

What we know and don't know about invasive vertebrates in Europe

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Introduction

Invasive species are those that have been introduced to regions beyond their native range, established in the wild, and spread substantially from their point of introduction (Blackburn et al., 2009; Lockwood et al., 2007). They can diminish biodiversity, introduce diseases, and cause further ecological problems and economic costs (Kettunen et al. 2009). Although a few early publications about invasive species date back to the 19th century (Darwin, 1859; reviewed in Cadotte, 2006), publications have only become numerous since the late 20th century (Richardson and Pyšek, 2008). Many hypotheses about invasive species have been proposed, but only recently has it become possible to test them adequately, as sufficient studies and data were not available before. A prominent example for a project that collected data on invaders in Europe is DAISIE (2009). With sufficient studies and data now available, invasion biology has entered a new stage where existing hypotheses can be rigorously tested, and those that fail these tests may be modified or replaced. Another challenge that invasion biology is currently facing is the need to build bridges with related disciplines (Davis, 2009). To illustrate these challenges and their implications for invasive species management (Clout and Williams, 2009), I outline to what degree we can currently answer the following questions, which have guided research on invasive species for decades (Drake et al., 1989): (1) How many species become invasive in a given region? (2) Which species become invasive? (3) Which regions are especially susceptible to invasive species? I will focus on invasive vertebrates in Europe, but for comparison, I will also mention other taxonomic groups and continents.

Keywords: biotic resistance hypothesis, exotic species, fast life histories, invasion biology, non-native species, propagule pressure, tens rule

How many species become invasive in a given region?

If policy makers are faced with the question whether or not to invest in border controls against accidental species introductions, they need to know what fraction of introduced species will become invasive. This fraction can then be used to parameterize cost-benefit models. A hypothesis that predicts this fraction is the tens rule, which says that of 100 introduced species, about 10 will establish themselves and 1 will become invasive (Williamson, 1996; Williamson and Brown, 1986). Recent studies, however, suggest that this hypothesis lacks empirical support, especially for vertebrates (Jeschke, 2008; Jeschke and Strayer, 2005).

Which species become invasive?

If a company plans to introduce a vertebrate species, e.g. for food production, it would be helpful to have a probability estimate that this species will become invasive. Having this goal in mind, invasion biologists are looking for the characteristics of invasive species that discriminate them from other species. There are many hypotheses about the characteristics of invasive species. A classical hypothesis says that species with a fast life history are more often invasive than species with a slow life history, i.e. invasive species tend to reproduce early, have a high fecundity, and a short lifespan (Lodge, 1993). Among mammals and birds, species with larger brains are supposedly more successful in invading new environments, due to their supposedly higher behavioural flexibility (Sol and Lefebvre, 2000; Sol et al., 2008). Besides these rather species-specific traits, there are also traits that characterize the association of species with humans and that also potentially influence invasiveness. Such traits were largely ignored in early studies on biological invasions but are now in the focus of many researchers. One such trait is propagule pressure, a composite trait that reflects how often individuals of a given species are introduced to a given region, and how many individuals are introduced each time (Blackburn et al., 2009; Lockwood et al., 2005). Recent studies about invasive vertebrates suggest that propagule pressure and other traits

characterizing their association with humans are stronger determinants of invasiveness than life-history traits, brain size, and other species-specific traits (e.g. Jeschke and Strayer, 2006).

Which regions are especially susceptible to invasive species?

Comparing different regions, e.g. different European countries, it is apparent that some regions host more invasive species than others. The classic idea to explain these differences is the biotic resistance hypothesis which says that regions with relatively low biodiversity and high human impact are more susceptible to invasions than regions with relatively high biodiversity and low human impact (Elton, 1958). However, recent studies of invasive vertebrates do not support this hypothesis (Chiron et al., 2009; Jeschke and Genovesi, 2011; Leprieur et al., 2008).

Conclusions

Many hypotheses about invasive vertebrates and other invaders lack empirical support. They are thus potentially misleading when designing management strategies against invaders. It is time to revise these hypotheses.

References

- Blackburn TM, Lockwood JL, Cassey P 2009 Avian invasions: the ecology and evolution of exotic bird species. Oxford University Press, Oxford, UK, 1-305
- Cadotte MW 2006 Darwin to Elton: early ecology and the problem of invasive species. In: Cadotte MW, McMahon SM, Fukami T (eds.), *Conceptual ecology and invasion biology: reciprocal approaches to nature*. p. 15-33, Springer, Dordrecht, Netherlands
- Chiron F, Shirley S, Kark S 2009 Human-related processes drive the richness of exotic birds in Europe. *Proceedings of the Royal Society B* 276: 47-53
- Clout MN, Williams PA 2009 *Invasive species management: a handbook of principles and techniques*. Oxford University Press, Oxford, UK, 1-308
- DAISIE 2009 *Handbook of alien species in Europe*. Springer, Dordrecht, Netherlands, 1-399
- Darwin C 1859 On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life. Murray, London, UK, 1-502
- Davis MA 2009 *Invasion biology*. Oxford University Press, Oxford, UK, 1-244
- Drake JA, Mooney HA, di Castri F, Groves RH, Kruger FJ, Rejmánek M, Williamson M 1989 *Biological invasions: a global perspective – SCOPE 37*, Wiley, Chichester, UK, 1-525
- Elton CS 1958 *The ecology of invasions by animals and plants*. Methuen, London, UK, 1-181
- Jeschke JM 2008 Across islands and continents, mammals are more successful invaders than birds. *Diversity and Distributions* 14: 913-916
- Jeschke JM, Genovesi P 2011 Do biodiversity and human impact influence the introduction or establishment of alien mammals? *Oikos* 120: 57-64
- Jeschke JM, Strayer DL 2005 Invasion success of vertebrates in Europe and North America. *Proceedings of the National Academy of Sciences USA* 102: 7198-7202
- Jeschke JM, Strayer DL 2006 Determinants of vertebrate invasion success in Europe and North America. *Global Change Biology* 12: 1608-1619
- Kettunen M, Genovesi P, Gollasch S, Pagad S, Starfinger U, ten Brink P, Shine C 2009 *Technical support to EU strategy on invasive alien species (IAS) – assessment of the impacts of IAS in Europe and the EU*. Institute for European Environmental Policy, Brussels, Belgium, 1-124
- Leprieur F, Beauchard O, Blanchet S, Oberdorff T, Brosse S 2008 Fish invasions in the world's river systems: when natural processes are blurred by human activities. *PLoS Biology* 6: e28
- Lockwood JL, Cassey P, Blackburn T 2005 The role of propagule pressure in explaining species invasions. *Trends in Ecology and Evolution* 20: 223-228
- Lockwood JL, Hoopes MF, Marchetti MP 2007 *Invasion ecology*. Blackwell, Malden, MA, USA, 1-304
- Lodge DM 1993 Biological invasions: lessons for ecology. *Trends in Ecology and Evolution* 8: 133-137
- Richardson DM, Pyšek P 2008 Fifty years of invasion ecology – the legacy of Charles Elton. *Diversity and Distributions* 14: 161-168
- Sol D, Bacher S, Reader SM, Lefebvre L 2008 Brain size predicts the success of mammal species introduced into novel environments. *American Naturalist* 172: S63-S71
- Sol D, Lefebvre L 2000 Behavioural flexibility predicts invasion success in birds introduced to New Zealand. *Oikos* 90: 599-605
- Williamson M 1996 *Biological invasions*. Chapman and Hall, London, UK, 1-256
- Williamson M, Brown KC 1986 The analysis and modelling of British invasions. *Philosophical Transactions of the Royal Society London B* 314: 505-522