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Spreading to a limit: the time required for a neophyte to reach its maximum range

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ABSTRACT

The average range size of alien plants in Spain reaches a maximum at 143 years. This is consistent with estimates of such a maximum in Ireland, Britain, Germany and the Czech Republic. A round figure of about 150 years on average for neophytes to reach their maximum range in European countries is indicated.

Keywords

Biological invasions, Europe, neophyte spread, range size, residence time.

In the January 2009 issue of *Diversity and Distributions* (volume 15 issue 1) there are two papers (Gassó *et al.*, 2009; Williamson *et al.*, 2009a) which consider the relationship between the residence time (Pyšek & Jarosík, 2005) and the geographical range of alien plant species in European countries. The countries are Spain in Gassó *et al.* and Ireland, Britain, Germany and the Czech Republic in Williamson *et al.* Williamson *et al.* worked with range sizes on a logit scale of grid squares and estimated, using reduced major axis (RMA) analyses, the time for neophytes (alien plants introduced after 1500 AD) to achieve the same average range size as natives. They assumed that all neophytes would eventually reach a maximum range even though none of their data sets showed a clear asymptote and argued that the neophyte average maximum would, in time, match the native average. They found times of 151, 177, 145 and 141 years for Ireland, Britain, Germany and the Czech Republic, respectively. It should perhaps be noted that this process can be modelled in various ways and that different models are needed for different species (Williamson *et al.*, 2009b).

Here we note that applying the same logit transformation used in Williamson *et al.* (2009a) to the range sizes in Gassó *et al.* (2009) gives a graph (Fig. 1) which shows unambiguously that neophytes in Spain, on average, reach a maximum range size at 143 years (the peak point in the loess line in Fig. 1). Figure 1 uses an upper limit of the area in Spain from which neophytes have been recorded. Using a different limit such all Spain, or even an infinite area (which implies a logarithm rather than a logit) does not affect the time to a maximum, the graph is scarcely changed. In general, it is best to use the actual area surveyed when transforming ranges by logits (Williamson & Gaston, 1999).

The Spanish data have a much larger proportion of records of plants introduced before 1800 AD than the data from the four countries in Williamson *et al.*, and clearly show an asymptote. The Spanish estimate is compatible with the spatial scale of resolution and the RMA estimates in Williamson *et al.*

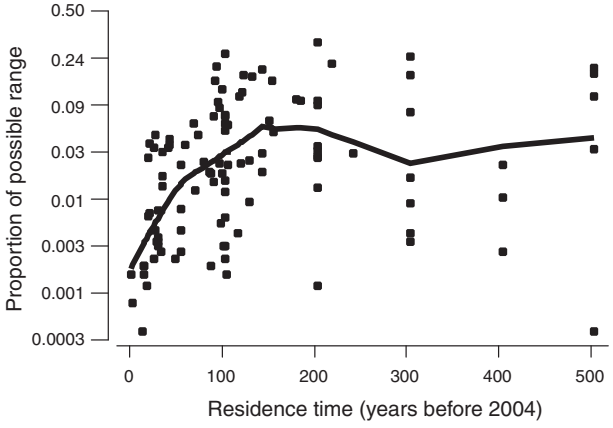

Figure 1 A loess plot (as in Williamson *et al.*, 2009a) with data points for 106 neophyte Spanish plants. The residence time is the time since the first publication of a record or the first dated herbarium specimen for a species. The current range size is on a logit scale using 2590 hectads (i.e. total number of hectads in Spain in which neophytes have been recorded out of 5096 total) as the upper limit. The data are a transformation of the data in Fig. 3 of Gassó *et al.* (2009).

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The grid squares used to estimate range size in Spain are 10×10 km, which are also used in Ireland and Britain and referred to there as hectads (Williamson *et al.*, 2006) as they have 100 km^2. The grid squares in Germany and the Czech Republic are 10′ longitude × 6′ latitude, roughly 130 km^2. Combining the five estimates gives an average time of 151.4 years (± 14.8, SD) for the time for an average neophyte in an European country to reach its maximum range, or, in round figures, about 150 years.

The five European countries are, within an order of magnitude, about 200 $k.km^2$, and we detected no effect of area on the time to reach a maximum. It is possible that this invariance comes from the homogeneity of trade and transport and economy within each country. The estimate of 150 years to a maximum and the figure presented here are of interest to policy makers, as the rate and completion of spread are much slower than is commonly thought (Perrings *et al.*, 2010), as well as to invasion biologists, noting that our understanding of the determinants of range size of species is still far from satisfactory (Gaston, 2009).

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BIOSKETCH

Mark Williamson is interested in invasion ecology and macroecology and combines the two in the study of distributions of alien species. MW conceived the idea, did the analysis and led the writing; NG, with MV, assembled the data; all authors discussed the analysis and contributed to the writing of the paper.

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