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Editorial: The adaptation, plasticity and extinction of forest plants to climate change: mechanisms behind the morphological, physiological, phenological and ecological traits

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Editorial on the Research Topic

The adaptation, plasticity and extinction of forest plants to climate change: mechanisms behind the morphological, physiological, phenological and ecological traits

Climate change is one of the greatest threats to humankind's current and future survival. Forests are one of the most essential solutions to addressing the effects of climate change by absorbing huge amounts of carbon dioxide (Pugh et al., 2019; Jiang et al., 2020; Wang et al., 2020). Furthermore, forest loss and degradation are both a cause and an effect of our changing climate (Sasaki and Putz, 2009; Griscom et al., 2017). The expected future climate with increasing drought episodes, seasonally warm temperatures, and severe storms, poses a challenge for forest management since it will affect the growth, mortality, species composition, and distribution of future forests (Figure 1; Huang et al., 2017; Shi et al., 2020). However, how the growth of different species responds differently to long-term drought and high temperatures has been poorly understood. Climate-growth relationships are an important tool for investigating tree growth responses under changing climate and thus provide a scientific basis for future forest management (Huang et al., 2022; Leifsson et al., 2024).

The papers collected in this Research Topic cover some important topics associated with climate change, including phenology, morphology, tree-ring growth, and wood anatomical traits of trees' response to long-term climate change in Australia's cool temperate rainforest, Amazon flooding forest, and Canada's temperate forest, and also includes drought and heavy metal control experiments, as well as an article investigating the mathematical intricacies of bamboo internode elongation.

FIGURE 1
The tree species trial in Lovrup Forest in Denmark (NST Vadehavet) after the storm on December 3, 1999. The trial provides an example of the effect of storms on individual tree species and their potential to withstand increasing and more powerful storms. This picture was obtained from Huang et al. (2018; Foto: Feb. 2000, B. Bilde Jørgensen).

Australian cold temperate moist forests are known to have the highest aboveground biomass carbon stocks of all forest types (Keith et al., 2009). However, little is known about the effects of Australia's cool temperate rainforest climate on long-term phenology. Vogado et al. provided 20 years of defoliation data from cool-temperature *Nothofagus* rainforests in New South Wales, Australia. They found that defoliation at the community level was mainly affected by *Nothofagus moorei*, driven by temperature and wind speed, and *Ceratopetalum apetalum*, driven by temperature, rainfall, and solar radiation. In addition, the average dates of community defoliation were increased by advanced solar radiation. All species presented seasonality in phenological behaviors, but seasonality peaked in different months and is influenced by different climate variables.

The Amazon floodplain forest is one of the largest flood-pulsed environments in the world (Junk et al., 2011), whose phenology and diameter increment are mainly triggered by flood pulses. de Sá et al. found that the tree growth and xylem anatomical characteristics of *Hydrochorea corymbosa* in várzea flooded forest in Central Amazon responded diversely to flooding and non-flooding periods. High flood levels during the end of the flood negatively affected vessel diameter in June and positively influenced parenchyma quantity in September and October. During the non-flooded period in December, the annual tree growth negatively correlated with the vapor pressure deficit. The vessel diameter was negatively affected by the September maximum temperature. The authors suggest that intensification of the hydrological regime and the severe droughts during the non-flooded periods can be a risk for *H. corymbosa* in the Central Amazonian floodplains.

Different tree species growing under the same conditions showed different plasticity and adaptation to climate change (Huang et al., 2017). Populations of a species descending from different origins may also exhibit different climatic adaptations. Zhou et al. observed that *Acer saccharum* seedlings originating from inland areas showed higher plasticity of bud burst than those from coastal areas at the beginning of leaf development in Quebec, Canada. Trees experiencing a wider climatic fluctuation may exhibit higher plasticity.

In addition to field experiments, control experiments are a method to study the effects of climate on trees by precisely controlling a single factor or multiple factors to examine the impacts of factor changes on tree growth. Xiao et al. set a pot experiment to investigate the effects of droughts and re-watering on the dynamics of non-structural carbohydrates (NSCs) in the different organs of two-year-old *Pinus yunnanensis* seedlings. Under drought, when the carbohydrates produced by photosynthesis could not satisfy the energy required for respiration, plants began to consume stored NSC. "Carbon starvation" occurs when stored NSCs cannot meet the energy required for cellular metabolism (McDowell et al., 2008, 2011). The author found that during the early stage of drought, the drought resistance of *P. yunnanensis* seedlings was enhanced by increasing soluble sugar concentration; in the later stages of drought, stored starch in organs, stems, and coarse roots were consumed. Growth under moderate drought was promoted after re-watering, suggesting that moderate drought stress can enhance drought tolerance and compensatory growth. Different drought treatments may lead to discrepancies in results. Zhao et al. found a diminishing relationship between trait patterns versus soil water content (SWC) from N-fixing non-legumes, N-fixing legumes to non-N-fixing plants. Whereas, several other studies have shown that drought intensification is more detrimental to non-N-fixing plants compared to N-fixing plants (Hofer et al., 2016, 2017). Climate change may increase runoff and accelerate leaching, thereby increasing heavy metal concentrations in soils. Alotaibi found that the increasing concentration of Pb and Cd delayed the *Calligonum comosum* seeds' germination rate and speed. The authors suggest that the enhanced redox proteins and proteins involved in ATP synthesis may be a possible mechanism for seed tolerance to heavy metals.

Bamboo is one of the fastest-growing plants on earth, which can grow almost a meter in a single day and grow to its full height of 2 m to above 30 m within a few months (Shi et al., 2017), and sequester large amounts of atmospheric carbon to mitigate climate change. However, the relationship between internode length and serial number changes with culm height growth is not well understood. Tan et al. investigated the mathematical intricacies of the internode elongation pattern of *Phyllostachys edulis*, *Phyllostachys iridescens*, and *Pseudosasa amabilis* involved in the rapid culm growth.

In conclusion, the papers published in this Research Topic expand the current understanding of the adaptation and plasticity of different species growing in diverse continents with diverse climate conditions to climate change, as well as the mechanisms behind the morphological, physiological, phenological, and ecological traits.

Author contributions

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Conflict of interest

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