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Persistence of carbon in the African forest understory

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Tropical forests acted as important carbon sinks during the last few decades. Predicting their future dynamics is critical to quantify their potential role in climate mitigation strategies. While the persistence of the carbon pool is a direct function of tree longevity, little is known about the age structure in tropical forests. Here we estimate total tree age and mean carbon age in different strata of African mixed forests using (i) growth-ring measurements combined with a unique cambial pinning experiment spanning 66 years and (ii) measurements of diameter growth rates. We find that mean carbon age in understory trees (73 years) is higher than that in intermediate forest strata (54 years) and is no different from carbon age in emergent trees, in spite of their much smaller size. Carbon longevity in the understory can be explained by slow and non-periodic cambial growth, resulting from adaptation of understory specialists to limited resource availability. The understory represents 11% of the stand-level carbon stock and 20% of net carbon uptake, while intermediate strata do not contribute to C uptake. Hence, the understory contributes both a long-lived carbon pool and a disproportionally high carbon sink. The highly differentiated behaviour of forest strata has important implications for accurate modelling of carbon cycling.