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Genetic diversity and structure in wild Robusta coffee (*Coffea canephora* A. Froehner) populations in Yangambi (DR Congo) and their relation to forest disturbance

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Degradation and regeneration of tropical forests can strongly affect gene flow in understorey species, resulting in genetic erosion and changes in genetic structure. Yet, these processes remain poorly studied in tropical Africa. *Coffea canephora* is an economically important species, found in the understorey of tropical rainforests of Central and West Africa, and the genetic diversity harboured in its wild populations is vital for sustainable coffee production worldwide. Here, we aimed to quantify genetic diversity, genetic structure, and pedigree relations in wild *C. canephora* populations, and we investigated associations between these descriptors and forest disturbance and regeneration. Therefore, we sampled 256 *C. canephora* individuals within 24 plots across three forest categories in Yangambi (DR Congo), and used genotyping-by-sequencing to identify 18,894 SNPs. Overall, we found high genetic diversity, and no evidence of genetic erosion in *C. canephora* in disturbed old-growth forest, as compared to undisturbed old-growth forest. In addition, an overall heterozygosity excess was found in all populations, which was expected for a self-incompatible species. Genetic structure was mainly a result of isolation-by-distance, reflecting geographical location, with low to moderate relatedness at finer scales. Populations in regrowth forest had lower allelic richness than populations in old-growth forest and were characterised by a lower inter-individual relatedness and a lack of isolation-by-distance, suggesting that they originated from different neighbouring populations and were subject to founder effects. Wild Robusta coffee populations in the study area still harbour high levels of genetic diversity, yet careful monitoring of their response to ongoing forest degradation remains required.

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INTRODUCTION

Tropical rainforests cover only 7% of the Earth's land surface but represent the world's richest reservoir of terrestrial biodiversity (Kier et al. 2005; Kreft and Jetz 2007). Over the past decades, human activities such as industrial logging and the encroachment of agriculture and infrastructure have negatively impacted tropical forest cover and resulted in the loss of biodiversity, jeopardising the provisioning of important ecosystem services such as carbon sequestration and climate regulation (Gardner et al. 2009; Curtis et al. 2018; Edwards et al. 2019). Less conspicuous than the loss of tropical forest cover is the ongoing degradation of tropical forests. Forest degradation refers to within-forest disturbance under a more or less intact canopy, and is mainly caused by selective logging and the removal of the understorey vegetation (Sasaki and Putz 2009; Tyukavina et al. 2018). Degradation of tropical forests may be as detrimental to biodiversity as forest cover loss due to the large spatial scales at which it occurs (Barlow et al. 2016). In the Congo Basin, for example, the rate of forest degradation has been estimated at 317,000 ha per year between 2000 and 2005 (Ernst et al. 2013), whereas Shapiro et al. (2021) reported that 23 million ha of forest has been degraded between 2000 and 2016 in this region.

Forest degradation may compromise the resilience and long-term stability of tropical rainforests because it can negatively affect the regeneration of the remaining woody plant species (Norden et al. 2009). Plant regeneration and fitness depend on multiple processes, including pollination, seed dispersal, germination and seedling establishment (Barret and Eckert 1990). Crucial aspects of gene flow early in the regeneration cycle, such as pollination and seed dispersal, can become strongly jeopardised through ongoing large-scale anthropogenic disturbance of tropical forests (Neushulz et al. 2016). Because many tropical canopy trees and understorey shrubs typically occur in population densities of less than one individual per ha, and due to widespread dioecy and self-incompatibility (SI) (Bawa et al. 1985; Hubbell and Foster 1986), pollen flow and successful pollination

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