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Dendrochronology in Mexico over the last seventy years

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Abstract

The study of dendrochronology has intensified in recent years due to its close relationship with addressing environmental issues. Therefore, the objective of this study was to analyze the development of dendrochronological research in Mexico through a comprehensive literature review, which included search engines, websites, and publications from national and international journals. The collected information was organized into a database and classified into nine categories to analyze study frequencies, species, and locations. A total of 229 documents published between 1944 and 2021 were identified, with a significant increase during the period from 2009 to 2021, when dendroclimatology emerged as the most studied subdiscipline. In total, 429 different chronologies were documented, primarily distributed in the Sierra Madre Occidental. The best-represented reconstructed period spanned from 1801 to 2019. The most frequently studied species were *Pseudotsuga menziesii* and *Pinus hartwegii*. The most common application of this science has been precipitation reconstruction. Due to its extensive biodiversity, Mexico has significant potential for dendrochronological research. However, it is essential to expand both the physical and intellectual boundaries of this field and broaden its spatial scope within the country.

Keywords: tree rings, chronologies, dendroclimatology, dendroecology, climate reconstruction.

Introduction

The development of forest ecosystems is primarily determined by environmental factors. When these factors align with optimal conditions, tree growth improves; conversely, under adverse conditions, growth tends to be limited (Villanueva-Díaz et al., 2011). The radial growth of woody forest species, particularly conifers, leads to the formation of growth rings. These anatomical structures inherently record temporal variability and influence of factors such as climate, wildfires, pests, diseases, geomorphological processes, competition, air pollution, and human management, among others (Franco-Ramos & Vázquez-Selem, 2017). Among these factors, climate has the greatest influence on natural forests (Rojas-García et al., 2020).

Dendrochronology is a science that examines temporal variability of physical, structural, and compositional changes in tree growth rings and their relationship with environmental conditions of the sites where they develop. This discipline makes it possible to reconstruct and study a part of the environmental history underlying the development of the

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trees, as it allows for the analysis of various climatic variables and ecological processes spanning from hundreds to thousands of years (Douglas, 1941).

Dating growth rings of species sensitive to specific environmental conditions has become a trusted tool for the historical analysis of these conditions, as it offers a wider temporal perspective than instrumental records (Villanueva-Díaz et al., 2002). Depending on the approach and application of dendrochronological series, this science is categorized into various fields, including dendroclimatology, dendroecology, dendropyrology, dendrochemistry, dendrogeomorphology, dendrohydrology, dendrovolcanology, and dendroarchaeology (Amoroso & Suarez, 2015).

The study of dendrochronology in Mexico began in the 1940s with the work of Schulman (1944). In the early 1960s, new chronologies were established during the expedition to Casas Grandes in Chihuahua, where a notable 500-year floating chronology was developed (Bannister & Scott, 1964). In the 1970s, the "Mexican Tree Ring Project" led to the development of several chronologies (Therrell, 2003), although their application has remained limited (Villanueva-Díaz et al., 2011). During this time, Naylor (1971) conducted a preliminary study in Oaxaca, but was unable to generate successful chronological advances.

At the beginning of the 21st century, the global interest in understanding the historical variability of climate and other environmental factors influencing forest dynamics (such as wildfires and atmospheric circulation phenomena) spurred the study of dendrochronology in Mexico. This was achieved through technical and financial contributions of international organizations (Villanueva-Díaz et al., 2002). In the last two decades, the use of multiple forest species with dendrochronological potential across various approaches has demonstrated Mexico's viability for the development of this science (Reyes-Basilio et al., 2020). These advancements have positioned the country as one of the leading nations in dendrochronological research in Latin America (Fo et al., 2009).

In this context, the objective of this article was to analyze the spatial-temporal evolution of dendrochronology studies in Mexico through a comprehensive literature review and the analysis of relevant scientific products. The goal was to generate information that provides a comprehensive understanding about the application of this science in the country, to diagnose research needs and opportunities, and to provide solid bases for decision-making for the development of dendrochronology.

Materials and methods

For this study, scientific publications (research articles) as well as gray literature (books and chapters, conference proceedings, technical brochures, and preprints) from 1944 to 2021 were considered. The latter, although less formal, represent relevant contributions from the scientific community that, directly and indirectly, are related to the progress of dendrochronology in Mexico (Montes de Oca-Montano, 2018). Information was searched and obtained through specialized search engines such as Science Direct, Scopus, Wiley Online Library, and Springer; additionally, websites like Google Scholar, Redalyc, SciELO, and PubMed were consulted. Special attention was paid to the contents of the main national forestry journals: Revista Mexicana de Ciencias Forestales, Madera y Bosques, Revista Chapingo Serie Ciencias Forestales y del Ambiente, Agrociencia, and Investigaciones Geográficas, as well as high-impact international journals: Dendrochronologia, Tree-Ring Research, Trees y Forest.

For the search, the following keywords were used in both Spanish and English: "dendrochronology", "growth rings", "Mexico", "dendroclimatology", "dendroecology", "radial growth", "chronologies", "climatic reconstruction", "tree rings", "fire scars" y "paleoclimatology", as well as their combinations using the logical operator AND. As inclusion criteria, all publications referring to dendrochronology in Mexico were considered.

The information collected was organized into a database in Microsoft Excel®, using macros to semi-automate the process. The information fields corresponded to two criteria: documents and content. The first criterion included a unique identifier composed of consecutive numbers, title, year of publication, journal, authors and institution of origin. For the content of the documents, the following was considered: study site (entity, latitude, longitude and altitude), species studied, type of vegetation, variable measured in the rings (ring width, earlywood, latewood, chemical composition, fire scars or geomorphic processes, among others), chronology ranga and period, reconstructed variable, and range and period of reconstruction.

Subsequently, the information was classified into nine categories based on the analysis of growth ring chronologies: dendroclimatology, dendroecology, dendropyrology, dendrochemistry, dendrogeomorphology, dendrohydrology, dendrovolcanology, dendroarchaeology, and others (which included systematic reviews, meta-analyses, sites suitable for dendrochronological studies, and reconstruction of agro-food variables). Each category was analyzed based on frequencies, species, and locations studied.

Results and discussion

A total of 229 documents related to dendrochronology in Mexico were identified. Of these, 90 % (206) were scientific articles, while books or book chapters accounted for 6.6 % (15), proceedings from scientific dissemination events made up 3 % (seven), and preprints represented 0.4 % (one).

The scientific articles were published in a wide range of indexed journals. A total of 83 different journals were identified, mainly foreign (74.4 %). This reflects the quality and scientific rigor of research in this field in Mexico, because these articles met the requirements for publishing their results in leading journals. More than half (53.66 %) of the published articles appeared in foreign journals, primarily from the United States (Figure 1). The national journals with the highest number of publications were Revista Mexicana de Ciencias Forestales, Madera y Bosques, and Revista Chapingo Serie Ciencias Forestales y del Ambiente.

Between 1944 and 2021, scientific production on dendrochronology in Mexico concentrated in 33 years. The average production during this period was 2.66 articles per year (205 articles in total). Although the first studies were conducted in the 1940s (Schulman, 1944), the initial uncertainty about Mexico's potential for the development of this discipline led to intermittent progress and the generation of a limited number of chronologies throughout the 20th century (Bannister & Scott, 1964; Villanueva-Díaz et al., 2000; Naylor, 1971). In contrast, the 21st century saw a significant shift in the research trend of this science.

Three periods of scientific production in dendrochronology in Mexico were identified (Figure 2). The first period (from 1944 to 1998) showed limited development and low productivity in dendrochronological research in the country. During these 54 years, only 12 scientific products were recorded (5 % of the total). According to Villanueva-Díaz et al. (2000), just over 40 chronologies were generated during this period.

In the second period (from 1999 to 2008), a substantial improvement was observed, with 17 % (39) of the 229 scientific products found published. Villanueva-Díaz et al. (2009) classify this period as one in which the knowledge of the application of dendrochronology in Mexico was strengthened. This resurgence was driven by four factors: 1) growing scientific interest in climate elements and their temporal variation, atmospheric circulation phenomena (Villanueva-Díaz et al., 2002), temporal availability of water resources (Villanueva-Díaz et al., 2007), and influence of other environmental factors on natural resources; 2) the establishment of a dendrochronology laboratory in Mexico; 3) national and international funding for research projects (Villanueva-Díaz et al., 2008); and 4) collaboration and technical support of international organizations (Villanueva-Díaz et al., 2011).

In the third period (from 2009 to 2021), the rise of dendrochronology in Mexico was consolidated, with 77.7 % (178) of the scientific products considered in this study being published.

The temporal analysis identified nine categories or research approaches, with the results emphasizing the predominance of studies focused on the relationship

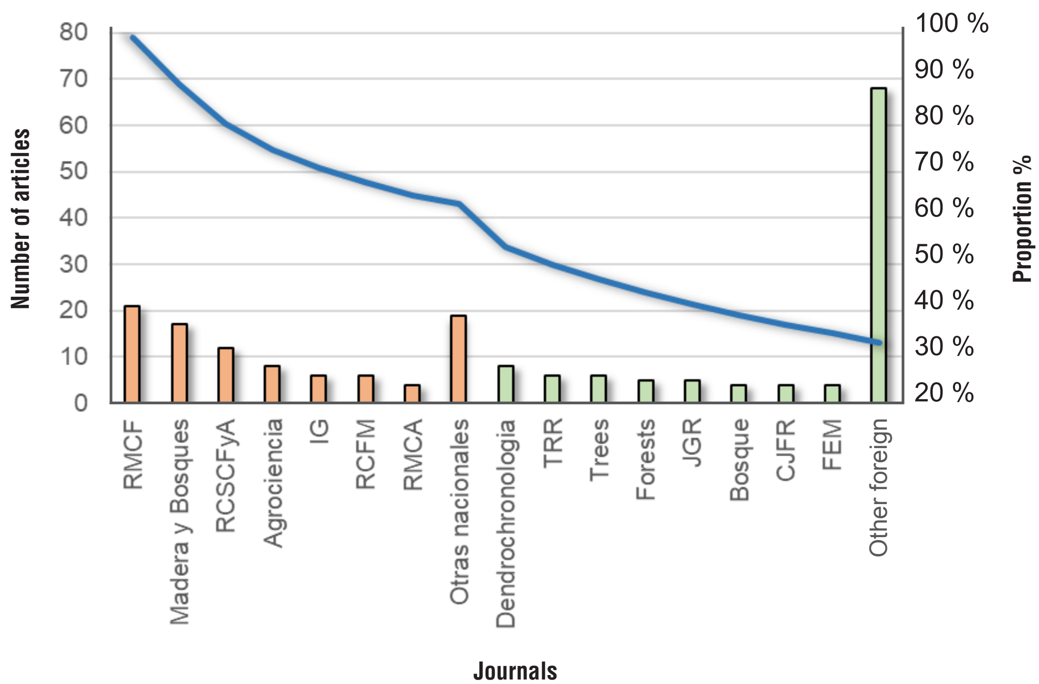

Figure 1. Distribution of the number of articles and national (orange) and foreign (green) journals that have published research on dendrochronology in Mexico. The blue line reflects the cumulative percentage. RMCF: Revista Mexicana de Ciencias Forestales; RCSCFyA: Revista Chapingo Serie Ciencias Forestales y del Ambiente; IG: Investigaciones Geográficas; RCFM: Revista de Ciencias Forestales en México; RMCA: Revista Mexicana de Ciencias Agrícolas; TRR: Tree-Ring Research; JGR: Journal of Geophysical Research; CJFR: Canadian Journal of Forest Research; FEM: Forest Ecology and Management.

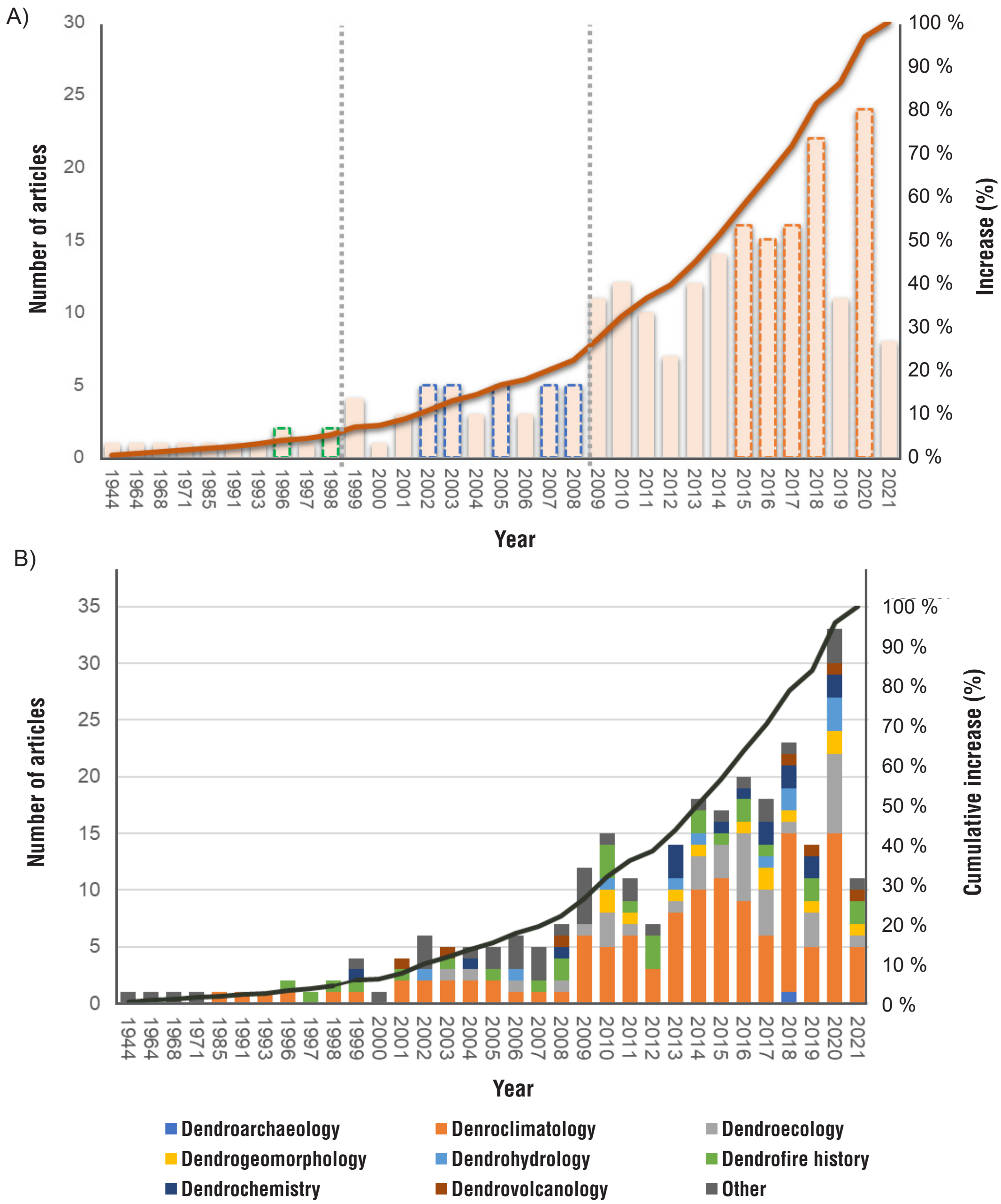

Figure 2. Scientific production related to dendrochronology in Mexico: A) three periods of scientific production (highlighted bars indicate outstanding production) and B) production according to the dendrochronology category.

between ring width and climate variables. Other approaches include research on the influence of environmental variables other than climate (Grissino-Mayer et al., 2005), dendrochronological potential, dissemination of methodologies, and innovation studies (Figure 2B).

Dendroclimatology

Dendroclimatology is based on the physiological ability of certain tree species to record climatic variability in their growth rings, making them genuine meteorological biostations (Cerano-Paredes et al., 2016, 2021). This physiological ability allows them to record dominant climate conditions, as well as interannual variations at a specific spatial scale and with seasonal resolution (Manzanilla-Quiñones et al., 2020). Dendrochronological methods help detect the relationship between ring width and climate variables, leading to the emergence of dendroclimatology. This subdiscipline is essential for analyzing global climate variability, the influence of atmospheric circulation phenomena, and their effects on natural resources (Cerano-Paredes et al., 2011; Gómez-Guerrero et al., 2013).

In Mexico, dendroclimatology represents the most developed approach within this science, with 53 % (122) of the scientific products analyzed. Research is mainly concentrated in the north and center of the country and has made it possible to evaluate how climatic variables influence forest development in these regions. In addition, they have made possible the reconstruction of climatic variables, such as seasonal precipitation and seasonal rainfall. (Cardoza-Martínez et al., 2018; Cerano-Paredes et al., 2011, 2021; Chávez-Gándara et al., 2017; Díaz-Ramírez et al., 2016; Irby et al., 2013; Manzanilla-Quiñones et al., 2018; Villanueva-Díaz et al., 2007, 2008, 2009).

Other climatic variables, such as temperature (Villanueva-Díaz et al., 2020) and evaporation (Pompa-García et al., 2013), have also shown a relationship with the development of growth rings. This connection has facilitated the identification of extreme events, such as drought occurrences (Martínez-Sifuentes et al., 2019).

The influence of atmospheric circulation patterns on the climatic variability of Mexico has generated significant interest (Pompa-García et al., 2015). These dendroclimatic studies have enabled the analysis of phenomena such as El Niño-Southern Oscillation (ENSO) (Cerano-Paredes et al., 2011; Pompa-García et al., 2013, 2015). Additionally, the relationship between adverse events and climate variability has been explored (Burns et al., 2014). Overall, the application of dendroclimatology has triggered the creation of an extensive network of chronologies and has allowed the evaluation of dendrochronological potential of a wide range of species (Acosta-Hernández et al., 2020).

Dendroecology

Trees can record certain ecological processes, and dendroecology, as a specialized branch of dendrochronology, focuses on their study (Rojas-García et al., 2020). This discipline has been used to identify the temporal occurrence of natural processes that influence the development of growth rings, making it possible to determine the significance of these processes for the development of forest ecosystems. In Mexico, dendroecology has had several applications. By analyzing stand structures and applying dendrochronology, researchers have estimated forest ages (Villanueva-Díaz et al., 2010), biomass quantities (Correa-Díaz et al., 2019, 2020; Martínez-Sifuentes et al., 2019), forest productivity (Arreola-Ortiz & Návar-Cháidez, 2010; Castruita-Esparza et al., 2016; Gómez-Guerrero et al., 2015; Reyes-Cortés et al., 2020) and the capacity of forests to capture carbon (García-Bedolla et al., 2015; Reyes-Basilio et al., 2020).

Other applications include evaluating the effects of extreme climatic events on the development of natural resources (Acosta-Hernández et al., 2020; Pacheco et al., 2020; Pompa-García et al., 2017; Rodríguez-Ramírez et al., 2018), assessing the impact of pests on tree radial growth (López-Sánchez et al., 2017), and analyzing wood anatomy and density (Morgado-González et al., 2019; Rodríguez-Ramírez et al., 2020).

Dendropyrochronology

Fire plays a crucial ecological role in certain forest ecosystems, and its benefits have been recognized by the scientific community. Dendropyrochronology provides tools for dating wildfires by analyzing the scars left by fire in tree growth rings. This allows for the estimation of parameters related to historical fire regimes (Cerano-Paredes et al., 2019) and provides a solid foundation for detecting anthropogenic disturbances, as well as for developing fire management strategies in forests (Sáenz-Ceja & Pérez-Salicrup, 2019).

In Mexico, this subdiscipline is becoming increasingly common, although studies remain scarce compared to the country's vast forested area (Cerano-Paredes et al., 2021; Sáenz-Ceja & Pérez-Salicrup, 2019). Most studies have identified changes in fire regimes, highlighting periods of fire exclusion, particularly in recent decades (Cerano-Paredes et al., 2021; Fulé & Covington, 1999; Sáenz-Ceja & Pérez-Salicrup, 2019; Yocom et al., 2014). These changes, mainly attributed to human activity, have raised concerns within the scientific community, as prolonged fire suppression can increase the risk of more severe future events due to the accumulation of combustible materials. Moreover, fire is an integral part of the ecology of many forests (Cerano-Paredes et al., 2021). Several studies have recommended incorporating fire management practices, such as prescribed burns, to reduce fuel loads and mitigate the risk of severe wildfires (Cerano-Paredes et al., 2021; Ponce-Calderón et al., 2021).

Some studies, such as that of Skinner et al. (2008) have explored the potential correlation between climate and fire occurrence. However, Fulé and Covington (1999) argue that this relationship is weak. These differences may be attributed to the specific conditions of each study site, including geographic location, topography, and vegetation type. Additionally, Stephens et al. (2010) analyzed the formation of fire scars and found that only a small proportion of trees exhibited scarring.

Dendrochemistry

Trees can absorb chemical components present in water, soil, and air. Variations in pollution levels or in the chemical composition of any of these media can be reflected in the chemical content of growth rings (Reyes-Camarillo et al., 2020). Through dendrochronological analysis, it is possible to determine the temporal variability of the chemical content in tree rings. Dendrochemistry is the subdiscipline that, with the support of chemical methods, allows for the evaluation of trees' physiological responses to variations in chemical elements (Correa-Díaz et al., 2020; Gómez-Guerrero et al., 2013).

In Mexico, dendrochemistry has received little attention in recent years. Studies have focused on three main areas: 1) analysis of stable isotopes and tree physiology (Beramendi-Orosco et al., 2018; Correa-Díaz et al., 2020; Gómez-Guerrero et al., 2013; Pacheco et al., 2020), 2) the impact of environmental pollution on chemical concentration in tree rings (Flores et al., 2017; Morton-Bermea et al., 2016), and 3) the determination of chemical element composition (Sheppard et al., 2008).

Dendrogeomorphology

In mountainous areas, characterized by steep slopes, massive movements of rocky and edaphic material are common, favored by gravity and geological, climatic and anthropic factors. These processes can cause damage and the removal of forest masses. Rock falls, landslides and debris flows can cause alterations in trees, which can be expressed as scarring, abrupt growth reduction, eccentric growth and traumatic resin ducts. Each alteration can be dated through the analysis of growth rings, which facilitates the reconstruction of past geomorphological processes (Stoffel et al., 2011).

In the mountains of Mexico, especially in the Sierra Transversal, debris flows, torrential floods (Franco-Ramos et al., 2019; Martínez-Sifuentes et al., 2019) and lahars (Bollschweiler et al., 2010; Franco-Ramos et al., 2016) have been reconstructed. Additionally, determining the age of trees inhabiting newly formed geomorphological surfaces has allowed estimating the minimum age of these structures (Franco-Ramos & Vázquez-Selem, 2017).

Dendrohydrology

Dendrohydrology is used as a reliable tool for reconstructing river flows, groundwater levels, lake level changes, and floods. By analyzing growth rings, it is possible to generate dendrohydrological reconstructions that provide insights into water resource availability (Villanueva-Díaz et al., 2018). In Mexico, this subdiscipline has been applied to reconstruct streamflow volumes, water body gauge levels, and runoff patterns (Therrell et al., 2006; Villanueva-Díaz et al., 2020).

Dendrovolcanology

The emission of ash and gases from volcanic eruptions can cause alterations in regional environmental conditions. When trees are partially or completely covered by volcanic ash, they may either perish or record abrupt changes in their development, such as the suppression of ring growth (Biondi et al., 2003).

Dendrochronological analysis allows for the reconstruction of eruptive events and the assessment of their effects on forest ecosystems (Torbenson, 2015) by linking volcanic eruptions with tree rings. However, for dendrovolcanological studies, it is crucial to distinguish between climate-induced stress signals and those caused by volcanic activity (Biondi et al., 2003).

In Mexico, dendrovolcanology has gained importance through the analysis of the effects of the volcanoes along the Trans-Mexican Volcanic Belt on trees in the region. These studies have enabled the reconstruction of eruptive events (Alcalá-Reygosa et al., 2018; Alfaro-Sánchez et al., 2020; Sheppard et al., 2008) and the tracing of pyroclastic flows (Franco-Ramos et al., 2019). Furthermore, it has been shown that volcanic eruptions lead to changes in the chemical composition of growth rings, which is why these studies are often complemented with dendrochemical analyses (Alfaro-Sánchez et al., 2020; Carlón-Allende et al., 2015).

Dendroarchaeology

In the past, wood played a crucial role in construction, especially from species that form growth rings. This characteristic has allowed dendrochronology to be used at archaeological sites with ancient wood, for dating historical buildings and other archaeological applications (Bernabei & Macchioni, 2012). While this tool is useful for extending chronologies and inferring historical events, the application of dendroarchaeology in Mexico has seen limited success. Villanueva-Díaz et al. (2011) note that until the early 2010s, there was only one successful example of this subdiscipline applied to prehistoric ruins in Casas Grandes, Chihuahua. Additionally, with the help of the "Wiggle Matching" radiocarbon, it was possible to date ancient wood obtained from two sites in the Malpaso Valley, Zacatecas (Turkon et al., 2018).

Other categories

The studies include those focused on systematic reviews and meta-analyses specific to Mexico (Acosta-Hernández et al., 2017; Villanueva-Díaz et al., 2000), as well as reviews on the development of dendrochronology in a broader region (Bannister & Scott, 1964; Giraldo-Jiménez, 2011; Rojas-García et al., 2020; Schulman, 1944). Additionally, suitable sites for dendrochronological studies (Carlón-Allende et al., 2015) and for the reconstruction of agro-food variables (Therrell et al., 2006) have been identified.

Figure 3 shows spatial distribution and volume of studies related to different categories of dendrochronology. Most of the research has been conducted in the central and northern parts of the country, with a higher concentration in the latter due to the predominance of dendroclimatic studies, both in terms of volume and spatial applicability.

A total of 429 chronologies were identified, primarily distributed across three physiographic provinces: the Sierra

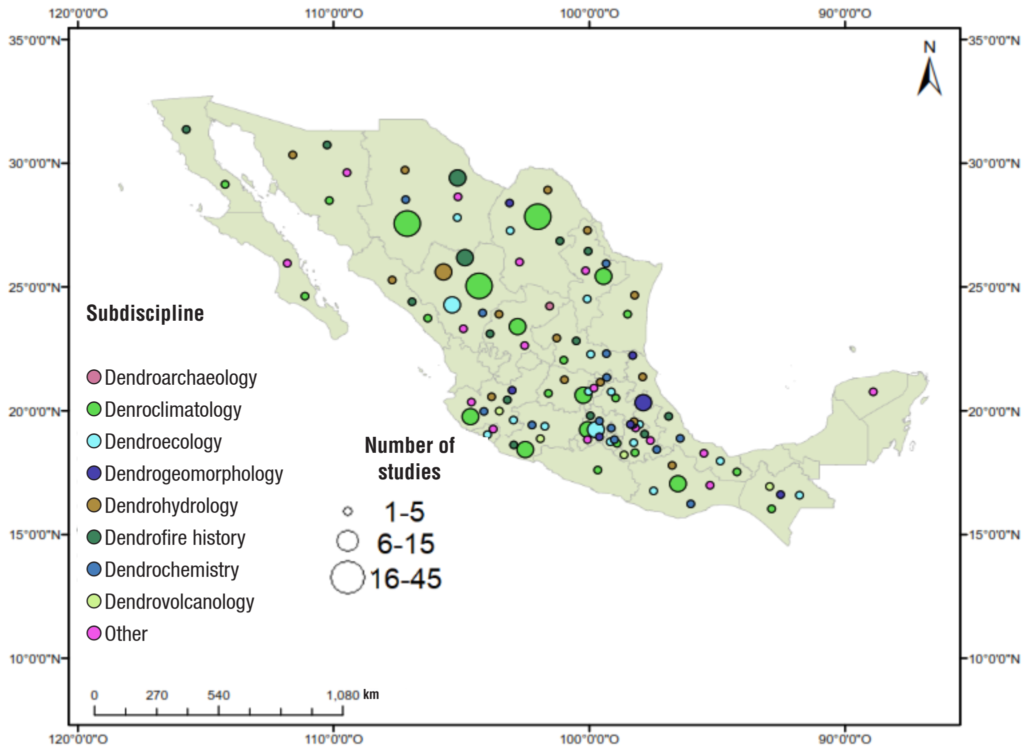

Figure 3. Spatial distribution of dendrochronology subdisciplines in Mexico.

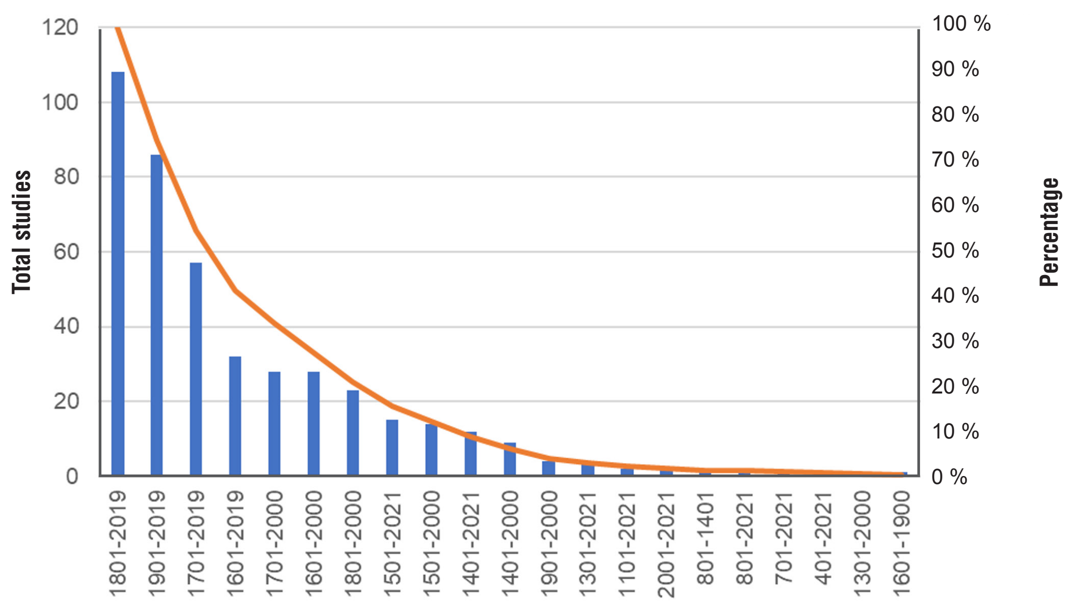

Figure 4. Range (period of years) of tree ring chronologies in Mexico

Madre Occidental (44.76 %), the Trans-Mexican Volcanic Belt (22.38 %), and the Sierra Madre Oriental (19.58 %). The remaining 13.28% is distributed across other provinces in the country. Chronologies have been developed in 28 states of Mexico, with Durango, Chihuahua, and Coahuila accounting for just over half (51 %). Regarding the species used, 53 different species have been reported, with the majority belonging to the conifer group (84.9 %), specifically the genus *Pinus* (60.38 %). Only eight broadleaf species have been used to create chronologies in Mexico, and three species dominate in terms of use: *Pseudotsuga menziesii* (23.78 %), *Pinus hartwegii* (10.26 %) and *Taxodium mucronatum* (8.86 %).

The chronologies span from the year 467 to 2019, covering a period of 1537 years. The longest chronology was created from the growth rings of *Taxodium mucronatum* in Los Peroles, San Luis Potosí (Villanueva-Díaz et al., 2007). However, since most of the chronologies are concentrated between 1801 and 2019, this period is the best represented (Figure 4). In Mexico, precipitation is the variable most closely related to the variability of tree rings, making it the most reconstructed variable.

Conclusions

Dendrochronological studies in Mexico have experienced notable growth since 1999, successfully exploring various approaches. However, there remains a dominance of climate variables as the primary factors influencing the variability in tree ring widths. Other research approaches in dendrochronology present opportunities for new studies in other regions of the country, particularly in the south.

Broadleaf species with dendrochronological potential need to be studied more in-depth, especially those found in tropical environments, where climatic seasonality is less pronounced. The vast biodiversity of Mexico's forest ecosystems offers an opportunity to expand knowledge in this area.

Dendrochronology in Mexico has significant potential for development. Future studies could focus on comparing the number of studies and species analyzed at an international level. It is essential to broaden both the physical and intellectual boundaries, as well as expand the spatial scope of dendrochronological research in the country.

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References

Acosta-Hernández, A. C., González-Cásares, M., Zúñiga-Vásquez, J. M., Hernández-Díaz, J. C., Goche-Telles, J. R., Prieto-Ruíz, J. Á., & Nájera-Luna, J. A. (2020). How drought drives seasonal radial growth in *Pinus strobiformis* from Northern Mexico. In M. Pompa-García (Ed.), *Latin American Dendroecology* (pp. 21-36). Springer International Publishing. https://doi.org/10.1007/978-3-030-36930-9_2

Acosta-Hernández, A., Pompa-García, M., & Camarero, J. (2017). An updated review of dendrochronological investigations in Mexico, a megadiverse country with a high potential for tree-ring sciences. *Forests*, *8*(5), 160. https://doi.org/10.3390/f8050160

Alcalá-Reygosa, J., Palacios, D., Schimmelpfennig, I., Vázquez-Selem, L., García-Sancho, L., Franco-Ramos, O., Villanueva, J., Zamorano, J. J., Aumaître, G., Bourlès, D., & Keddadouche, K. (2018). Dating late Holocene lava flows in Pico de Orizaba (Mexico) by means of *in situ*-produced cosmogenic ^{36}Cl, lichenometry and dendrochronology. *Quaternary Geochronology*, *47*, 93-106. https://doi.org/10.1016/j.quageo.2018.05.011

Alfaro-Sánchez, R., Camarero, J. J., Querejeta, J. I., Sagra, J., Moya, D., & Rodríguez-Trejo, D. A. (2020). Volcanic activity signals in tree-rings at the treeline of the Popocatépetl, Mexico. *Dendrochronologia*, *59*, 125663. https://doi.org/10.1016/j.dendro.2020.125663

Amoroso, M., & Suarez, M. L. (2015). La aplicación del análisis de los anillos de crecimiento a interrogantes ecológicos: Un breve repaso de la dendroecología en hispanoamérica. *Ecosistemas*, *24*(2), 1-6. https://doi.org/10.7818/ECOS.2015.24-2.01

Arreola-Ortiz, M. R., & Návar-Cháidez, J. J. (2010). Análisis de sequías y productividad con cronologías de *Pseudotsuga menziesii* Rob. & Fern., y su asociación con El Niño en el nordeste de México. *Investigaciones Geográficas*, *71*, 7-20. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0188-46112010000100002

Bannister, B., & Scott, S. D. (1964). Dendrochronology in Mexico. *Laboratory of Tree-Ring Research Archives. The University of Arizona*. https://repository.arizona.edu/handle/10150/303005

Beramendi-Orosco, L. E., Johnson, K. R., Noronha, A. L., González-Hernández, G., & Villanueva-Díaz, J. (2018). High precision radiocarbon concentrations in tree rings from Northeastern Mexico: A new record with annual resolution for dating the recent past. *Quaternary Geochronology*, *48*, 1-6. https://doi.org/10.1016/j.quageo.2018.07.007

Bernabei, M., & Macchioni, N. (2012). La datación dendrocronológica en el estudio de los edificios históricos. *Loggia, Arquitectura & Restauración*, *24-25*, 104. https://doi.org/10.4995/loggia.2012.3003

Biondi, F., Galindo-Estrada, I., Gavilanes-Ruiz, J. C., & Elizalde-Torres, A. (2003). Tree growth response to the 1913 eruption of Volcán de Fuego de Colima, Mexico. *Quaternary Research*, *59*(3), 293-299. https://doi.org/10.1016/S0033-5894(03)00034-6

Bollschweiler, M., Stoffel, M., Vázquez-Selem, L., & Palacios, D. (2010). Tree-ring reconstruction of past lahar activity at Popocatépetl volcano, Mexico. *The Holocene*, *20*(2), 10. https://doi.org/10.1177/0959683609350394

Burns, J. N., Acuna-Soto, R., & Stahle, D. W. (2014). Drought and epidemic typhus, central Mexico, 1655-1918. *Emerging Infectious Diseases*, *20*(3), 442-447. https://doi.org/10.3201/eid2003.131366

Cardoza-Martínez, G. F., Cerano-Paredes, J., Villanueva Díaz, J., Cervantes-Martínez, R., Guerra-de la Cruz, V., & Estrada-Ávalos, J. (2018). Reconstrucción de la precipitación anual para la región oriental del estado de Tlaxcala. *Revista Mexicana de Ciencias Forestales*, *5*(23), 110-127. https://doi.org/10.29298/rmcf.v5i23.345

Carlón-Allende, T., Mendoza, M. E., Villanueva-Díaz, J., & Pérez-Salicrup, D. R. (2015). Análisis espacial del paisaje como base para muestreos dendrocronológicos: El caso de la Reserva de la Biosfera. *Madera y Bosques*, *21*(2), 11-22. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1405-04712015000200001

Castruita-Esparza, L. U., Correa-Díaz, A., Gómez-Guerrero, A., Villanueva-Díaz, J., Ramírez-Guzmán, M. E., Velázquez-Martínez, A., & Ángeles-Pérez, G. (2016). Basal area increment series of dominant trees of *Pseudotsuga menziesii* (Mirb.) Franco show periodicity according to global climate patterns. *Revista Chapingo Serie Ciencias Forestales y del Ambiente*, *22*(3), 379-397. https://doi.org/10.5154/r.rchscfa.2015.10.048

Cerano-Paredes, J., Rodríguez-Trejo, D. A., Iniguez, J. M., Cervantes-Martínez, R., Villanueva-Díaz, J., & Franco-Ramos, O. (2021). Fire history (1896-2013) in an *Abies religiosa* forest in the Sierra Norte of Puebla, Mexico. *Forests*, *12*(6), 13. https://doi.org/10.3390/f12060700

Cerano-Paredes, J., Villanueva-Díaz, J., Valdez-Cepeda, R. D., Cornejo-Oviedo, E. H., Sánchez-Cohen, I., & Constante-García, V. (2011). Variabilidad histórica de la precipitación reconstruida con anillos de árboles para el sureste de Coahuila. *Revista Mexicana de Ciencias Forestales*, *2*(4), 33-48. https://doi.org/10.29298/rmcf.v2i4.599

Cerano-Paredes, J., Villanueva-Díaz, J., Vázquez-Selem, L., Cervantes-Martínez, R., Esquivel-Arriaga, G., Guerra-de la Cruz, V., & Fulé, P. Z. (2016). Régimen histórico de incendios y su relación con el clima en un bosque de *Pinus hartwegii* al norte del estado de Puebla, México. *Bosque (Valdivia)*, *37*(2), 389-399. https://doi.org/10.4067/S0717-92002016000200017

Cerano-Paredes, J., Villanueva-Díaz, J., Vázquez-Selem, L., Cervantes-Martínez, R., Magaña-Rueda, V. O., Constante-García, V., Esquivel-Arriaga, G., & Valdez-Cepeda, R. D. (2019). Climatic influence on fire regime (1700 to 2008) in the Nazas watershed, Durango, Mexico. *Fire Ecology*, *15*(1), 9. https://doi.org/10.1186/s42408-018-0020-x

Chávez-Gándara, M. P., Cerano-Paredes, J., Nájera-Luna, J. A., Pereda-Breceda, V., Esquivel-Arriaga, G., Cervantes-Martínez, R., Cambrón-Sandoval, V. H., Cruz-Cobos, F., & Corral-Rivas, S. (2017). Reconstrucción de la precipitación invierno-primavera con base en anillos de crecimiento de árboles para la región de San Dimas, Durango, México. *Bosque (Valdivia)*, *38*(2), 387-399. https://doi.org/10.4067/S0717-92002017000200016

Correa-Díaz, A., Gómez-Guerrero, A., Vargas-Hernández, J. J., Rozenberg, P., & Horwath, W. R. (2020). Long-term wood micro-density variation in alpine forests at central México and their spatial links with remotely sensed information. *Forests, 11*(4), 452. https://doi.org/10.3390/f11040452

Correa-Díaz, A., Silva, L. C., Horwath, W. R., Gómez-Guerrero, A., Vargas-Hernández, J., Villanueva-Díaz, J., Velázquez-Martínez, A., & Suárez-Espinoza, J. (2019). Linking remote sensing and dendrochronology to quantify climate-induced shifts in high-elevation forests over space and time. *Journal of Geophysical Research: Biogeosciences*, *124*(1), 166-183. https://doi.org/10.1029/2018JG004687

Díaz-Ramírez, B., Villanueva-Díaz, J., & Cerano-Paredes, J. (2016). Reconstrucción de la precipitación estacional con anillos de crecimiento para la región hidrológica Presidio-San Pedro. *Madera y Bosques*, *22*(1), 11-123. https://doi.org/10.21829/myb.2016.221480

Douglas, A. E. (1941). Crossdating in Dendrochronology. *Journal of Forestry*, *39*, 825-831. https://www.ltrr.arizona.edu/~ellisqm/outgoing/dendroecology2014/readings/douglass1941.pdf

Flores, J. A., Solís, C., Huerta, A., Ortiz, M. E., Rodríguez-Ceja, M. G., Villanueva, J., & Chávez, E. (2017). Historic binnacle of $^{14}C/^{12}C$ concentration in Mexico City. *Physics Procedia*, *90*, 2-9. https://doi.org/10.1016/j.phpro.2017.09.007

Fo, M. T., Roig, F. A., & Pollito, P. A. (2009). Dendrocronología y dendroecología tropical: Marco histórico y experiencias exitosas en los países de América Latina. *Ecología en Bolivia*, *44*(2), 73-82. http://www.scielo.org.bo/scielo.php?script=sci_arttext&pid=S1605-25282009000200001

Franco-Ramos, O., Castillo, M., & Muñoz-Salinas, E. (2016). Using tree-ring analysis to evaluate intra-eruptive lahar activity in the Nexpayantla Gorge, Popocatépetl volcano (central Mexico). *CATENA*, *147*, 205-215. https://doi.org/10.1016/j.catena.2016.06.045

Franco-Ramos, O., Stoffel, M., & Ballesteros-Cánovas, J. A. (2019). Reconstruction of debris-flow activity in a temperate mountain forest catchment of central Mexico. *Journal of Mountain Science*, *16*(9), 2096-2109. https://doi.org/10.1007/s11629-019-5496-6

Franco-Ramos, O., & Vázquez-Selem, L. (2017). Trabajo de campo dendrocronológico para estudios de geografía física. Experiencias en los volcanes Popocatépetl e Iztaccíhuatl, 2006-2017. *Investigaciones Geográficas*, *94*, 13. https://doi.org/10.14350/rig.59574

Fulé, P. Z., & Covington, W. W. (1999). Fire regime changes in La Michilía Biosphere Reserve, Durango, Mexico. *Conservation Biology*, *13*(3), 640-652.

García-Bedolla, A., Aguilar-Cumplido, E., Pompa-García, M., Hernández-Díaz, J. C., & Yerena-Yamalliel, J. I. (2015). Captura de carbono en *Pinus cembroides* Zucc., medida a partir de anillos de crecimiento. In F. Paz-Pellat, J. Wong-González, & R. Torres-Alamilla (Eds.), *Estado actual del conocimiento del ciclo del carbono y sus interacciones en México*. Programa Mexicano del Carbono, Centro del Cambio Global y la Sustentabilidad en el Sureste, A.C. y Centro Internacional de Vinculación y Enseñanza de la Universidad Juárez Autónoma de Tabasco.

Giraldo-Jiménez, J. A. (2011). Dendrocronología en el trópico: Aplicaciones actuales y potenciales. *Colombia Forestal*, *14*(1), 97-111. https://doi.org/10.14483/udistrital.jour.colomb.for.2011.1.a08

Gómez-Guerrero, A., Martínez-Molina, Martínez-Trinidad, T., Velázquez-Martínez, A., Sardiñas-Gómez, O., Rivera, C., & Toruño, P. J.

(2015). Índices de anillos de crecimiento en dos coníferas del Centro de México. *Revista Iberoamericana de Bioeconomía y Cambio Climático*, *1*(1), 134-148. https://doi.org/10.5377/ribcc.v1i1.2146

Gómez-Guerrero, A., Silva, C. R., Barrera-Reyes, M., Kishchuk, B., Velázquez-Martínez, A., Martínez-Trinidad, T., Plascencia-Escalante, F. O., & Horwath, W. R. (2013). Growth decline and divergent tree ring isotopic composition ($\delta^{13}C$ and $\delta^{18}O$) contradict predictions of CO_2 stimulation in high altitudinal forests. *Global Change Biology*, *19*(6), 1748-1758. https://doi.org/10.1111/gcb.12170

Grissino-Mayer, H. D., Deweese, G. G., & Williams, D. A. (2005). Tree-ring dating of the Karr-Koussevitzky double bass: A case study in Dendromusicology. *Tree-Ring Research*, *61*(2), 77-86. https://doi.org/10.3959/1536-1098-61.2.77

Irby, C. M., Fulé, P. Z., Yocom, L. L., & Villanueva-Díaz, J. (2013). Reconstrucción dendrocronológica de patrones de precipitación de largo plazo en el Parque Nacional de Basaseachi, Chihuahua, México. *Madera y Bosques*, *19*(1), 93-105. https://www.redalyc.org/pdf/617/61727444007.pdf

López-Sánchez, J. Á., Méndez-González, J., Zermeño-González, A., Cerano-Paredes, J., & García-Aranda, M. A. (2017). Impacto de descortezadores en el incremento radial de *Pinus teocote* Schiede. ex Schltdl. & Cham. y *Pseudotsuga menziesii* (Mirb.) Franco. *Revista Mexicana de Ciencias Forestales*, *8*(41), 82-108. https://doi.org/10.29298/rmcf.v8i41.27

Manzanilla-Quiñones, U., Aguirre-Calderón, O. A., Jiménez-Pérez, J., & Villanueva-Díaz, J. (2020). Sensibilidad climática en anchuras de anillos de crecimiento de *Pinus hartwegii*: Una especie alpina mexicana con potencial dendroclimático. *Revista Mexicana de Biodiversidad*, *91*, 1-15. https://doi.org/10.22201/ib.20078706e.2020.91.3117

Manzanilla-Quiñones, U., Ortega-Rodríguez, J. M., & Amador-García, A. (2018). Reconstrucción de temperatura y precipitación en la cuenca del lago de Cuitzeo, México. *Mitigación del Daño Ambienta,l Agroalimentario y Forestal de México*, *4*(4), 59-74.

Martínez-Sifuentes, A. R., Villanueva-Díaz, J., Estrada-Ávalos, J., & Castruita-Esparza, U. (2019). Reconstrucción de sequías y asociación climática en la cuenca del Río Conchos, Chihuahua. *Quinto Congreso Nacional de Riego y Drenaje*, 1-20. https://www.riego.mx/congresos/comeii2019/docs/ponencias/extenso/COMEII-19039.pdf

Montes de Oca-Montano, J. (2018). La literatura gris cambia de color: Un enfoque desde los problemas sociales de la ciencia y la tecnología. *MediSur*, *16*(3), 424-436. https://www.redalyc.org/journal/1800/180061648011/html/

Morgado-González, G., Gómez-Guerrero, A., Villanueva-Díaz, J., Terrazas, T., Ramírez-Herrera, C., & Hernández-de la Rosa, P. (2019). Densidad de la madera de *Pinus hartwegii* Lind. en dos niveles altitudinales y de exposición. *Agrociencia*, *53*(4), 645-660. https://www.agrociencia-colpos.org/index.php/agrociencia/article/view/1834

Morton-Bermea, O., Beramendi-Orosco, L., Martínez-Reyes, Á., Hernández-Álvarez, E., & González-Hernández, G. (2016). Increase in platinum group elements in Mexico City as revealed from growth rings of *Taxodium mucronatum* Ten. *Environmental Geochemistry and Health*, *38*(1), 195-202. https://doi.org/10.1007/s10653-015-9703-2

Naylor, T. H. (1971). Dendrochronology in Oaxaca, Mexico: A preliminary study. *Tree-Ring Bulletin*, *31*, 25-29.

Pacheco, A., Camarero, J. J., Pompa-García, M., Battipaglia, G., Voltas, J., & Carrer, M. (2020). Growth, wood anatomy and stable isotopes show species-specific couplings in three Mexican conifers inhabiting drought-prone areas. *Science of The Total Environment*, *698*, 134055. https://doi.org/10.1016/j.scitotenv.2019.134055

Pompa-García, M., Cerano-Paredes, J., & Fulé, P. Z. (2013). Variation in radial growth of *Pinus cooperi* in response to climatic signals across an elevational gradient. *Dendrochronologia*, *31*(3), 198-204. https://doi.org/10.1016/j.dendro.2013.05.003

Pompa-García, M., González-Cásares, M., Acosta-Hernández, A., Camarero, J., & Rodríguez-Catón, M. (2017). Drought influence over radial growth of Mexican conifers inhabiting mesic and xeric sites. *Forests*, *8*(5), 175. https://doi.org/10.3390/f8050175

Pompa-García, M., Miranda-Aragón, L., & Aguirre-Salado, C. A. (2015). Tree growth response to ENSO in Durango, Mexico. *International Journal of Biometeorology*, *59*(1), 89-97. https://doi.org/10.1007/s00484-014-0828-2

Ponce-Calderón, L., Rodríguez-Trejo, D., Villanueva-Díaz, J., Bilbao, B., Álvarez-Gordillo, G., & Vera-Cortés, G. (2021). Historical fire ecology and its effect on vegetation dynamics of the Lagunas de Montebello National Park, Chiapas, México. *IForest - Biogeosciences and Forestry*, *14*(6), 548-559. https://doi.org/10.3832/ifor3682-014

Reyes-Basilio, I. B., Acosta-Hernández, A. C., González-Cásares, M., & Pompa-García, M. (2020). Perspectivas de los anillos de crecimiento para estimación potencial de carbono en México. *Madera y Bosques*, *26*(2), e2632112. https://doi.org/10.21829/myb.2020.2632112

Reyes-Camarillo, F., Pérez-Evangelista, E., Villanueva-Díaz, J., Pulido-Machado, A., & Ramos-Cruz, C. M. (2020). La dendroquímica como herramienta para la determinación y análisis de metales pesados. *Ciencia e Innovación*.

Reyes-Cortés, L. M., Vargas-Hernández, J. J., Aldrete, A., Gómez-Guerrero, A., & Honorato-Salazar, J. A. (2020). Radial growth in *Pinus patula* Schltdl. & Cham. And its relationship with growing space and climatic factors. *Revista Chapingo Serie Ciencias Forestales y del Ambiente*, *26*(2), 157-172. https://doi.org/10.5154/r.rchscfa.2019.04.036

Rodríguez-Ramírez, E. C., Luna-Vega, I., & Rozas, V. (2018). Tree-ring research of Mexican beech (*Fagus grandifolia* subsp. *Mexicana*) a relict tree endemic to eastern Mexico. *Tree-Ring Research*, *74*(1), 94-107. https://doi.org/10.3959/1536-1098-74.1.94

Rodríguez-Ramírez, E. C., Valdez-Nieto, J. A., Vázquez-García, J. A., Dieringer, G., & Luna-Vega, I. (2020). Plastic responses of *Magnolia schiedeana* Schltdl., a relict-endangered Mexican cloud forest tree, to climatic events: Evidences from leaf venation and wood vessel anatomy. *Forests*, *11*(7), 737. https://doi.org/10.3390/f11070737

Rojas-García, F., Gómez-Guerrero, A., Gutiérrez-García, G., Ángeles-Pérez, G., Reyes-Hernández, V. J., & de Jong, B. H. J. (2020). Aplicaciones de la dendroecología en el manejo forestal: Una revisión. *Madera y Bosques*, *26*(3), e2632116. https://doi.org/10.21829/myb.2020.2632116

Sáenz-Ceja, J. E., & Pérez-Salicrup, D. R. (2019). Dendrochronological reconstruction of fire history in coniferous forests in the Monarch Butterfly Biosphere Reserve, Mexico. *Fire Ecology*, *15*(18), 1-17. https://doi.org/10.1186/s42408-019-0034-z

Schulman, E. (1944). Dendrochronology in Mexico, I. *Tree-Ring Bulletin*, *10*(3), 18-24.

Sheppard, P. R., Ort, M. H., Anderson, K. C., Elson, M. D., Vázquez-Selem, L., Clemens, A. W., Little, N. C., & Speakman, R. J. (2008). Multiple dendrochronological signals indicate the eruption of ParíCutin volcano, Michoacán, Mexico. *Tree-Ring Research*, *64*(2), 97-108. https://doi.org/10.3959/2008-3.1

Skinner, C. N., Burk, J. H., Barbour, M. G., Franco-Vizcaíno, E., & Stephens, S. L. (2008). Influences of climate on fire regimes in montane forests of north-western Mexico. *Journal of Biogeography*, *35*(8), 1436-1451. https://doi.org/10.1111/j.1365-2699.2008.01893.x

Stephens, S. L., Fry, D. L., Collins, B. M., Skinner, C. N., Franco-Vizcaino, E., & Freed, T. J. (2010). Fire-scar formation in *Jeffrey pine* - mixed conifer forests in the Sierra San Pedro Mártir, Mexico. *Canadian Journal of Forest Research*, *40*, 1497-1505. https://doi.org/10.1139/X10-083

Stoffel, M., Bollschweiler, M., Vázquez-Selem, L., Franco-Ramos, O., & Palacios, D. (2011). Dendrogeomorphic dating of rockfalls on low-latitude, high-elevation slopes: Rodadero, Iztaccíhuatl volcano, Mexico. *Earth Surface Processes and Landforms*, *36*(9), 1209-1217. https://doi.org/10.1002/esp.2146

Therrell, M. (2003). *Tree rings, climate, and history in Mexico* [Doctoral dissertation, University of Arkansas].

Therrell, M. D., Stahle, D. W., Villanueva-Diaz, J., Cornejo-Oviedo, E. H., & Cleaveland, M. K. (2006). Tree-ring reconstructed maize yield in central Mexico: 1474-2001. *Climatic Change*, *74*(4), 493-504. https://doi.org/10.1007/s10584-006-6865-z

Torbenson, M. C. (2015). *Dendrochronology*. British Society for Geomorphology.

Turkon, P., Manning, S. W., Griggs, C., Santos-Ramírez, M. A., Nelson, B. A., Torreblanca-Padilla, C., & Wild, E. M. (2018). Applications of dendrochronology in northwestern Mexico. *Latin American Antiquity*, *29*(1), 102-121. https://doi.org/10.1017/laq.2017.60

Villanueva-Díaz, J., Cerano-Paredes, J., Benavides, J. D., Stahle, D. W., Estrada-Ávalos, J., Constante-García, V., & Tostado-Plascencia, M. (2018). Reconstrucción de los niveles del lago de Chapala con series dendrocronológicas de *Taxodium mucronatum* Ten. *Revista Mexicana de Ciencias Forestales*, *3*(14), 055-068. https://doi.org/10.29298/rmcf.v3i14.474

Villanueva-Díaz, J., Cerano-Paredes, J., Constante-García, V., Montes-González, L. E., & Vázquez-Selem, L. (2009). *Muestreo dendrocronológico: Colecta, preparación y procesamiento de núcleos de crecimiento y secciones transversales*. INIFAP-CENID RASPA.

Villanueva-Díaz, J., Cerano-Paredes, J., & Estrada-Ávalos, J. (2008). Reconstrucción de precipitación estacional de *Pseudotsuga menziesii* (mirb.) Franco en Sierra la Madera, Cuatrociénegas, Coahuila. *Revista Ciencias Forestales en México*, *33*(104), 17-35. https://cienciasforestales.inifap.gob.mx/index.php/forestales/article/view/737

Villanueva-Díaz, J., Cerano-Paredes, J., Stahle, D. W., Constante-García, V., Vázquez-Selem, L., Estrada-Ávalos, J., & Benavides-Solorio, J. D. (2010). Árboles longevos de México. *Revista Mexicana de Ciencias Forestales*, *1*(2), 7-29. https://doi.org/10.29298/rmcf.v1i2.634

Villanueva-Díaz, J., Cerano-Paredes, J., Stahle, D. W., Luckman, B. H., Therrell, M. D., Cleaveland, M. K., & Fulé, P. Z. (2011). La dendrocronología y reconstrucciones paleoclimáticas en el Norte-Centro de México. In B. Ortega-Guerrero, & M. E. Caballero-Miranda (Eds.), *Escenarios de cambio climático: Registros del cuaternario en América Latina* (pp. 47-72). Universidad Nacional Autónoma de México.

Villanueva-Díaz, J., Stahle, D. W., Cleaveland, M. K., & Therrell, M. D. (2000). Estado actual de la dendrocronología en México. *Revista Mexicana de Ciencias Forestales*, *25*(88). https://cienciasforestales.inifap.gob.mx/index.php/forestales/article/view/921

Villanueva-Díaz, J., Stahle, D. W., Luckman, B. H., Cerano-Paredes, J., Therrell, M. D., Cleaveland, M. K., & Cornejo-Oviedo, E. (2007). Winter-spring precipitation reconstructions from tree rings for northeast Mexico. *Climatic Change*, *83*(1-2), 117-131. https://doi.org/10.1007/s10584-006-9144-0

Villanueva-Díaz, J., Stahle, D. W., Therrell, M. D., Beramendi-Orosco, L., Estrada-Ávalos, J., Martínez-Sifuentes, A. R., Astudillo-Sánchez, C. C., Cervantes-Martínez, R., & Cerano-Paredes, J. (2020). The climatic response of baldcypress (*Taxodium mucronatum* Ten.) in San Luis Potosi, Mexico. *Trees*, *34*(2), 623-635. https://doi.org/10.1007/s00468-019-01944-0

Villanueva-Díaz, J., Stahle, D. W., Therrell, M. D., & Cleaveland, M. K. (2002). La dendrocronología en México y sus aplicaciones paleoclimáticas y ecológicas. *XIV Semana Internacional de Agronomía FAZ-UJED*.

Yocom, L., Fulé, P., Falk, D., García-Domínguez, C., Cornejo-Oviedo, E. H., Brown, P., Villanueva-Díaz, J., Cerano, J., & Cortés-Montaño, C. (2014). Fine-scale factors influence fire regimes in mixed-conifer forests on three high mountains in Mexico. *International Journal of Wildland Fire*, *23*(7), 957-968. https://doi.org/10.1071/WF13214