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Nature Plants, Volume 11, 942–943 (May 2025)

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Phylogenetic conservatism of plant habitat preferences reflects evolutionary adaptations to historic environmental conditions. The human-driven extinction of large herbivores across Europe has had profound effects on forest canopy properties creating a mismatch between the preferred and current conditions of the understory plants housed within these forests. Strategies for the long-term preservation of plant biodiversity should therefore consider the role of large herbivores in shaping local and regional species assemblages.

As the largest contributors to Earth's biomass (1), vascular plants shape the structure and function of terrestrial ecosystems – forests being the embodiment of this "plant dominance" (2). In European forest ecosystems, the impact of humans on the landscape is widespread (3) and new management and conservation strategies are needed to preserve the remaining biodiversity. Traditional views of forest dynamics and management planning, but also some conservation policies, identify mature stages of forest ecosystems as dominated by closed-canopy tree stands. However, recent research from Szymon Czyżewski & Jens-Chris Svenning (4) reports that, rather than favouring the semi-open canopies currently found in European forests, temperate forest plants prefer the light conditions proffered by a semi-open canopy. This finding reflects the coevolution of plant species with large herbivores and the present lack of such animals may therefore increase the extinction risk for many plants within European temperate forests.

Starting from the assumption that the plant species presently living in European temperate forests evolved in the last 0.1-10 Myr when large herbivores were present in Europe, Czyżewski & Svenning asked whether the habitat affinity of these plants could be explained as an adaptation to a forest structure and dynamics linked to the presence of mammalian herbivory. They modelled the ecological niche of 917 plant species using a large dataset of Ecological Indicator Values (EIV), obtaining their responses to different forest structure and frequency-intensity disturbance scenarios and then calculating plant extinction risks as a function of large herbivore loss.

Surprisingly, understory plants were found to prefer forest ecosystems that are spatially heterogeneous and characterised by semi-open canopy conditions, rather than being adapted to uniformly closed-canopy environments. They also found that temperate forest plant species with affinity for open canopies also have affinity for low-severity but high-frequency disturbance - consistent with the scenario characterised by the presence a rich fauna of large herbivores that, by providing a high frequency and low intensity disturbance, promotes local niche differentiation and supports high plant diversity (6). This has similarities to the Vera hypothesis (7), according to which post-glacial temperate

Europe was dominated by open wood-pasture maintained by large herbivores, rather than closed forests.

The paper therefore supports the view that functional heterogeneity and biogeochemical dynamics of present temperate forest ecosystems deviates from the evolutionary baseline that drove the evolution of the present flora largely because of the lack of large herbivores. This research may have important implications for biodiversity conservation as they found that plant species exhibiting a preference for large herbivore-moderated habitats were at a higher risk of extinction. This may therefore support biodiversity conservation scenarios in which a higher presence of wild herbivores could aid restoration of ecosystem processes.

A clear understanding of the drivers affecting the relationship between biodiversity persistence and ecosystem dynamics across spatial scales is poorly resolved. This paper also contributes to this understanding by highlighting the potential role of large herbivores in supporting niche availability for plant species in temperate forest ecosystems of Europe. The fragility of a purely deterministic model of forest dynamics, as a linear-succession theory at the plant community levels, has already been questioned (8). New elements emerging from this and other research (6) show how ecosystem processes affecting biodiversity on evolutionary scale still needs to be investigated.

Despite the vast amounts of data available for forest ecosystems, our understanding of their natural dynamics is still incomplete. Too often, simple patterns in tree cover are misused to model the complex processes of forest dynamics (9). True forest ecosystems are characterized by complex interactions among trees, soil, flora, fauna, and microbiota, and cannot be confused with simplified tree-dominated structures (9-10). The work by Czyżewski & Svenning highlights the limits of traditional approaches based on simple pattern identification. Long-term conservation scenarios should take into account the requirement of many European temperate plants for heterogeneous canopy conditions.

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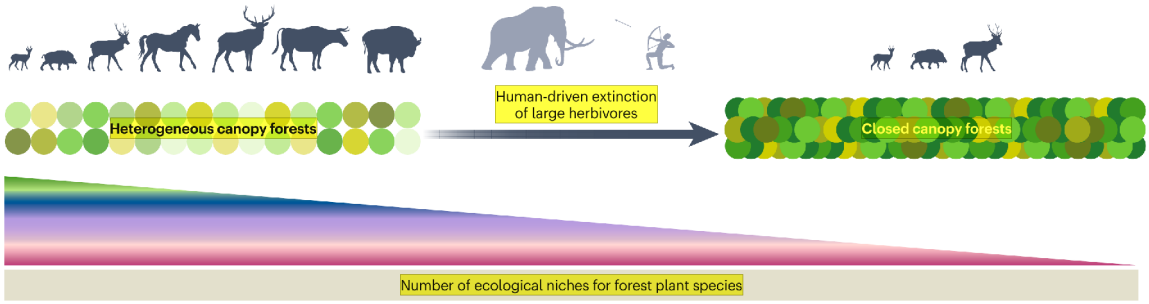

Figure 1. Large herbivores shape the available niche spaces for plant species in European temperate forests

The analyses performed by Czyżewski & Svenning (4) support the hypothesis that the presence of large herbivores shaped the ecological niches of most plant species in European temperate forests through evolutionary time scale and that the recent human driven extirpation of these herbivores reduced the number of available niches increasing the extinction risk for these plants.