

## Biotic invasions in Europe: the case of the grey squirrel in Italy; general trends, threats, and strategies for the future

P. GENOVESI

### Abstract

The American grey squirrel (*Sciurus carolinensis*), introduced into Great Britain and Italy, replaces the native red squirrel (*S. vulgaris*) in all overlap areas through a competitive exclusion. Italy presents the only populations of grey squirrels living in continental Europe. After the failure of an eradication campaign launched in 1997, an expansion of the alien species to the entire Alps and to a large portion of Eurasia is considered probable in the next 40-50 years, and a further colonisation of a large portion of Eurasia in the long term is a possible scenario with potential catastrophic effects at an ecosystem scale. This example confirms the threats caused by biotic invasions. The increased level of trade, transport and tourism, and the unprecedented accessibility of goods, are determining an enormous growth of species movement (either intentional or accidental), with the concrete risk of wholesale alteration of the earth's biota through the homogenisation of ecosystems.

Despite the inadequacy of our level of comprehension of the epidemiology of invasions, the rapid increase of the threat requires urgent actions at a global and regional scale. Our ability to set up mechanisms to significantly reduce new unwanted introductions, and to control and eradicate newly arrived species will be critical for conserving our biological diversity in the next future. Europe, characterised by highly developed economy, disappearance of borders in most of the regions, and a diversity of habitats and ecosystems, is particularly vulnerable to biotic invasions. The development of a common strategy to address this issue is thus a priority at a regional scale, requiring a comprehensive approach from a biological, socio-economic and political perspective.

### Introduction

The movement of plants and animals is a key element of human culture from prehistoric times (see MCNEELY 2001 for a review). The introduction of crops and domestic animals has been a fundamental condition for the movements of human populations across the world and the colonisation of new lands. But if organisms introduced into new regions are an essential part of our life (most of our food is made of introduced vegetables and farm animals), they have also altered virtually all landscapes on earth causing severe impacts on the biological diversity (MACK 2001, MOONEY & HOBBS 2000). Furthermore, the introduction of pathogens deeply affects human well being, and alien pests cause huge economic losses (total losses estimated for North America exceed 150 billions of Euro: OTA 1993, PIMENTEL *et al.* 2000).

Introductions in Europe and the Mediterranean basin have started in a far past and, in some cases, the impacts

on native biological diversity occurred so long ago that we hardly perceive this phenomenon as deeply affecting the biological diversity of the region. For example, in the Upper Pleistocene the Mediterranean islands hosted an impressive number of endemic species (almost all mammal species and half of the genera were endemic: CHEYLAN 1991). The colonisation by man occurred in the Mesolithic and early Neolithic and led to a dramatic increase of biotic immigrations into island environments, through the introduction of domestic, feral and game species, but also the accidental transport of rodents (mammals immigration rate increased by 2 to 30 times from the Pleistocene to the Holocene: VIGNE 1992 & 1999). And these invasions played a major role in the massive extinction of the original mammal species which occurred in the last ten millennia (CHEYLAN 1991, VIGNE 1999).

But although the history of biotic invasions in Europe is very ancient, the phenomenon has grown rapidly and enormously in recent times, as a result of the growth of pet trade, tourism, transports and the accessibility of goods. Focussing on mammals (for which fossil records permit to have a better picture of the ancient colonisation cases), KURTEN (1968) listed only five post-glacial immigrants for Europe. In contrast, only in the Italian peninsula, 11 species of mammals have been introduced in recent times, 6 of which presenting self-sustaining populations (ANDREOTTI *et al.* 2001). A similar trend is being recorded in Scotland, where 5 alien mammal species established in the last two centuries (WELCH *et al.* 2001), and in the Nordic countries (12 species introduced in the same period following WEIDEMA 2000). The dramatic increase of biotic invasions is evident when looking at the trend of new cases of alien species established into the wild, which indicates an exponential growth of the threat (fig. 1).

Biotic invasions represent a major challenge for conservation in the new millennium. The increased level of trades, transports and tourism, and the unprecedented accessibility of goods caused by the globalisation of the economy, are determining an enormous growth of species movements (either intentional or accidental), with the

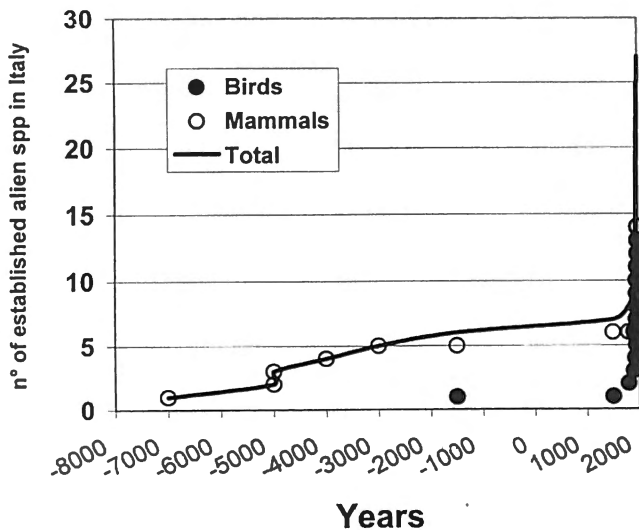


Fig. 1 — Naturalised and acclimatised alien species of mammals and birds in Italy. Total number and trend of increase (data from ANDREOTTI *et al.* 2001).

concrete risk of wholesale alteration of the earth's biota through the homogenisation of ecosystems. In the present paper, on the basis of the grey squirrel case in Italy, I will discuss some crucial steps that we need to pursue in the European region to address the issue in the next future.

### The case of the grey squirrel invasion in Italy

An emblematic case of the threats posed by invasive alien species in Europe is the invasion of the grey squirrel in Italy (fig. 2).

The American grey squirrel (*Sciurus carolinensis*), introduced into Great Britain and Italy for ornamental purposes, replaces the native red squirrel (*S. vulgaris*) in all overlap areas through competitive exclusion (GURNELL & PEPPER 1993, WAUTERS *et al.* 1997). The grey squirrel also damages trees through bark-stripping activity that can facilitate the penetration of insects and fungi and degrade timber quality, especially for hardwood (KENWARD 1983 & 1989, ROWE & GILL 1985, DAGNALL *et al.* 1998).

Italy presents three grey squirrel populations, the largest being in Piedmont (range in winter 1999-2000 = 880 km<sup>2</sup>; GENOVESI & BERTOLINO 2001a). In recent years, the Piedmont grey squirrel populations expanded rapidly, has now reached the Alps (GENOVESI & BERTOLINO 2001a) and is predicted to colonise all the Alps arriving to France in 30-50 years (LURZ *et al.* 2001).

In respect to the specific provisions of the Bern Convention and of the Convention on Biological Diversity on the control of alien species, Italy has the obligation to carry on, if feasible, the eradication of alien species threatening biological diversity. In this respect, in 1996 the Italian National Wildlife Institute (the Italian Govern-

ment agency for wildlife conservation) launched an eradication campaign of the grey squirrel.

The campaign was supported by the main national non governmental organisations (WWF, etc.) and the removal methods (live trapping, anaesthesia and subsequent euthanasia) were decided after a consultation of the animal right groups (GENOVESI & BERTOLINO 2001b). The preliminary results of the campaign, that included an experimental removal of an isolated population in order to test the efficiency of the removal techniques, were very positive (> 50 % of the estimated total population removed within the first 2 weeks of trapping). Nevertheless, the program was strongly opposed by some radical right groups which took the coordinator of the project and the director of the National Wildlife Institute to court in June 1997 (one month after the start of the campaign). The judiciary case ended in 2001, with the acquittal of the two officers. However, the three years suspension of the campaign determined an expansion of the population to a level that at present makes the eradication of the grey squirrel an impracticable option (GENOVESI & BERTOLINO 2001a). Nevertheless, the national guidelines (produced by the National Wildlife Institute for the Italian Ministry of Environment) clearly showed that a strong commitment at the highest state levels (providing an extraordinary legal instrument and substantial resources) would still allow the eradication (GENOVESI & BERTOLINO 2001a). Otherwise, in the medium to long term, grey squirrels are likely to expand through Eurasia, threatening the survival of the native red squirrel in most of its range and altering the entire forest ecosystems of the region. The ultimate outcome could be an ecological catastrophe at a continental scale.

### Lessons learned

The grey squirrel story shows how the scarce public awareness on the issue severely affects our ability to

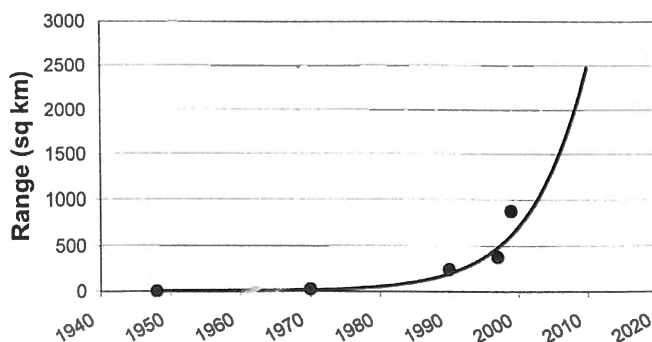


Fig. 2 — Grey squirrel expansion in the 1970-1999 period. Distribution in 1970, 1990 and 1997 based on data published in WAUTERS *et al.* 1997 (modified). Distribution in 1999 defined on the basis of hair-tube data.

mitigate the threats posed by biotic invasions. The long history of introductions in Europe partly accounts for this limited perception, that is shared by the general public, the decision makers, but also by a part of the academic world (see for example MEINESZ 1999 on the *Caulerpa taxifolia* invasion). This is evident if, for example, we compare the European picture with areas more recently affected by this threat. In New Zealand, for example, where almost all introductions occurred after the discovery of the island by Europeans (1769), the effects caused by the invasions are particularly visible and the public support to the actions carried out to prevent and control aliens is very strong (VEITCH & CLOUT 2001). As a result, New Zealand approved a biosecurity policy (WARREN 2001) that is probably the most efficient prevention and mitigation system so far adopted internationally.

Despite the limited awareness on the issue, Europe, characterised by a highly developed economy, disappearance of borders in most of the regions, and a diversity of habitats and ecosystems, is particularly vulnerable to new biotic invasions, as confirmed by the data of the surveys recently realised in several European countries (ANDREOTTI *et al.* 2001, WELCH *et al.* 2001, WEIDEMA 2000).

However, apart from the limited awareness, the failure of the eradication of the grey squirrel from Italy also originated from a combination of inadequate legal framework (SHINE *et al.* 2000), lack of means to circulate information on the effects of aliens and on the means to control them, and lack of specific financial and management tools to address the issue.

The rapid increase of the threats posed by invasive aliens requires urgent actions at a global and regional scale. In synthesis, the keywords for dealing with biotic invasions are awareness, prevention and control. Our ability to set up mechanisms to significantly reduce new unwanted introductions, and to control and eradicate newly arrived species (GENOVESI 2000) will be critical for conserving our biological diversity in the next future.

Europe urgently needs to develop a comprehensive strategy on invasive alien species, dealing with the very different aspects of the issue, supported by adequate financial instruments, technical advice, capacity building, and sharing of information.

### A strategy for the future

Invasive alien species are a cross-cutting issue, and to face the threats related to this growing phenomenon it is fundamental to develop a comprehensive strategy, based on the establishment of a framework of biosecurity policies, actions and clear allocation of roles and responsibilities.

This is a very complex task, touching very different aspects (international trade regulations, control during transport, border controls and quarantine, detection of new propagules, public perception of control methods, etc.). It is thus critical to obtain the co-ordination, commitment and co-operation of several different sectors of

the society, including ministries with different responsibilities, the academic world, different technical bodies, etc.

Several organisations and fora (IUCN-GISP, Bern Convention, Convention on Biological Diversity, etc.) have, in the last decade, tried to identify the key elements that need to be included in a strategy on invasive alien species. In particular at the European level, the regional section of the IUCN Invasive Species Specialist Group and the Bern Convention have produced a document that was presented at last SBSTTA (GENOVESI *et al.* 2001), aimed at stimulating a discussion at the European level on the issue. Following, the main elements of this draft strategy are reported.

Aim of a European strategy on alien invasive species is to prevent (or minimise) biological diversity loss caused by invasive alien species in Europe. This requires a greater awareness of the public and decision-makers; the prevention of unwanted introductions; where prevention fails, the eradication (when feasible and desirable) or containment and effective control of alien species; the restoration of native biological diversity.

Given our limited ability to predict which species will become invasive, prevention should be based on the precautionary principle. All unauthorised introductions should be prohibited. Authorisation should be based on a risk assessment, but when no clear responses can be obtained, alien species should be considered "guilty until proven innocent". In order to prevent new invasions, efforts should be concentrated at the place of origin (preventing the export of potentially invasive species) and on the major pathways. Border control is potentially the most effective way, at the international level, to prevent intentional and unintentional introductions. To provide an effective filter to new introductions, it is crucial to develop a "pied list" system, containing a "black list" (species whose importation is prohibited) and a "white list" (species classified beneficial or low risk). Any other species must be subject to a risk assessment prior to introduction. The burden of proof that a proposed introduction is unlikely to cause harm to ecosystems, habitats or species, should be with the proposer of the introduction.

Prevention can reduce new introductions, but cannot halt them. When an alien species has been detected, i.e. when prevention has not been successful, precaution dictates that an eradication programme should always be considered first. Eradication is the most coherent solution in terms of biodiversity conservation and can be more effective, cost effective and ethical than other management alternatives such as control, containment and do-nothing approaches. Rapid action is often crucial to effectively mitigate the effects of new introductions. This means that it is important to set up early detection mechanisms, a simple authorisation process, a clear line of authority and contingency funding. Early detection is a prerequisite for effective management of invasive alien species. It requires the circulation of information about alien species and the methods to monitor their presence.

Given the aim of preventing biodiversity loss on a global scale, a strategy on invasive alien species should also include restoration measures (conservation of key biodiversity areas, reintroduction of native species after eradications have been realised, etc.).

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Piero GENOVESI

Istituto Nazionale per la Fauna Selvatica - Alessandro Ghighi  
Via Cà Fornacetta 9  
I-40064 Ozzano Emilia (Bologna)  
Italy