the capacity to deal with numerous statistical models, ranges of initial conditions, different climate projections, and many more effects. Personally, I never liked the idea of automatically processing hundreds of species without careful consideration of predictor sets with regard to a specific species. However, I will now use BIOMOD even for single species projections, simply because the general framework makes ensemble forecasting so easy for us. And if one chooses to use only a few carefully chosen predictors, then BIOMOD can successfully process many species simultaneously.

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commentary

Geographic patterns of establishment success among exotic bird populations

Human-mediated species invasions are a major component of global environmental change and there remains a pressing need to understand the mechanisms by which a species becomes invasive. With this in mind, the key stage in the invasion pathway (*sensu* Williamson and Brown 1986) is species establishment. It is at this stage, when a species has been transported outside its native geographic range and released in a novel recipient environment, that a species either fails or succeeds to establish an exotic population. However, while much attention has been focussed on what species-level traits determine establishment success in exotic bird populations (Blackburn et al. 2009), relatively less research has concerned the role of location-level variables.

The most obvious reason for this relative 'lack of research' is that in most cases, comparative analyses have consisted of large datasets of good quality records of different species to single specific locations (e.g. Hawaii, Moulton et al. 2001; Australia, Duncan et al. 2001; New Zealand, Duncan et al. 2006) rather than repeated introductions of the same species to multiple locations. Bird species are conspicuous elements of the environment and their distribution and abundance have attracted considerable research attention in the discipline of biogeography (e.g. Gaston and Blackburn 2000). It is therefore somewhat surprising that autecological studies of exotic birds have received disproportionately limited research attention within invasion biology (Pyšek et al. 2008). A recent article in the *Journal of Biogeography* (Strubbe and Matthysen 2009), provides a timely example of a study that addresses this bias.

Diederik Strubbe and Erik Matthysen compiled data on the introductions and establishment success of two parakeet species (ring-necked *Psittacula krameri* and monk *Myiopsitta monachus* parakeets) across their exotic European distribution. In doing so, the authors provide one of the first comparative biogeographic studies to test environment-level features of establishment success among exotic birds. In total, 181 introduction events were used for their analysis in the exotic range. In their native ranges, parakeet occurrence was estimated using the presence-only method MAXENT (Phillips et al. 2006). For both parakeet species, individually, their establishment success in Europe was 53%. Data from environmental and climatological variables were used to test the relative influence of alternative 'climate-matching' and 'human-activity' hypotheses. The authors found that parakeet establishment success was greater in areas of more dense human population settlement and, both in the native and exotic ranges, their distribution was associated with a smaller number of annual frost days. Further examination revealed that both species were equally sensitive to frost in their exotic range, the majority of failed introductions occurring in regions with more than 50 frost days per year. Human activity can influence establishment success both indirectly, through habitat modification and provision

of resources (e.g. supplementary food and breeding sites), and directly by increasing the local introduction effort. Interestingly, Strubbe and Matthysen (2009) found that after controlling for the number of parakeets released during the first introduction event, human population density was still an important predictor of establishment success.

If environmental change continues in mainland Europe, as is likely for the considerable future, then local geographic features such as climate warming and increased urbanization may act to increase the probability of establishment success for the parakeet species even further. Strubbe and Matthysen (2009) only included in their analyses exotic parakeet populations that were introduced before the year 2000, evidenced breeding in the 2007 breeding season, and had not indicated a population crash in recent years. The authors note that the exotic parakeet populations range in size (and distribution) between a few individuals and many thousands. In many cases, the time since introduction will explain the differences in population size. In others, features of the biotic and abiotic environment will likely be responsible for influencing whether a population, once established, continues to grow and spread. The spread of exotic bird populations has attracted considerably less empirical and comparative investigation than any other stage of the invasion pathway. Although in the past biological invasions have been modelled in relatively simple terms using parameter sparse models (Hastings et al. 2005), this approach does not offer insight into the individual processes influencing population expansion. It is clear that as data on the differences in the distribution of exotic bird populations become available the features that influence their variability in growth and spread will be of considerable future importance in studies of invasion biogeography.

Strubbe and Matthysen (2009) note that the large dataset available to them for analysis was, at least in part, facilitated by the particular conspicuousness of the parakeet species and the large number of amateur bird watchers living and visiting in mainland Europe. Few exotic species are similarly conspicuous or well distributed, and future studies of this kind will only be possible with accurate date on introduction events and the concerted monitoring of exotic populations across a wide range of habitats and regions.

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