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Editorial

Advances and perspectives on the ecology and management of *Castanea* species

Species of chestnut (*Castanea* spp.) are naturally widespread throughout temperate forests of the northern hemisphere in Asia, Europe, and North America. Populations have been naturalized outside of species' native ranges in Europe, North America, South America and Oceania. The wide diffusion on a planetary level over tens of millions of years has resulted in high genetic variability within the genus and species adaptations to disparate environmental conditions (Dane et al., 2003; Mellano et al., 2012; Krebs et al., 2019). Perhaps more than many other tree species, the history of chestnut has been closely linked to human civilizations who utilized chestnut as an agricultural and forest resource over millennia. Chestnut species have had important cultural significance for Indigenous communities, although much Traditional Ecological Knowledge has been lost (Barnhill-Dilling and Delborne, 2019), and chestnut species have been subjected to challenges of the contemporary Anthropocene, from globalization to climate change. Alterations to disturbance regimes, particularly related to drought and fire, and the introduction of nonnative pests and pathogens, have reduced genetic diversity and population densities, particularly for species in North America, Europe, and western Asia (Mellano et al., 2012; Dalgleish et al., 2016). Forest management practices, genomic tools, tree breeding, and prediction models have been developed and tested to meet these challenges (Jacobs et al., 2013; Fernandes et al., 2022). Most strategies, however, are underdeveloped and species specific, including for American chestnut (Burnham et al., 1986; Anagnostakis, 2012; Fei et al., 2012) and sweet chestnut (Conedera et al., 2016; Manetti et al., 2019; Marcolin et al., 2020; Patrício et al., 2020). A global perspective for chestnut sustainability, conservation, and management has largely been missing in the literature, excluding proceedings from International Chestnut Symposia (e.g., Double and MacDonald, 2014).

These considerations contributed to formation of a chestnut working party within the Silviculture Division of the International Union of Forest Research Organizations (IUFRO) (Working Party 1.01.13, https://www.iufro.org/science/divisions/division-1/10000/10100/10113/). One of the Working Party's first objectives was to provide a platform for sharing emerging research topics and results for a better understanding of the strategies necessary for the sustainability and restoration of chestnut forests and related agroforestry ecosystems. The Special Issue on the Ecology and Management of Castanea Species brought together diverse research from around the globe, highlighting the importance of chestnut forests and their cultural and ecological significance. The papers covered a wide range of topics, from pathology and physiological research to silvicultural and management practices. The research presented here suggests that while there are commonalities across species, there is no 'one-size-fits-all' approach to managing chestnut forests. Successful strategies are tailored to specific management goals within particular geographic regions or stand conditions.

Authors with affiliations from twelve different countries contributed to twenty-two papers accepted for publication, of which eleven focused on American chestnut [*C. dentata* (Marsh.) Borkh.], nine on sweet chestnut (*C. sativa* Mill.), and one on Chinese chinkapin [*C. henryi* (Skan) Rehder & E.H. Wilson]; one paper integrated two chestnut species (American and sweet chestnuts). Although this Special Issue was open to topics for all chestnut species, the majority of the contributions were focused on sweet and American chestnut. Three studies from North America utilized Chinese chestnut (*C. mollissima*) as a control treatment in experiments testing Chinese-American chestnut backcross hybrids (Brown et al., 2022, 2023 this issue; Clark et al., 2023a this issue), but studies using Asian chestnut species as the primary species of interest were limited to one paper (Chen et al., 2023 this issue). It is probable that the importance of non-forestry goals, in addition to linguistic restrictions, were significant obstacles to producing technical-scientific literature for Asian species.

Much of the research in the Special Issue was directed towards artificially regenerated forests in Europe, South America, and North America, but primary goals of planting chestnut differed among the continents. For European forests and naturalized forests in South America, the goals were related primarily to timber or improvements on wood production (Benedetti-Ruiz et al., 2023 this issue; Loewe-Muñoz et al., 2023 this issue; Manetti et al., 2022 this issue; Patrício et al., 2022 this issue), while planting chestnut in North America was related primarily to fulfill ecological restoration goals (Brown et al., 2022, 2023 this issue; Clark, et al., 2022 this issue; Pinchot et al., 2022 this issue; Schaberg et al., 2022 this issue; Clark, et al., 2023a this issue; Evans et al., 2023 this issue). Reinvigorating abandoned coppice forests was an important research topic for sweet chestnut in Europe (Vericat et al., 2022 this issue; Manetti et al., 2022 this issue).

For American chestnut, the research was often field based to answer novel questions, such as temporal dynamics of non-structural carbohydrates (Montague et al., 2022 this issue), soil mycology (Brown et al., 2023 this issue), and species comparisons of growth and soil fungal effects between two species within the Fagaceae family (Brown et al., 2022 this issue). For the first time, assisted migration using backcross hybrid chestnuts (Clark et al., 2022 this issue) and physiology of transgenic chestnut (Evans et al., 2023 this issue) were studied in a silvicultural context. Two studies examined provenance or genetic differences in field performance (Schaberg et al., 2022 this issue; Clark et al., 2023a this issue), revealing that pure American chestnut and backcross American chestnut hybrids have exceptional growth, even when limited by cold temperatures, but hybrids do not yet have durable

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blight resistance.

There were themes that spanned species and continents: browse effects on planted seedlings and resprouting shoots (Bottero et al., 2022 this issue; Pinchot et al., 2022 this issue), co-occurring species effects on population dynamics (Campagnaro et al., 2023 this issue; Dalgleish et al., 2023 this issue), and modelling tools to improve management in a changing climate (Patrício et al., 2022 this issue; Henderson et al., 2023 this issue; Menéndez-Miguélez et al., 2023 this issue). For the first time, a synthesis paper was published that summarizes silvicultural histories and current strategies and examined potential synergies for two chestnut species (American and sweet) (Clark et al., 2023b this issue). Some studies were conducted at relatively small scales of the single organism, such as nursery production of Chinese chinkapin (Chen et al., 2023 this issue) and factors affecting hypovirulent blight control of sweet chestnut in England (Romon-Ochoa et al., 2023 this issue). Only one paper had a wildlife component, reporting mast preference comparisons among oaks (*Quercus*), American chestnut, and chestnut hybrids (Wright et al., 2022 this issue), a research topic that has gone virtually unstudied (but see Minser et al., 1995).

Based on the contributions found in this Special Issue, chestnut ecology and silvicultural research has evolved towards refining management for production of myriad resources and cultural values. Management goals appear to be largely based on economic returns for European, Asian, and naturalized populations in South America, but ecological restoration of an extirpated species is the primary goal for North American populations. Research, regardless of primary objectives, will need to include climate-forward approaches as well as mitigation for forest abandonment and nonnative pests. Notably, Phytophthora root rot (as known in North America) or ink disease (as known in Europe) [causal organisms *Phytophthora cinnamomi* Rands and *P. cambivora* (Petri) Buisman], chestnut blight [causal organism *Cryphonectria parasitica* (Murrill) Barr.], and Asian gall wasp (*Dryocosmus kuriphilus* Yasumatsu) represent significant threats. Additionally, ecological and silvicultural strategies will increasingly rely on modeling for population distributions, growth and yield, and/or stand dynamics to better predict responses to specific management actions within a changing climate.

Looking to the future, continued research and collaboration will be necessary to ensure the sustainability of chestnut forests in the face of challenges such as climate change, nonnative pests and pathogens, and changing disturbance regimes. Despite the research advancements and synthesis presented in the papers of this Special Issue, knowledge gaps still exist (Clark et al., 2023b this issue). Some examples include testing close-to-nature silvicultural approaches, responses to prescribed fire or wildfire, and developing economic markets for emerging products. Greater emphasis on global collaboration and knowledge sharing, as well as the development and testing of new strategies and technologies, will be key to the success of filling knowledge gaps and future research efforts. With continued collaboration and knowledge synthesis, we hope to ensure the survival and continued importance of chestnut species for generations to come.

Lastly, the varied research activities of the genus *Castanea* at a global level corresponds to a relatively small community of researchers. Therefore, we have to especially thank all of the authors who submitted papers for consideration and the reviewers who provided their valuable input (even for multiple submissions). We greatly appreciate Dan Binkley, the handling editor, who provided invaluable assistance for production of this Special Issue.

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Enrico Marcolin[a], Stacy L. Clark[b,*], Maria Sameiro Patrício[c,d], Verónica Loewe-Muñoz[e,f]

[a] *Department of Land, Environment, Agriculture and Forestry (TESAF), University of Padova, Via dell'Università 16, 35020 Legnaro (PD), Italy*

[b] *Southern Research Station, U.S.D.A. Forest Service, 2505 E. J. Chapman Drive, Rm 427 Plant Biotech Bldg, Knoxville, TN 37996-4563, United States*

[c] *Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal*

[d] *Laboratório Associado para a Sustentabilidade e Tecnologia em Regiões de Montanha (SusTEC), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253 Bragança, Portugal*

[e] *Chilean Forest Institute (INFOR), Metropolitan Office, Sucre 2397, Santiago, Chile*

[f] *Centro Nacional de Excelencia para la Industria de la Madera (CENAMAD), Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, Santiago, Chile*

[*] Corresponding author at: Southern Research Station, U.S.D.A. Forest Service, 2505 E. J. Chapman Drive, Rm 427 Plant Biotech Bldg, Knoxville, TN 37996-4563, United States (S.L. Clark).

E-mail addresses: enrico.marcolin@unipd.it (E. Marcolin), stacy.l.clark@usda.gov (S.L. Clark), sampat@ipb.pt (M.S. Patrício), vloewe@infor.cl (V. Loewe-Muñoz).