therein). According to Swetnam et al. (1999), archival records are classifiable as “natural” and “documentary”. Natural archives are

**Fig. 1** Evolution of the number of publications that contained among their topics (title, abstract or keywords) the terms “Biological Invasion” (grey solid line), “Historical Ecology” (black dashed line), and “Historical Ecology” and “Invasion” or “Invasive” or “Exotic” (black solid line) according to the Web of Science (WoS) database from 1985 to 2014



those “recorded” by earth-system processes, such as sedimentation, animal deposits, annual plant and animal growth cycles, and other layered records (see examples in Swetnam et al. 1999). For example, pollen of American native *Zea mays* (maize/corn), which preserves very well, first appears in a European marine sediment core in 1600 (Mercuri et al. 2012; see also Table 1). Documentary archives include written accounts and records, such as the old chronicles that reported early European rabbit (*Oryctolagus cuniculus*) introductions in America (see below) or spreadsheet with records of explorers (Table 1). Furthermore, historical information has been also gathered from other documentary archives like old maps or photographs to assess patterns and processes associated with biological invasions (Table 1). Interestingly, some studies combined different methods and data sources (Table 1), because this can extend information about environmental processes across a broad range of temporal and spatial scales (Swetnam et al. 1999; but see also McCune et al. 2013).

Historical ecological investigations have been conducted at very different temporal and spatial scales (Swetnam et al. 1999). In the particular case of historical studies on invasive species, the time frame spans from decades to centuries and millennia (Table 1). Nevertheless, most historical ecological studies cover the past 200 years (Szabó and Hédl 2011; see also Table 1), although most landscapes have been heavily influenced by humans for millennia (Birks et al. 1998). One usually needs a perspective

longer than two centuries to appreciate the effects of humans on ecosystems (Szabó and Hédl 2011), and particularly to understand human-mediated introductions (Clavero 2014). The spatial extent of many historical ecological studies related to biological invasions is rather local or regional (Table 1). The main reason explaining this fact might be that historical sources are usually precisely defined in time, but not in space (Szabó and Hédl 2011). From this point of view, conducting studies about biological invasions at large spatial scales using historical information is challenging.

Following, we will use the history of European rabbit introduction into America as a pertinent and informative case study, covering several centuries and a whole continent, to highlight the important role of historical ecology in the field of invasion biology, in order to stimulate researchers to link both disciplines. Using this example and other previously published in the literature, we will identify several potential applications of historical ecology to better understand biological invasions and to manage efficiently the risk that invasive species pose for native ecosystems.

### The introduction of European rabbits in America as a case study

Originated in south-western Europe, European rabbits are considered to be able colonizers of new environments, due to their high ecological adaptability, which

**Table 1** Some examples of papers that contained “Historical Ecology” and “invasion” or “invasive” or “exotic” among their topics (title, abstract or keywords) according to the Web of Science (WoS)

Study	Main objective	Study area	Time period	Source of information
Garbarino et al. (2014)	Study the dynamic of pasture patches	European Alps	1954–2000	Aerial photographs
Clavero and Villero (2014)	Describe the long-term dynamics in the distribution of three introduced fish species	Spain	Sixteenth century to present	Historical written accounts
Buisson et al. (2014)	Describe the reference (historical) ecosystem	South-eastern France	Not mentioned	Catalogue with botanical data
McCune et al. (2013)	Review different historical sources that help to understand human-ecosystem interrelationships	British Columbia (Canada)	12,000 years ago (archaeology, paleoecology)/Since 1800s (other sources)	Several (archaeology, paleoecology, written historical records, maps, photographs, etc.)
Restrepo et al. (2012)	Study the impacts of climate variability and human colonization on the vegetation	Galapagos Islands (Ecuador)	Last 2690 years	Fossil pollen record
Jurskis (2009)	Assess the (long-term) conservation of grassy woodlands	South-western New South Wales (Australia)	Early 1800s to present	Spreadsheet with records of explorers
Lavoie and Saint-Louis (2008)	Reconstruct the 100 year history of botanical composition	Bic National Park (Canada)	1904–2005	Several (books, floras, governmental publications, field notes, herbaria, etc.)
Malmstrom et al. (2007)	Investigate whether competition mediated by barley and cereal yellow dwarf viruses may have facilitated historical grassland invasion	California (USA)	Late 1800s and early 1900s	Preserved virus infections in herbarium specimens
Petty et al. (2007)	Synthesize the history and ecological impacts of the rapid expansion and eradication of the exotic Asian water buffalo	Kakadu National Park (Australia)	1880 to present	Records by explorers and settlers
Carroll and Loye (2006)	Map historical changes in the range and density of the Miami blue butterfly and in the ranges of balloon vines	Florida (USA)	1896–1998 (balloon vines)/last 50 years (butterflies)	Florida State Arthropod collection and herbaria
Dutoit and Alard (1995)	Study secondary succession changes in a chalk grassland	Nature Reserve of des Roches de Saint Adrien (France)	1822–1994	Several (maps, aerial photographs, postal letters, local studies on history and geography, etc.)

The main objective of each study, the study area and time period, and the historical sources of information used in each case are shown

is based on their broad diet and environmental tolerance, rapid dispersal, and high reproduction rate (Thompson and King 1994). Rabbits are also furry and edible animals that were semi-domesticated some t-hundreds of years ago, and have been transported to many places for human use (Van Dam 2001). As a consequence, they have successfully invaded several areas in Europe, Africa, Australia, and America, as

well as many islands in the Pacific, off the African coast, New Zealand, and the Caribbean (Flux 1994). In many of these places, European rabbits are regarded as one of the most harmful mammal pests, because of their enormous ability to influence the ecosystems they invade (e.g. Cooke 2012).

In America, introduced European rabbits currently inhabit only some islands and some continental areas



**Fig. 2** European rabbit introductions into Hispanic America between fifteenth and eighteenth centuries. The current distribution of European rabbits in America is represented in grey. References corresponding to each number in the map: 1 Catholic Monarchs (1493. Real Cédula, 23 de Mayo de 1493, Patronato,

9. Archivo General de Indias, Sevilla; quoted in Camps 2003, 2008); 2 Fernández de Oviedo (1535); 3 De la Vega (1609); 4 De Acosta (1590); 5 Pallas (1619); 6 Cobo (1653); 7 Ayesta (1765); 8 Falkner (1774); 9 Molina (1788)

in South America. They are present in Tierra del Fuego and Patagonia in southern Chile and Argentina, in the west-central Argentinian provinces of Mendoza and Neuquén, and in central Chile (Fig. 2; see also Bonino and Soriguer 2009). The history of European rabbit introductions into America has been frequently reviewed in the scientific literature (e.g. Howard and Amaya 1975; Flux 1994; Jaksic 1998; Jaksic et al. 2002; Bonino and Soriguer 2009). However, nearly all of rabbit introductions reported in these studies occurred during the nineteenth and twentieth centuries, whereas earlier cases were ignored or received much less attention (but see Camps 2003, 2008).

Here, we describe the story of European rabbit introductions into Hispanic America prior to the nineteenth century in a context of biological invasions.

Overall, this article does not intend to be an exhaustive review of the introductions of European rabbits into Hispanic America. Yet, we aimed to expand the known story of European rabbit invasions in America more than 300 years to the past, and to explore some potential biological mechanisms that might explain how those historical introductions resulted in the current European rabbit range in America. This information was available in various Spanish historical sources, such as royal decrees, colonial chronicles, natural histories, and descriptions of maritime expeditions, and in articles published on this topic in Spanish popular journals and books (e.g. Fernández de Navarrete 1825; Camps 2003, 2008). Potential cases of rabbit introductions in areas that do not share a Spanish colonial history, such as part of North America, Brazil

and other American territories were not explored, since their analysis would imply the use of different types of non Hispanic sources. Possible introduction records from Mexico and its Viceroyalty of New Spain were also excluded, as there were abundant references to native *Sylvilagus* rabbits in the ancient and colonial Mexican literature, which could have confounded our interpretation of the information.

#### Reports of European rabbit introductions in old chronicles

The transport of domestic animals by the ships that made the first travels between Spain and America was very common. These animals were carried either as a food source for the crew during the long trip or to breed at the destination (e.g. Masseti 2011). As early as October 1493, after the second voyage of Christopher Columbus to the New World, some of these animals, including living European rabbits, arrived to Hispaniola Island (number 1 in Fig. 2). From there, they were supposedly distributed to other islands in the Caribbean area (Catholic Monarchs 1493. Real Cédula, 23 de Mayo de 1493, Patronato, 9. Archivo General de Indias, Sevilla; quoted in Camps 2003, 2008). This might have been the first time that European rabbits arrived in America. A couple of years later, the Spanish Monarchs issued a memorandum authorizing items that should be transported in a voyage of four ships to America; the list of animals included, among others, more than 200 hens, 100 pigs, 6 mares and “as many living rabbits as needed” (Catholic Monarchs 1495. Memorial de las cosas que son menester proveer luego para despacho de cuatro carabelas que vayan para las Indias; quoted in Fernández de Navarrete 1825). This list gives an idea of the importance placed upon the transportation of European rabbits in the Spanish trips to America at the end of fifteenth century.

Around 1535, Gonzalo Fernández de Oviedo provided a good description of the rabbits that he found in Panama, which, in his words, seemed to be autochthonous. Briefly, he wrote that these rabbits looked like hares and their size was smaller than that of Spanish rabbits (Fernández de Oviedo 1535). This description fits well with the characteristics of *Sylvilagus* rabbits, which currently inhabit some areas in Central America, including Panama (Chapman and Flux 1990). However, Fernández de Oviedo said that

in Nicaragua there were also many rabbits like those from Spain. His frequent contact with the “Spanish rabbits” (he stated that he “had eaten many of them”) and the fact that he was able to differentiate these from the native rabbits observed in Panama, make us conclude that the former might be European rabbits that had been introduced to Nicaragua (number 2 in Fig. 2). Besides, Fernández de Oviedo warned about the risks associated with the release of invasive European rabbits into new environments; according to his words, the Canary Islands (Spain) had been ravaged by overabundant introduced rabbits, which had devoured cereal crops.

The first detailed and unequivocal description of a successful European rabbit introduction into the wild within America was narrated by the Inca Garcilaso de la Vega, based on his stay in America until 1560. He stated that European rabbits were introduced to Cuzco (Peru; number 3 in Fig. 2) by Antonio López, a Spanish clergyman, who carried one male and one female rabbits in a cage. According to De la Vega (1609), the pregnant female rabbit escaped and gave birth “in a wild forest of alder trees or poplars”. After that “rabbits bred so fast that they completely covered the land” (page 607). De la Vega (1609) also mentioned that European rabbits were transported from Cuzco to many other places, where they were bred. De la Vega (1609) also wrote that there were rabbits in Quito (Ecuador), but these were slightly different from the Spanish rabbits; according to his words, smaller in size and with darker hair. He was surely referring to *Sylvilagus* rabbits, which again suggests that he was able to differentiate between both types of rabbits, as was the aforementioned Fernández de Oviedo. Nevertheless, the priest José de Acosta stated that in the “Kingdom of Quito” (Ecuador; number 4 in Fig. 2) there were, among other game animals, native rabbits, but he clarified that the best rabbits were those that had been brought from Spain (De Acosta 1590). According to this, European rabbits also had been introduced to Ecuador during the sixteenth century.

At the beginning of the seventeenth century, the Jesuit brother Gerónimo Pallas provided a detailed description of the livestock, poultry, and other domestic animals present in Cartagena de Indias (Colombia; number 5 in Fig. 2). He specified that, after the introduction of the Castilian rabbits, European domestic rabbits occurred with native rabbits (Pallas 1619). It was not stated, however, if European

rabbits had been released (or escaped) into the wild. In this sense, Bernabé Cobo wrote in the first half of this century that wild rabbits belonging to the same species as Spanish rabbits were found in some places of America (Cobo 1653). In addition, he stated that Spanish people bred rabbits in the “Kingdom of Peru” (number 6 in Fig. 2), and that these rabbits were brought from Spain with other European animals by the first sailors. According to this author, there were many rabbitries in Lima, and rabbits were valued economically.

During the second half of the eighteenth century, Spaniards started to look for an appropriate place in the Patagonia to establish a colony. The Cape Horn navigation had begun to be a highly traveled route and France, Britain, and Spain disputed the control of the area (Lacroix 1841; González 1977). In 1765 a ship named Purísima Concepción, which travelled from Cádiz (southern Spain) to El Callao (Peru), was shipwrecked near the coast of Tierra del Fuego in Argentina. One of the survivors, a sailor called José de Ayesta, wrote a diary in which he narrated their experiences until they built a new ship to go back home. Regarding how they obtained food, he wrote: “...at the beginning, indigenous people supplied us with fish and fruits several times...The land was very fertile in the hills, in one of which I cultivated beans and corn...In addition, I introduced many rabbits into the forest” (Ayesta 1765; number 7 in Fig. 2). To our knowledge, this is the first description (and the only one in first person) of an intentional introduction of European rabbits into the wild in America. Although Ayesta’s narration does not tell about the success of that introduction, the truth is that European rabbits were introduced also to Tierra del Fuego, and not only to the Falkland Islands, one century before 1880, which is the earliest introduction date cited in previous studies (Jaksic and Yáñez 1983; Bonino and Soriguer 2009). The lack of emphasis on the introduction of rabbits in the Ayesta’s narration suggests that rabbit transportation by the ships, as well as the attempts made by the sailors to create new rabbit populations into the wild, were not unusual.

In northern Argentinean Patagonia (north of the area currently known as Peninsula de Valdés), Thomas Falkner (1774) described a place called “Bahía sin Fondo”, which he regarded to be perfect to establish a human settlement because, among other things, “there were many rabbits and hares” (number 8 in Fig. 2).

Unfortunately, no additional information about those rabbits was provided but, given that no rabbit species is currently present in that place, it is likely that they were introduced European rabbits. Alternatively, it is also possible that this author confused European rabbits (and hares) with the native Patagonian maras (*Dolichotis patagonum*), although these are nearly eight times larger than European rabbits (Campos et al. 2001).

The first references to European rabbits in Chile are from the end of the eighteenth century (reviewed in Camus et al. 2008; number 9 in Fig. 2). Molina (1788) compared rabbits with the native Guinea pig (*Cavia porcellus*): “despite its similarity with rabbits, the Guinea pig evades them, and they are never seen together”. He also wrote that rabbits and guinea pigs shared the same predators (Molina textually described the rabbit predators as “gatos y topos”, which in Spanish mean cats and moles, although it is not possible to know the species he was referring to regarding moles). He also wrote that people preferred the meat of viscachas (*Lagidium* sp.) to that of rabbits or hares (Molina 1788). These indirect references to rabbits suggest that they might have been introduced to Chile already in the eighteenth century (see also Greer 1965; Zunino 1989; Camus et al. 2008), considerably before than what traditionally has been accepted in the literature (Lataste 1892; Housse 1953; Jaksic 1998; Jaksic et al. 2002).

#### Multiple introduction events, but only a few long-term successful invasions

Historical documents prove that European travellers very frequently transported domestic animals and seeds, including European rabbits, to Hispanic America since the fifteenth century (see also Crosby 2004; Masseti 2011). It was a common practice to leave animals at different points along their route, as described by the sailor from the shipwreck in Tierra del Fuego, mentioned above. Some of these animals established viable feral populations after they had been abandoned. For example, Bougainville left behind horses, cattle, and European rabbits in 1767, when the French colonizers abandoned the Falkland Islands, and these animals were the origin of the plentiful flocks found there 70 years later (Montgomery 1842).

Old chronicles reported frequent European rabbit introductions into Hispanic America between the

fifteenth and eighteenth centuries. Nevertheless, it is likely that multiple unobserved and/or unreported introduction events of European rabbits took place, as was the case of other invasive species (Li et al. 2012). Although European rabbits apparently could have been introduced to many places and probably many times, they only persisted in a few localized areas (Fig. 2). This suggests that a high propagule pressure (i.e. many introduction events and/or many individuals per introduction; Lockwood et al. 2005) could have been necessary for successful colonization, and that the European rabbit might not be as successful a colonizer as it typically has been thought to be (Thompson and King 1994). In fact, the need for multiple introduction events for successful European rabbit establishment also has been observed in other parts of the world. In Germany, for example, domestic rabbits were kept since the twelfth century, and, although they escaped (or were released) frequently, the first wild colonies were not recorded until 1423 (Flux 1994). Similarly, domestic rabbits arrived in Australia with the first fleet in 1788, but they did not spread beyond the settlements where they had been liberated. The successful introduction of rabbits began in 1859 at Geelong, Victoria, with the arrival of 20 wild English rabbits (Flux 1994). Even Darwin (1839, page 249) suggested that multiple translocations of “small colonies” were needed to facilitate the spread of rabbits in the Falklands.

#### Potential biotic resistance to European rabbit invasion

Historical documents reported some successful cases of European rabbit establishment in natural American environments where the species is not present today. For example, European wild rabbits seemed to have been abundant in Cuzco and Quito during the sixteenth and seventeenth centuries, respectively (De Acosta 1590; De la Vega 1609). This indicates that many European rabbit introductions were only temporally successful, probably due to some delayed degree of biotic resistance to the species' invasion. Thus, it is likely that, following a rapid spread, some wild rabbit populations were eliminated by native predators, as occurred in other places (e.g. Germany; see above). In addition, native American *Sylvilagus* rabbits might have resisted European rabbit invasion through direct competition or disease transmission; e.g. myxoma

virus induces a benign disease in *Sylvilagus* rabbits, its natural hosts, whereas it causes myxomatosis, a systemic and usually fatal disease, in European rabbits (Fenner and Fantini 1999). This might explain why European rabbits currently only occur in American areas that are not occupied by native *Sylvilagus* rabbits. Other biotic factors (e.g. climate oscillations, other diseases, etc.) also might have shaped the current distributions of rabbits in America since those early introductions between the fifteenth and eighteenth centuries. In addition, according to some of the stories reviewed here, indigenous people actively hunted rabbits in some American regions (e.g. De Acosta 1590; De la Vega 1609; Pallas 1619; Cobo 1653). A high human hunting pressure therefore also could have contributed to keeping rabbit populations under control in some instances.

#### Some general considerations about how historical ecology can benefit invasion biology

The need of integrating knowledge from multiple disciplines to address environmental and conservation issues is increasingly recognized (White et al. 2009), and particularly the effects of invasive species on biodiversity (McCune et al. 2013). In this regard, the fact that European rabbit introductions into America reported in old chronicles had been ignored in previous reviews of the invasion of America by rabbits (e.g. Flux 1994; Bonino and Soriguer 2009) highlights the importance of incorporating historical information into the study of invasive species that have been introduced long ago.

Historical knowledge has been proved to be useful for the evaluation of the origin of some species whose distributions have been altered by humans since long time, and to determine when such species were introduced out of their ranges. For example, in 1769 Daines Barrington proposed the hypothesis that sweet chestnut (*Castanea sativa*) was not native to Britain (Barrington 1769), and this was followed by a debate in which, among other sources of information, historical documents were used (summarized in Rackham 1980). Similarly, historical documents suggest that the white-clawed crayfish (*Austropotamobius italicus*) was introduced in Spain in the eighteenth century (Clavero 2014; Clavero and Villero 2014), although it is currently the focus of several



conservation initiatives, because it was previously thought to be native. In addition, long-term analyses of the progression of historical invasions can be relevant for understanding the invasion process, and the current range of invasive species. The description of early European rabbit introductions into America shown in this article constitutes a good example in this regard.

Also, historical information can be useful to evaluate propagule pressure (Lockwood et al. 2005), as it is relatively frequent that multiple introduction events remain unobserved and/or unreported, as occurred in the case of early European rabbit introductions in America. In the same sense, historical ecology could have contributed to assess red-swamp crayfish (*Procambarus clarkii*) introductions in China, where it was originally thought that the species was introduced from Japan only once, before genetic analyses suggested that multiple unobserved introduction events and cryptic invasions could have occurred (Li et al. 2012). In addition, historical records of failed introductions can provide relevant information about the mechanisms underlying the resistance to invasions. The mechanisms of potential biotic resistance to European rabbit invasion mentioned above seem to be good examples of this use of historical ecology to understand invasion biology.

History provides opportunity to assess policy making and management as an adaptive process (Newell et al. 2005), as the effects of past management systems can provide an indication of how current ecosystems may react to management effort (Szabó 2010). In other words, if you cannot remember the past you are condemned to repeat it. In the case of invasive species, historical ecology may help to prevent future invasions of species that were introduced in the past, in addition to alert damage caused by those invasive species. In this sense, old chronicles reported that European rabbits were frequently transported to America between the fifteenth and eighteenth centuries despite the fact that their harmful effects on invaded ecosystems in the Canary Islands already had been noticed (Fernández de Oviedo 1535). In fact, only a few decades before that, introduced European rabbits in Porto Santo Island spread so fast and their damage were so important that people were forced to move back to Portugal, according to De las Casas (1517). Interestingly, something similar occurred several centuries later, when European rabbits were introduced into Australia and New Zealand, although

they were already considered to be one of the most detrimental invasive pest species in many other places, including the United Kingdom (Lees and Bell 2008).

To conclude, the present article shows that placing biological invasions in an historical context can be very useful for a better understanding of different aspects of the ecology of invasive species. From this perspective, we strongly recommend the incorporation of historical information into the study of invasive species that have been introduced long ago. This could be done through a working partnership between ecologists, conservation biologists, and historians (Pooley 2013), as in our article, although barriers between disciplines should be smoothed (Szabó and Hédl 2011).

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