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NEWS AND COMMENTARY

Forest fragmentation

A fragmented future for the forest flora

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Almost daily, proclamations bombard us with warnings about extensive deforestation on a global level. Digging a bit deeper, there are data to support these proclamations. UN statistics show an annual rate of global forest cover change of −0.22% from 1990 to 2000 (Food and Agriculture Association of the United Nations, 2006). Even though that rate has improved slightly, declining to an annual rate of −0.18% from 2000 to 2005, this improvement is largely due to conversion to plantations. Deforestation is occurring against the backdrop of increasing global population, which has doubled over the past 40 years to reach its present level of 6.9 billion and is projected to grow to over 9 billion by 2050 (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2008).

Demand for land and other natural resources will only increase, and processes leading to future conversion of forests and other vegetation types to fragments distributed across managed landscapes are likely to accelerate. The inevitable consequence of these related trends is that species' survival will become ever more dependent on their being able to adapt to an increasingly fragmented landscape. In this issue, Cuartas-Hernández and Núñez-Farfan (2006) examine the impact of fragmentation on *Dieffenbachia seguine*, an understory herb in the Los Tuxtlas region of Mexico, showing that to date forest fragmentation has had limited impacts on gene flow across the landscape.

The portfolio of methods used by Cuartas-Hernández and Núñez-Farfan (2006) to investigate landscape-level patterns of genetic integration allows distinction between historical effects and ongoing processes of change. The standard approach of using analysis of variance to study the distribution of genetic variation within and among populations is their starting point, but they then move on to investigate more subtle details of sibship structure and heterogeneity in paternal contributions to seed set on different maternal parents. Although the analysis of variance investigates historical effects on population genetic structure, the latter is more focused on contemporary processes and is therefore a better basis for predicting the future genetic fate of fragmented populations. The findings by Cuartas-Hernández and Núñez-Farfan (2006) show that *D. seguine* is likely to sustain some degree of genetic integration at the landscape level under the magnitude of forest fragmentation that currently exists in the Los Tuxtlas region.

There is growing evidence that trees distributed among forest fragments can maintain some degree of genetic integration (Bittencourt and Sebbenn, 2007; Dunphy and Hamrick, 2007; Bacles and Ennos, 2008; Andrianoelina *et al*., 2009), and the same appears to be true of understory plant species (Gonzales *et al*., 2006; Cibrian-Jaramillo *et al*., 2009). However, maintaining gene flow and maintaining local population sustainability are two different things. There can be subtle but important impacts of population isolation and smaller local population sizes on genetic variation (Cuartas-Hernández and Núñez-Farfan, 2006), mating compatibility (Byers and Meagher, 1992) or even gender expression (Byers *et al*., 2005) that can affect seed set and long-term population viability. Cuartas-Hernández and Núñez-Farfan (2006) mentioned in passing that isolated populations of *D. seguine* indeed show reduced fruit set, and they presented evidence that this species is self-incompatible. Thus, an important question to pursue is whether even appreciable large-scale gene flow may not be sufficient to counteract breeding system consequences of fragmentation. Moreover, the relationship between forest fragmentation and the overall landscape of Los Tuxtlas is dynamic in that the region is still experiencing ongoing deforestation (Mendoza *et al*., 2005), so that their emphasis on genetic processes rather than just measures of extant genetic variation is crucial to going beyond a snapshot of the current situation.

If effective strategies for biodiversity management are to be developed, it will be critical to understand the interplay among: changes in population distribution at a landscape level (meta-population structure), ecological limitations on future redistribution and colonization patterns and capacity for genetic integration in the face of changing meta-population structure. In the near term, meta-population dynamics will indicate the viability of local populations, but the degree of genetic integration will determine the level of opportunity for species to maintain and exchange genetic variation to facilitate adaptation to the changing ecological context in the longer term.

Genetic studies such as the one presented by Cuartas-Hernández and Núñez-Farfan (2006) are a first step in future biodiversity management. Such studies need to be coupled with landscape-level analysis of meta-population structure and opportunities for future meta-population dynamics in an ecologically fragmented landscape (Rivers *et al*., 2010). Moreover, species-specific studies provide a useful baseline for understanding the impacts of fragmentation on evolution. Follow-up studies on such species after they have been fragmented over a longer period (30 years, 40 years,…) will help us to understand how species adapt to the changes we have imposed on their ecological context and evolutionary potential.

Conflict of interest

The author declares no conflict of interest.

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