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Tropical Forest Mysteries: Unveiling the Global Consistency of Common Tree Species Patterns

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The paper titled "Consistent patterns of common species across tropical tree communities" was published in the journal Nature on January 10, 2024, by authors Declan L.M. Cooper, Simon L.Lewis, Martin J.P. Sullivan, and others, are from the Department of Geography, University College London, London, UK; the Centre for Biodiversity and Environment Research, Department of Genetics, Evolution and Environment, University College London, London, UK; and the School of Geography, University of Leeds, Leeds, UK. The research presents a comprehensive study on the abundance patterns of common tree species across old-growth tropical forests in Africa, Amazonia, and Southeast Asia. Using inventory data of over a million trees, the study estimates that a small percentage of species account for half of the tropical trees in these regions. Despite differences in biogeographic history, a consistent pattern of species abundance distribution is observed across continents, suggesting universal mechanisms of tree community assembly.

1 Experimental Data Analysis

The study's key results are derived from analyzing inventory data of 1 003 805 trees across 1 568 locations. Rarefaction analysis and resampling techniques are used to standardize sampling and assess species abundance patterns. The analysis shows that, consistently across continents, approximately 2.2%-2.3% of species comprise 50% of tropical trees. These findings are visualized through figures such as location maps of inventory plots and rarefaction curves, indicating a notable consistency in the proportion of common species across diverse tropical forests.

Based on Figure 1, the study seems to have analyzed 1 568 plots across different tropical forest regions, with the plots marked by dots and categorized by continental areas. The dark green dots represent plots from the Amazonia, Africa, and Southeast Asia regions—these are areas to which the study's findings are extrapolated. The light green areas depict 'tropical and subtropical moist broadleaf forests', which is the biome the study considers as closed canopy tropical forests. This distribution of plots suggests a comprehensive geographic coverage within the specified tropical forest biome, potentially providing a diverse set of data points for the study.

Figure 2 illustrates the relationship between sample size and biodiversity metrics in tropical tree communities by using rarefaction curves. It compares the number of hyperdominants, total species, hyperdominant percentage, and Fisher's α values across tropical Africa (magenta), Amazonia (cyan), and Southeast Asia (blue). As the sample size increases, indicated by the number of stems, there is a general rise in the number of hyperdominants and total species, which tends to plateau, suggesting a threshold of biodiversity in these regions. The hyperdominant percentage decreases with more samples, possibly indicating that hyperdominance is more apparent in smaller samples. The Fisher's α, a measure of diversity, shows a variable increase. The shaded areas denote 95% confidence intervals, giving a visual representation of the reliability of the data across resampling iterations. The curves emphasize the importance of sample size in estimating biodiversity and the dominance of certain species within these ecosystems.

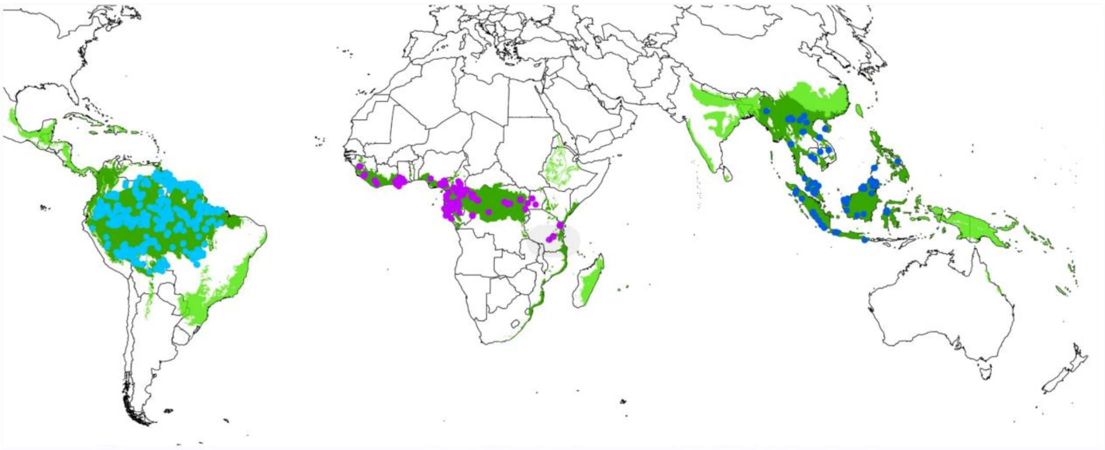

Figure 1 Location of the 1 568 plots, tropical forest regions, and tropical forest biome extent used in the study

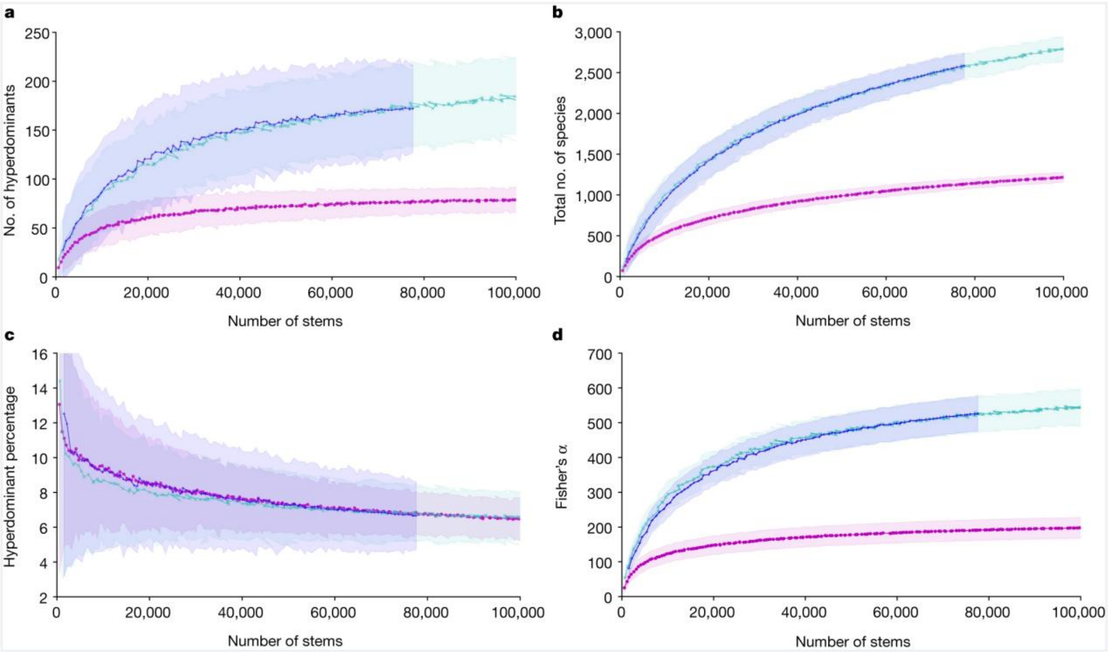

Figure 2 Rarefaction curves showing the effect of increasing sample size on the number of hyperdominants, total species, hyperdominant percentage and fitted values of Fisher's α in tropical tree communities

Table 1 presents a comparative analysis of tree species hyperdominance in tropical forests across Africa, Amazonia, and Southeast Asia, standardized to a common sample size of 77 587 trees. Africa has the lowest number of hyperdominants (77) and total species (1 132), whereas Amazonia exhibits the highest in both categories, with 174 hyperdominants and 2 656 total species. Southeast Asia is comparable to Amazonia in species richness but slightly less in hyperdominance. Hyperdominant percentages are fairly similar across regions, ranging from 6.79% in Africa to around 6.60% in Amazonia and 6.65% in Southeast Asia. Fisher's α, a diversity index, is notably higher in Amazonia (525) and Southeast Asia (526) compared to Africa (191), suggesting greater species diversity in the Amazonian and Southeast Asian forests relative to African forests at this sample size.

Figure 3 depicts the dominance-diversity relationship in tropical forests of Amazonia, Africa, and Southeast Asia by showing the dominant proportion of total species required to account for various dominance thresholds (10% to 90%) of the total number of stems. The circles indicate data rarefied to the Southeast Asia dataset size, while diamonds represent extrapolated regional scale data. It shows that for a lower dominance threshold, a small percentage of total species is sufficient to account for the given percentage of stems. As the dominance threshold increases, the proportion of species required to meet the threshold also increases, with the highest variability observed at extreme dominance thresholds, particularly in the Amazon. The plot highlights notable differences in species dominance between rarefied and extrapolated data, suggesting that dominance patterns may differ significantly when projected across larger scales. This also underscores the variation in species dominance among different tropical regions, with Southeast Asia showing a narrower confidence interval, indicating more consistent results across samples.

Table 1 Tree species hyperdominance results for African, Amazonian and Southeast Asian tropical forests, resampled to the common sample size of 77 587 trees

	Number of hyperdominants	Total species	Hyperdominant percentage	Fisher's α
Africa	77 [62, 92]	1,132 [1,069, 1,194]	6.79 [5.39, 8.20]	191 [161, 220]
Amazonia	174 [134, 215]	2,565 [2,419, 2,711]	6.80 [5.24, 8.36]	525 [475, 575]
Southeast Asia	172 [125, 219]	2,585 [2,440, 2,730]	6.65 [4.59, 8.71]	526 [476, 577]

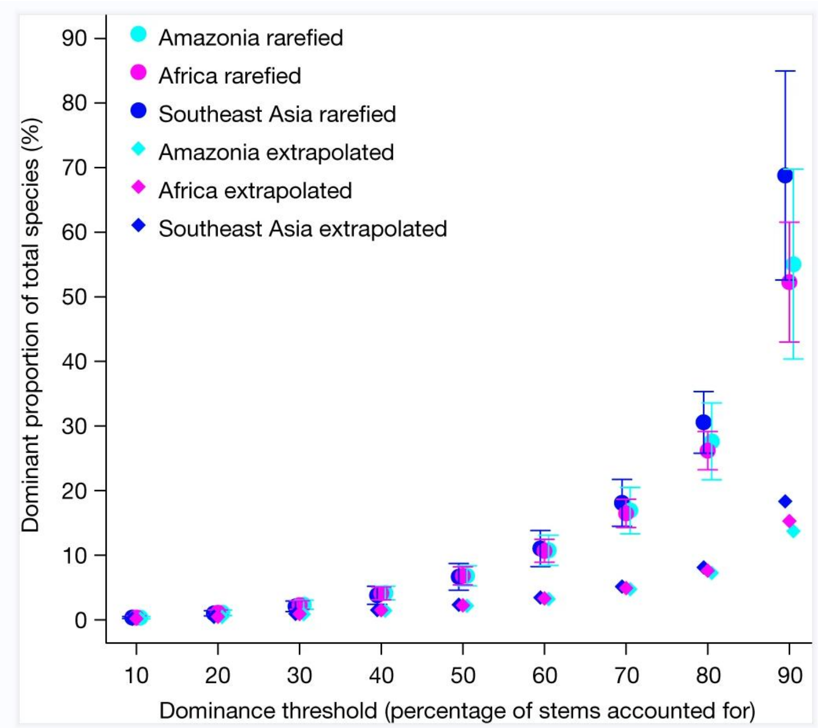

Figure 3 The minimum percentage of total species required to account for given dominance thresholds of the total number of stems when this varies from 10% to 90%

Table 2 presents extrapolated data on hyperdominance in tree species across tropical forests of Africa, Amazonia, and Southeast Asia at a regional scale. Africa is reported to have 104 hyperdominant species, with a total species count of 4 638, and the hyperdominant percentage is the lowest at 2.23%. Amazonia has the highest number of hyperdominants at 299 and the greatest species richness with 13 826 species, yet its hyperdominant percentage is slightly lower than Africa's at 2.16%. Southeast Asia has 278 hyperdominants with a total of 11 963 species, and the highest hyperdominant percentage among the three regions at 2.32%. The combined total shows 681 hyperdominants out of 30,427 species across the regions, resulting in a hyperdominant percentage of 2.24%. Prediction intervals in brackets provide an estimate of uncertainty, accounting for the variability in the data and the potential error in extrapolation methods used. This table suggests that while Amazonia is the most species-rich, Southeast Asia has a slightly higher proportion of hyperdominants relative to its species count.

Table 2 Extrapolated tree species hyperdominance results for African, Amazonian, Southeast Asian tropical forests at the regional scale

	Number of hyperdominants	Total species	Hyperdominant percentage
Africa	**104** [101, 107]	**4,638** [4,511, 4,764]	**2.23**
Amazonia	**299** [295, 304]	**13,826** [13,615, 14,036]	**2.16**
Southeast Asia	**278** [268, 289]	**11,963** [11,451, 12,475]	**2.32**
Total[a]	**681** [664, 700]	**30,427** [29,577, 31,275]	**2.24**

2 Analysis of Research Findings

The study uncovers a surprisingly consistent pattern of common tree species across the world's most biodiverse ecosystems. This consistency holds true despite varying climatic, biogeographic, and anthropogenic factors across the studied regions. The identified common species offer a manageable subset for targeted ecological research, suggesting that understanding these species' roles could significantly advance our knowledge of tropical forest ecology, productivity, and responses to environmental changes.

3 Evaluation of the Research

The research provides a groundbreaking perspective on tropical forest biodiversity by highlighting the significance of common species in understanding complex ecological dynamics. The methodology, encompassing comprehensive data analysis and innovative approaches to data standardization, sets a high standard for ecological studies. However, the reliance on existing inventory data and the variability in plot sizes and species identification precision may introduce limitations to the study's generalizability.

4 Conclusions

This study challenges the traditional focus on the vast species richness of tropical forests by demonstrating the disproportionate importance of a relatively small number of common species. The findings advocate for a shift in conservation and research priorities towards these common species to enhance our understanding of tropical forests' ecological and functional dynamics.

5 Access the Full Text

Cooper D.L.M., Lewis S.L., Sullivan M.J.P. et al. Consistent patterns of common species across tropical tree communities. Nature 625, 728-734 (2024). https://doi.org/10.1038/s41586-023-06820-z.

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