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Bird Diversity and the Resilience of Southwestern Ethiopian Forests

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Abstract

Coffee forests in southwestern Ethiopia host a diverse community of birds including some endemics. Different ecological bird groups respond differently to coffee management intensity, to amount of forest cover, and to distance to the forest edge. In this commentary, we highlight the implications of these differential responses for the resilience of the forest ecosystem and outline research priorities for future studies of bird diversity in the region.

Keywords

bird diversity, coffee forest, ecological groups, resilience, forest ecosystem

Commentary on: Rodrigues P, Dugo GS, Dorresteijn I, Schultner J, Hanspach J, Hylander K, Senbeta F, Fischer J. Coffee management and the conservation of forest bird diversity in southwestern Ethiopia. *Biologic Conserv*. 2018;217:131–139.

Ethiopia's highlands are part of a biodiversity hotspot (Mittermeier et al., 2004), sustain large areas of continuous and undisturbed moist evergreen forest, and are where coffee (*Coffea arabica*) originates (Senbeta & Denish, 2006). In the southwestern highlands, coffee is traditionally grown in the forest, under the shade of native trees, and management is implemented using traditional practices such as the pruning and thinning of the canopy and the clearing of the understory (Aerts et al., 2011). However, high rates of human population growth and deforestation (mainly for cropland expansion) together with the intensification of the coffee production systems are currently threatening the forest ecosystems in the region (Tadesse, Zavaleta, Shennan, & FitzSimmons, 2014). Forest coffee management, in particular, can have diverse outcomes for biodiversity conservation. On one hand, it provides a source of income from native forest, thus providing an incentive to help slow down deforestation (Hylander, Neomissa, Delrue, & Enkosa, 2013). On the other hand, a shift toward more intensively managed coffee, where vegetation structure and composition are simplified, most likely would be detrimental to biodiversity (Aerts et al., 2011).

In a recent study (Rodrigues et al., 2018), we assessed changes in the forest bird community along a gradient of coffee management intensity. We sought to understand how bird community composition, and richness and abundance of different ecological groups of birds responded to coffee management and landscape context. We surveyed birds at a total of 66 forest points that differed in their degree of coffee management and accessibility. The location of sampling sites ranged from the deep forest interior in nearly undisturbed forests to locations close to the forest edge—which is often but not always where coffee is most intensively produced and managed (Figure 1). In this commentary, we expand the discussion of our study's results, highlighting implications for the resilience of the forest ecosystem and outlining research priorities for future studies of bird diversity in the region.

Overall, we found a diverse community of forest birds (76 species, 6 of which were endemic to the highlands of Ethiopia and Eritrea), and we found no effect of coffee management and landscape context on total species

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Figure 1. Southwestern Ethiopian forests: (a) view of continuous moist evergreen forests, (b) forest interior without management for coffee production, and (c) forest intensively managed for coffee production. Credit of pictures: (a) and (c) Patrícia Rodrigues and (b) Girma Shumi Dugo.

richness and total abundance of birds. However, the richness and abundance of forest specialists and the richness of dietary specialists increased with higher forest naturalness (a local, management-related effect) and with increasing distance from the edge and amount of forest cover (a landscape context effect). As we explain later, these results have important implications for conservation measures, land management decisions, and the resilience of forest ecosystems (Figure 2).

One of our major findings, the lack of response of total bird richness and total abundance to both coffee management intensity and landscape context indicates that these two measures of diversity, when considered alone, may be insufficient to describe the diversity of an ecological community and can even mask changes in community patterns (Lewis, 2009). Thus, this result highlights the importance of complementing total species richness and total abundance measures with guild-specific responses in the characterization of ecological communities undergoing environmental disturbance (Mac Nally, Fleishman, Thomson, & Dobkin, 2008).

Furthermore, the assessment of specific bird assemblages that are based on ecological criteria or functional attributes (such as feeding guilds or foraging strategies) allows the connection with specific functions and ecosystem services provided by birds. For instance, frugivorous birds are important seed dispersers and thus play a key role in forest regeneration, while insectivores play an important pest control function (Johnson, Kellermann, & Stercho, 2010). The decrease of both richness and abundance of different ecological groups thus may entail consequences for the ecosystem functions and services those groups provide (Clough, Putra, Pitopang, & Tscharntke, 2009; Şekercioğlu, 2006). Although a decline in richness alone might not compromise the delivery of a service (because few but dominant species may be able to maintain the function; Winfree, Fox, Williams, Reilly, & Cariveau, 2015), it can have a negative effect on the resilience of communities by reducing response diversity. Response diversity describes the diversity of responses that different organisms exhibit to a particular disturbance or environmental change (Elmqvist et al., 2003).

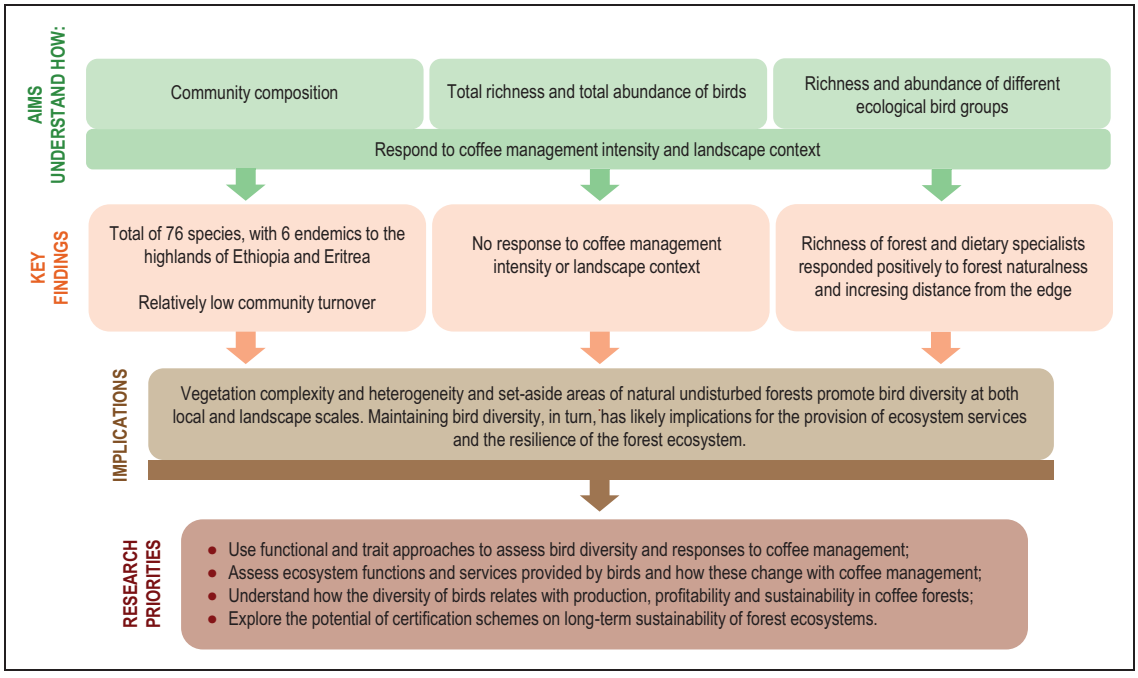

Figure 2. Aims of the study, major findings, implications for conservation and land management decisions, and research priorities for future studies on bird diversity in southwestern Ethiopia.

Reduced response diversity can undermine resilience because in a situation with low response diversity, a given change may negatively affect many species at the same time, thus compromising the capacity of the ecosystem as a whole to absorb and recover from disturbances (Mori, Furukawa, & Sasaki, 2013).

Although our results do not allow us to draw conclusions regarding specific implications of declines of different ecological groups on ecosystem services and ecosystem resilience (see, for instance, Karp, Ziv, Zook, Ehrlich, & Daily, 2011), they highlight the general importance of looking at responses of different ecological groups separately when addressing the effects and implications of forest management on biodiversity. For instance, our results suggest that forest naturalness benefits the richness of frugivores. However, as the abundance of frugivores was not affected by coffee management or landscape context, the service of seed dispersal might still be secured by the dominant frugivore species in the immediate term—but there might be a decline in response diversity and hence resilience to further changes in the future.

Possible scenarios for southwestern Ethiopian coffee forests span a wide range of possibilities. It is possible that coffee agroforests will expand into existing croplands, while traditional coffee is maintained in the forest. This would not only improve overall forest connectivity and reduce fragmentation but could also lead to landscape and forest homogenization. At the other extreme, it is possible that farmland will further expand into currently forested areas, causing further fragmentation of natural forests, and accelerated biodiversity loss due to the intensification of coffee management in the remnant patches.

Despite the uncertainty associated with the future of southwestern Ethiopian forests, it is likely that coffee production will continue to be a major activity in the region. Therefore, understanding the extent to which coffee management affects different ecological communities and ecosystem services should be a priority for the region. Further research should focus on (a) the use of functional diversity and trait approaches to assess bird diversity and the responses to coffee management, (b) the assessment of ecosystem functions and services provided by birds and how these change with coffee management and landscape configuration, (c) understanding the relationships between bird diversity and the production and sustainability of coffee forests, and (d) the assessment of the potential of different coffee certification schemes (fair trade, organic, and bird-friendly) to improve the long-term sustainability of the forest ecosystem (Figure 2).

Ultimately, the resilience and sustainability of southwestern Ethiopian coffee ecosystems will rely on how well the forests will be preserved and managed. Management and conservation measures should encourage traditional practices that promote the structural complexity of vegetation, as well as the maintenance and protection of large undisturbed areas of natural forest.

Declaration of Conflicting Interests

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