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News & views

Ecology

Migratory birds distribute seeds to new climates

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Birds that travel long distances can disperse seeds far and wide. An assessment of the timing and direction of European bird migration reveals how these patterns might affect seed dispersal as the planet warms.

The rapid pace of global warming and its effects on habitats raise the question of whether species are able to keep up so that they remain in suitable living conditions. Some animals can move fast to adjust to a swiftly changing climate. Plants, being less mobile, rely on means such as seed dispersal by animals, wind or water to move to new areas, but this redistribution typically occurs within one kilometre of the original plant[1]. Writing in *Nature*, González-Varo *et al.*[2] shed light on the potential capacity of migratory birds to aid seed dispersal.

When the climate in a plant's usual range becomes hotter than it can tolerate, it must colonize new, cooler areas that might lie many kilometres away. It is not fully clear how plants distribute their seeds across great distances, let alone how they cross geographical barriers. One explanation for long-distance seed dispersal is through transport by migratory birds. Such birds ingest viable seeds when eating fruit (Fig. 1) and can move them tens or hundreds of kilometres outside the range of a plant species[3]. In this mode of dispersal, the seeds pass through the bird's digestive tract unharmed[4,5] and are deposited in faeces, which provides fertilizer that aids plant growth. In the case of European migratory birds, for example, the direction of seed dispersal will depend on whether the timing of fruit production coincides with a bird's southward trip to warmer regions around the Equator, or northward to cooler regions. Many aspects of this process have been a mystery until now.

González-Varo and colleagues report how plants might be able to keep pace with rapid climate change through the help of migrating birds. The authors analysed the fruiting times of plants, patterns of bird migration and the interactions between fruit-eating birds and fleshy-fruited plants across Europe. Plants with fleshy fruits were chosen for this study because most of their seed transport is by migratory birds[6], and because fleshy-fruited plants are an important component of the woody-plant community in Europe. The common approach until now has been to predict plant dispersal and colonization using models fitted to abiotic factors, such as the current climate. González-Varo *et al.* instead analysed an impressive data set of 949 different seed-dispersal interactions between bird and plant communities, together with data on entire fruiting times and migratory patterns of birds across Europe. The researchers also analysed DNA traces from bird faeces to identify the plants and birds responsible for seed dispersal.

The authors hypothesized that the direction of seed migration depends on how the plants interact with migratory birds, the frequency of these interactions or the number of bird species that might transport seeds from each plant species. González-Varo and colleagues found that 86% of plant species studied might have seeds dispersed by birds during their southward trip towards drier and hotter equatorial regions in autumn, whereas only about one-third of the plant species might be dispersed by birds migrating north in spring. This dispersal trend was more pronounced in temperate plants than in the Mediterranean plant communities examined. These results are in general agreement with well-known patterns of fruiting times and bird migrations. For example, the fruit of most fleshy-fruited plants in Europe ripens at a time that coincides with when birds migrate south towards the Equator[7].

Perhaps the most striking feature of these inferred seed movements is the observation that 35% of plant species across European communities, which are closely related on the evolutionary tree (phylogenetically related), might benefit from long-distance dispersal by the northward journey of migratory birds. This particular subset of plants tends to fruit over a long period of time, or has fruits that

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Figure 1 | A young blackcap bird (*Sylvia atricapilla*) eating elderberries.

persist over the winter. This means that the ability of plants to keep up with climate change could be shaped by their evolutionary history — implying that future plant communities in the Northern Hemisphere will probably come from plant species that are phylogenetically closely related and that have migrated from the south. Or, to put it another way, the overwhelming majority of plant species that are dispersed south towards drier and hotter regions at the Equator will probably be less able to keep pace with rapid climate change in their new locations than will the few 'winners' that are instead dispersed north to cooler climates. This has implications for understanding how plants will respond to climate change, and for assessing ecosystem functions and community assembly at higher levels of the food chain. However, for seeds of a given plant species, more evidence is needed to assess whether passing through the guts of birds affects germination success.

To determine which birds might be responsible for the plant redistributions to cooler climates in the north, the authors categorized European bird migrants into Palaearctic (those that fly to southern Europe and northern Africa during their non-breeding season) and Afro-Palaearctic (those that winter in sub-Saharan Africa). Only a few common Palaearctic migrants, such as the blackcap (*Sylvia atricapilla*; Fig. 1) or blackbird (*Turdus merula*), provide most of this crucial dispersal service northwards to cooler regions across Europe. Because migratory birds are able to relocate a small, non-random subset of plants, this could well have a strong influence on the types of plant community that will form under climate-change conditions.

A major problem, however, is that the role of these birds in dispersing seeds over long distances is already at risk from human pressures and environmental changes[8]. Understanding these large-scale seed-dispersal interactions offers a way for targeted conservation actions to protect the areas that are most vulnerable to climate change. This could include boosting protection efforts in and around the wintering grounds of migratory birds — locations that are already experiencing a rise in human pressures, such as illegal bird hunting.

González-Varo and colleagues' focus on seed dispersal across a Northern Hemisphere region means that, as with most ecological analyses, the results are dependent on scale, which can cause issues when interpreting data[9]. Because the Northern Hemisphere has more land area and steeper seasonal temperature gradients than the Southern Hemisphere does, seed-dispersal interactions might have different patterns from those occurring in the Southern Hemisphere or in aquatic systems.

For example, seed-eating birds from the genus *Quelea* migrate from the Southern Hemisphere to spend the dry season in equatorial West Africa, then move southwards again when the rains arrive. Their arrival in southern Africa usually coincides with the end of the wet season in this region, when annual grass seeds are in abundance. It will be worth investigating whether migratory birds in the Southern Hemisphere also influence the redistribution of plant communities during global warming. Likewise, exploring the long-distance dispersal of seeds of aquatic plants, such as seagrasses[10] by water birds, is another area for future research that might benefit from González-Varo and colleagues' methods.

This study provides a great example of how migratory birds might assist plant redistribution to new locations that would normally be difficult for them to reach on their own, and which might offer a suitable climate. As the planet warms, understanding how such biological mechanisms reorganize plant communities complements the information available from climate-projection models, which offer predictions of future species distributions.

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