

## COMMENTARY

## Inbreeding and population dynamics: implications for conservation strategies

A. McGowan, L. I. Wright & J. Hunt

Centre for Ecology and Conservation, University of Exeter, Penryn, UK

### Correspondence

Andrew McGowan, Centre for Ecology and Conservation, School of Biosciences, University of Exeter, Cornwall Campus, Penryn, TR10 9EZ UK.  
Tel: +44 01326 371842; Fax: +44 01326 370721  
Email: amcgowan@exeter.ac.uk

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Inbreeding, inbreeding depression and low population genetic diversity are well known to decrease population fitness in wild populations (Keller & Waller, 2002), but how these processes influence extinction risk is still a major unresolved issue in conservation biology. One of the major questions that is yet to be addressed is whether these phenomena have an impact on population dynamics in wild populations, although results from butterfly and plant studies (Newman & Pilson, 1997; Saccheri *et al.*, 1998; Ramula, Toivonen & Mutikainen, 2007) suggest this is likely to be the case. The study by Reed, Nicholas & Stratton (2007) focuses on whether inbreeding levels, within several populations of wolf spiders (*Rabidosa* sp.) that differ in life history, negatively impact population dynamics and increase the risk of extinction. This study is an excellent first step in the poorly understood area of inbreeding, environmental stress and extinction risk in wild populations. For many reasons, the authors' populations of wolf spiders appear to be an ideal model system for addressing these types of questions in a natural setting, which until now have almost entirely been the focus of laboratory experiments and computer simulations, with a few notable exceptions (Newman & Pilson, 1997; Saccheri *et al.*, 1998; Ramula *et al.*, 2007).

One of the main strengths of Reed *et al.*'s (2007) study is that there is almost complete data collection of key life-history traits coupled with strong molecular data on levels of genetic diversity. Their elegant use of the life histories of both spider species enables measures of fecundity, population size and survival, which are fundamental components of population dynamic models. The authors also measure pre-capture rates, which is essential as many spider populations are known to be food limited (Wise, 2006), and a wide range of population sizes (*c.* 50–26 000) are examined, allowing for any effects of population size to be more easily detected. Furthermore, molecular genetic data support the view that spider populations are 'truly' isolated and have essentially no gene flow between them. Gene flow between populations

is probably the single biggest drawback of attempting this type of study in wild populations. Collectively, these features provide the ideal setting for their subsequent investigations.

On a more cautionary note, the authors use neutral genetic variation of 15 polymorphic loci to demonstrate that population size positively correlates with population genetic diversity and expected heterozygosity levels. However, estimating inbreeding levels via neutral genetic markers may not realistically represent 'true' levels of inbreeding (Slate *et al.*, 2004). Furthermore, assuming that low population genetic diversity and/or small population size equates to low genetic quality may not always be valid. For example, individuals in a small population with low genetic diversity may be exceptionally well adapted to their local environment and have a higher mean individual fitness than might be expected.

Perhaps the most interesting feature of Reed *et al.*'s (2007) study is that they were able to successfully demonstrate an overall impact of genetic quality on population growth rate, over and above the effects of food limitation and density dependence. In fact, density-dependent mechanisms, in this case competition between spiderlings and/or cannibalism, only further exaggerated genetic effects on population growth rate. This study therefore provides a useful baseline for researchers who are planning experiments to further test the importance of genetic quality to population dynamics. Such experiments are in great demand, particularly for a wider variety of species, so that generalities can be made. It is also noteworthy that in a year of high fecundity and high offspring production, which in most systems would be considered a 'good' year, actually turned out to be a 'poor' year when followed through time. Reed *et al.* (2007) demonstrate that this temporal effect is likely to be due to increased competition and reduced pre-capture rates associated with increasing population density. This result highlights the difficulties associated with using a single estimate of offspring production to predict the long-term success of a population.

Threatened species, by definition, are characterized by small populations that are often isolated or fragmented and have low population genetic diversity. However, extinction risk due to genetic quality has largely been dismissed as being of conservation importance, in all but the smallest of populations. Reed *et al.* (2007) show that inbreeding levels are more important to population growth rate during times of environmental stress and that small populations (<500 individuals) decrease proportionately more in size when subject to stressful conditions. This highlights the need for interactions between genetic diversity and the environment to be given a far higher profile on the conservation agenda than it currently receives. However, it should be pointed out that none of the populations studied by Reed *et al.* (2007) actually went extinct. It would seem essential to know the levels of inbreeding and the type and magnitude of environmental stress populations need to experience before extinction is the only outcome.

Reed *et al.* (2007) quite rightly point out that their negative interaction between inbreeding and stress has important implications for conservation organizations, particularly since the current criteria for ranking conservation priorities is almost entirely dependent on population size. By successfully demonstrating the need to consider interactions between inbreeding and negative environmental perturbations, Reed *et al.* (2007) have effectively posed a further dilemma for conservation programs. Should conservation efforts be directed towards increasing population numbers, maximizing population genetic variation, ameliorating negative environmental stresses or combinations of all three? Reed *et al.* (2007) suggest that emphasis should be placed on maximizing genetic variation although we urge caution. Researchers have shown that small fragmented populations demonstrate local adaptation and the need to be managed as independent units (Ficetola & De Bernadi, 2005; Oyler-McCance, Taylor & Quinn, 2005), meaning that there are no generalities that can be broadly applied. Invariably, the resolution to these dilemmas should be dictated by the individual circumstances of each species and/or population and the perceived costs and benefits of adopting each approach. However, whether the findings of Reed *et al.* (2007) are able to integrate into working conservation strategies still remains to be seen.

In conclusion, the study by Reed *et al.* (2007) is exactly the type of study that is needed to uncover the complex interaction between inbreeding and the environment on the risk of extinction in wild populations. However, more studies that build on this template in a range of other species are required before the general significance of these effects will be known.

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