

history

American Chestnut: Re-Examining the Historical Attributes of a Lost Tree

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American chestnut (*Castanea dentata*) has been described as a towering giant dominating eastern deciduous forests. To determine whether this portrayal was accurate, we compared pre- and postblight descriptions of American chestnut. Preblight sources most frequently reported maximum height of mature American chestnut as 100 ft whereas postblight descriptions most frequently report a maximum height of 120 ft. In preblight sources, the maximum diameter reported for American chestnut was 13 ft, and in postblight sources 17 ft was regularly identified as the maximum diameter. We hypothesize that confusion between tree circumference and diameter and the inability to correct false descriptions with measurements has resulted in an increase in the reported maximum size of American chestnut in postblight sources.

Keywords: *Castanea dentata*, American chestnut

In North America, chestnut blight was first identified in 1904 in a population of American chestnut (*Castanea dentata* (Marshall) Borkh.) trees growing in the Bronx Zoological Park in New York (Roane et al. 1986). The initial source of the fungus was infected nursery stock from Asia (Ronderos 2000). Many state forest agencies developed plans in an attempt to slow or halt the spread of chestnut blight. The Commonwealth of Pennsylvania was especially proactive and harvested all of the living American chestnut trees from portions of its forests, but it was unsuccessful at preventing the spread of the blight (Smith 2000). The spread of the blight was estimated at 19 miles per year via wind, birds, and mammals, which transported spores to distant, uninfected forests (Evans and Finkral 2010, Heald et al. 1915, Heald and Studhalter 1913, Scharf and De Palma 1981).

Cryphonectria parasitica (Murr.) Barr is the fungal pathogen responsible for chestnut blight (Anagnostakis 1982). The fungus infiltrates the bark, causing cankers and damaging the cambium. The fungus eventually destroys xylem function, killing both stem and branches above the canker (Anagnostakis 2001, Metcalf 1912). Although trees are top-killed, the roots survive and new sprouts can grow, but they typically succumb to the fungus before getting large enough to fruit and flower (Paillet 1984). Cankers grow faster and cause more xylem damage in American chestnut than in Asian species of chestnut (*Castanea mollissima* Blume and *Castanea crenata* Siebold) (Anagnostakis 1987, 1992). The European chestnut (*Castanea sativa* Mill.) is also less susceptible to the blight because of the high prevalence of a double-stranded RNA virus that infects the fungus. This causes a hypovirulent form of the fungus and allows European chestnut to

be more resistant to the blight than American chestnut (Bryner et al. 2014, Choi and Nuss 1992). *C. parasitica* infected with the virus may produce superficial cankers on chestnut, but the virus-infected fungus is less likely to kill the stem (Bryner et al. 2014, McManus et al. 1989). In North America, nothing appears to slow the spread of the fungus, and infected American chestnut trees experienced high mortality, with surviving individuals persisting as understory sprouts mostly on dry ridge tops (Burke 2012).

Endothia parasitica caused changes in the frequency and size of canopy gaps and caused a long-term shift in species composition. Large canopy gaps created by dead American chestnut were filled by neighboring trees (McCormick and Platt 1980), and increased sunlight to the forest floor facilitated the growth of seedlings and saplings (Woods and Shanks 1959). Black oak (*Quercus velutina* Lam.), chestnut oak (*Quercus montana* Willd.), hickory (*Carya* spp.), northern red oak (*Quercus rubra* L.), red maple (*Acer rubrum* L.), and yellow-poplar (*Liriodendron tulipifera* L.) all increased in dominance to fill space formerly occupied by American chestnut (Elliott and Swank 2008, Nelson 1955, van de Gevel et al. 2012).

The loss of American chestnut as a canopy species in eastern forests had rippling effects through forest food webs and ecosys-

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tem processes. American chestnut produced more nutritious seeds than the species that replaced it (Diamond et al. 2000, Keever 1953), and animals and insects that depended on American chestnut as a primary food source had to rely on other hard mast for their food supply (Wang et al. 2013). American chestnut leaf litter contained higher levels of nutrients than the average levels found in leaf litter from co-occurring species (Rhoades 2007), suggesting that the loss of American chestnut trees could have altered insect communities and nutrient cycling.

The preblight geographic range of American chestnut spanned from Ontario south to northern Alabama. The tree's eastern limits were coastal areas of Massachusetts and southern Maine, and its western limits were Michigan and Illinois. In the South, the range narrowed and followed the Appalachian Mountains (Pinchot 1907). Faison and Foster's (2014) examination of historical land survey records reported that American chestnut occupied 2–12% of the abundance of trees recorded by surveyors as witness or bearing trees in mountainous regions in preblight eastern deciduous forests. American chestnut's deep tap root allowed it to survive on various soil types and topographic positions; however, it was most common on xeric, south-facing slopes (Hough 1878, Zon 1904). The tree reached sexual maturity at 15–20 years of age, and germination was most successful under a light litter layer, which protected seeds from extreme winter temperatures but did not hinder the germinating sprout from pushing through the litter layer in the spring (Leué 1888). In forests with high disturbance levels, the most common form of reproduction for American chestnut was sprouts (Figure 1; see lower left photograph). Seasonality influenced stump sprout vitality. Winter damage to the stem produced vigorous, rapidly growing sprouts and summer damage yielded weaker, slowly growing sprouts (Zon 1904).

The first cohort of foresters in the United States, many of who were cited in the previous paragraph, began their education coincidentally with the introduction of the chestnut blight. For this early generation of foresters, the loss of American chestnut was a charismatic event that affected their entire career. It is human nature to romanticize events in the past, and there is the potential that our current view of American chestnut as a "giant" (Ronderos 2000, p. 10) of the

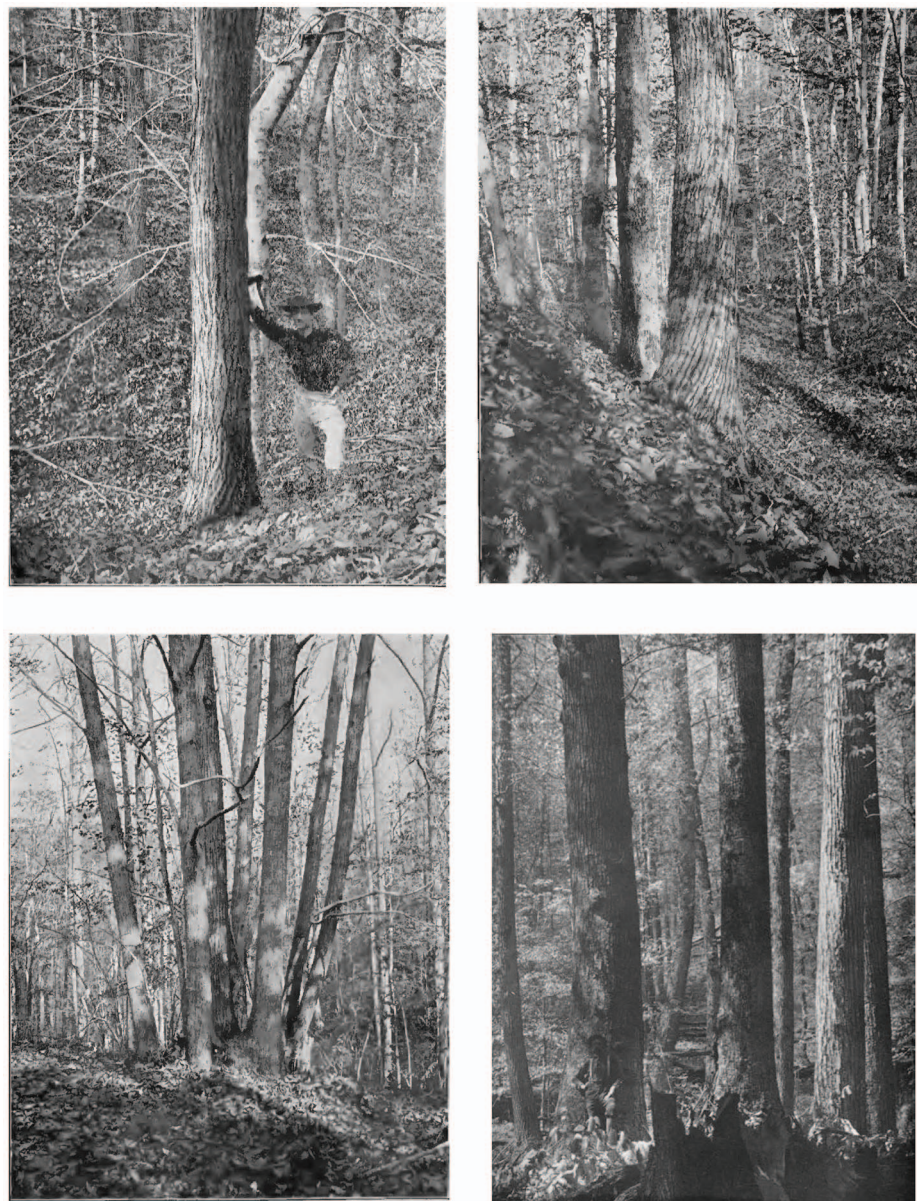


Figure 1. Four historical photographs that provide a realistic portrait of typical, mature American chestnut in preblight forests. The lower left shows a coppice or stump sprout-origin American chestnut tree. The lower left photograph is from North Carolina (Anonymous 1910), and the other photographs are from Maryland (Zon 1904).

Management and Policy Implications

The loss of a dominant forest species can lead to a species being perceived as having been unrealistically large. This article documents the increase in size and stature that has occurred in descriptions of American chestnut since its virtual elimination from eastern deciduous forests. Very little measured data exist about the actual size of American chestnut. Therefore, forest historians must reconstruct the role of this species from descriptions that appear to become increasingly unreliable with time since the introduction of the chestnut blight. These findings point to the need to permanently archive reliable forest inventory data for all tree species in today's forest, especially given the uncertain future of species such as eastern hemlock, ash, and white bark pine.

preblight forest may be a unrealistic view of this lost species. In this study, we compare descriptions of growth rate, height, and diameter of American chestnut in preblight versus postblight sources to identify whether scientific writers described American chestnut differently after its loss from the forest. In this comparison, we did not focus on tree measurements because data on pre- or postblight American chestnut are uncommon. Instead, we documented potential shifts in perceptions of the size of this species by including primary and secondary sources.

Sources of Historical American Chestnut Information

We took a multipronged approach to find pre- and postblight information and data on the growth rate and size of American chestnut. For preblight periods we examined publications and documents of well-known, historical foresters such as Carl Schenk, François André Michaux, Gifford Pinchot, and Raphael Zon; resources related to American chestnut archived by the Forest History Society and our library's special collections; and historical forest inventory data. For preblight and postblight periods, we examined government documents that included American chestnut in the title or keywords as well as books about forests and forest health. Database searches of scientific articles were made with keywords such as *American chestnut* and *Castanea dentata* using Web of Science, Agricola, and Treesearch. We examined early issues of the *Forestry Quarterly* (currently the *Journal of Forestry*) published by the Society of American Foresters from 1902 to 1910. We used various subscription-based databases and search engines, including Summon, Worldcat, and Hathi Trust. To locate articles in newspapers and other popular magazines, a phrase search was conducted in the subscription-based databases C19: The 19th Century Index and two ProQuest indices (PAIS and American Periodicals). We also used the openly available search engines Google Books and Google Scholar.

We examined each source for reported quantitative tree descriptions of American chestnut. Quantitative descriptions needed to include height, diameter, and/or growth rate for American chestnut and/or co-occurring species. The quantitative material allowed us to compare the stature of American chestnut with other tree species in the eastern deciduous forest and allowed us to com-

Table 1. Descriptions of American chestnut size from sources published before the blight affected this species.

Height		Diameter		Source
Maximum (ft)	Typical (ft)	Maximum (ft)	Typical (ft)	
—	50–80	5 ^b	—	(Mathews 1896)
120	50–70	13	5	(Pinchot and Ashe 1897)
100	—	8–12	3–4	(Hough 1898)
—	—	10	7	(Mauray and Fontaine 1876)
—	60–100	10	6	(Rogers 1906)
100	—	10–12	3–4	(Sargent 1896)
100	60–80	—	—	(Seton 1912) ^a
—	60–80	—	4–5	(Marshall 1785)
100	—	6–8	—	(Weed and Emerson 1910) ^a
100	—	13	—	(Britton 1908)
100	—	—	—	(Keeler 1900)
90–100	60–70	7 ^b	3–5 ^b	(Emerson 1846)
—	70–80	—	5 ^b	(Anonymous 1834)
—	70–80	—	5 ^b	(Browne 1832)
90	50–70	—	5 ^b	(Curtis 1860)
—	50–60	—	4–5	(Bacon 1877)
—	50–80	—	—	(Lounsberry and Rowan 1900)
—	50–80	—	—	(Newhall 1897)
—	—	—	5 ^b	(Michaux et al. 1865)

These sources are from silvics manuals, dendrology texts, government documents, and articles in trade magazines or newspapers.

^a This source was reporting from before the blight entered the area.

^b Originally reported as circumference.

pare the reported size and growth rate of American chestnut between preblight and postblight sources. We differentiated between an average and a maximum size limit because many sources reported one or the other or both. For example, Emerson (1846, p. 164) provided this description of American chestnut: "It rises with a straight, erect stem, hardly diminishing in size, to the height of sixty or seventy, and in forests in the southwest part of the State [Massachusetts] to ninety or one hundred feet." We listed this source as citing 60–70 ft for average height and 90–100 ft for maximum height.

Results and Discussion

Growth Rate of American Chestnut

Historical data provided evidence that in preblight forests, American chestnut had a fast growth rate and was able to grow faster than many species in eastern deciduous forests. In Connecticut (Graves 1905), 30- to 50-year-old American chestnut trees had diameter growth measured as two to three times that of eastern red cedar (*Juniperus virginiana* L.). In even-aged stands, American chestnut was the tallest tree measured (75 ft), with the tallest chestnut oak 56 ft and the tallest northern red oak 53 ft (Anonymous 1901). This indicates that American chestnut had faster height growth than most other trees. This rapid growth rate continues

to be discussed in postblight sources: "No other tree of the forest can equal it in the speed with which it makes wood ... its record fast growth, makes it a forest marvel" (Smith 1912, p. 144) and "chestnut trees grew faster than their neighbors maybe half again as fast as oaks and usually 20% faster than quick growing poplars" (Cornett 2010).

Height of American Chestnut

A comparison of pre- and postblight qualitative descriptions reveals an increase in the upper limit of the reported maximum height of American chestnut in postblight documents. Preblight sources most frequently reported a maximum height of mature American chestnut as 100 ft, and postblight descriptions most frequently report a maximum height of 120 ft (Tables 1 and 2).

In descriptions of preblight forests, American chestnut is identified as among the tallest trees, with several common species being equal in height (Bacon 1877, Illick 1914, Mathews 1915). American chestnut, longleaf pine (*Pinus palustris* Mill.), sugar maple (*Acer saccharum* Marshall), white ash (*Fraxinus americana* L.), and yellow-poplar all reached the same maximum height of 100–120 ft (Anonymous 1915a, 1915b, Detwiler 1915a, 1915b, 1915c). At sites in Tennessee, mature yellow-poplar, white oak (*Quercus alba* L.), and American chestnut were all similar in height (Ashe 1911, 1913,

Table 2. Descriptions of American chestnut size from sources published after the chestnut blight.

Height		Diameter		Citation
Maximum (ft)	Typical (ft)	Maximum (ft)	Typical (ft)	
—	—	—	10	(Clarkson 1964)
—	120	—	7	(Lutts 2004)
—	—	17	—	(Sisco 2004)
130	80–100	8–10	4–5	(Furgurson 2015)
130	—	—	—	(Williamson 2004)
130	100–105	—	4–7	(Cornett 2010)
120	50–70	6–9	—	(Mathews 1915)
120	80–100	8	2–4	(Woods and Shanks 1959)
120	60–90	7	3–5	(Saucier 1973)
120	80–100	—	2–4	(Pinchot 1907)
120	—	5	—	(Wang et al. 2013)
120	—	13	—	(Davis 2000)
120	—	17	—	(Freinkel 2007)
120	—	5	—	(Buttrick 1925)
—	80–120	—	5	(Money 2007)
—	100	17	5	(French et al. 2007)
100–120	60–90	17	3–5	(Detwiler 1915a)
100	60–80	17	3–4	(Illick 1914)
100	70–90	—	—	(Smith 2000)
—	100	8–10	5	(Ronderos 2000)
—	—	10–12	—	(Peattie 1991)
—	—	11 ^a	—	(Elwen 1915)
—	—	—	5	(Bolgiano 2002)

These sources are books, scientific journal articles, government reports, articles in trade magazines or newspapers, silvics manuals, and an educational film.

^a Originally reported as circumference.

Hall 1910). However, in postblight sources, American chestnut is identified as the tallest tree in eastern forests, with descriptions such as “Redwood of the East” (French et al. 2007, p. 24) and “towered above the living forest” (Cornett 2010). We found only a single postblight source that retained the preblight context of American chestnut as being among the tallest trees. Smith (2000, p. 13) says “only two other species, white pine and yellow-poplar could grow taller.” On the basis of historical descriptions and data, American chestnut was a tall tree within preblight forests, but it shared this position with ash, oaks, pines, sugar maple, and yellow-poplar.

Diameter of American Chestnut

When diameter descriptions of American chestnut are compared between pre- and postblight sources, the upper limit of the reported size of the tree is often larger in postblight sources. Preblight sources describe the typical diameter of a mature tree as 3–7 ft and maximum reported diameter of 13 ft (Table 1). Postblight sources report the typical diameter of American chestnut as 2–10 ft, with a maximum reported diameter of 17 ft (Table 2).

Tree diameter measurements in Maryland show that American chestnut was sim-

ilar in girth to northern red oak, white oak, and yellow-poplar (Zon 1904; Table 3). In a young stand in Connecticut that was measured in 1901, before chestnut blight, tree diameter measurements identified American chestnut as the largest tree at the site (maximum dbh = 9.8 in.), with northern red oak (maximum dbh = 7.1 in.) and chestnut oak (maximum dbh = 8.3 in.) slightly smaller in size (Table 3). Historical photographs from preblight periods also reveal that the maximum diameter achieved by American chestnut was very similar to the maximum diameter of northern red oak, yellow-poplar, and beech (Figure 2). It was a bit more difficult to ascertain the “typical” diameter of mature American chestnut from photographs, but on the basis of the original captions, the four preblight photographs of American chestnut shown in Figure 1 seem to represent “typical” mature trees. On the basis of preblight diameter measurements and historical photographs, it appears that American chestnut was a large-diameter tree within historical forests, but it shared this position with oaks, beech, and yellow-poplar.

Exaggeration of American Chestnut Size

Where did the modern interpretation of American chestnuts as “giants” and “red-

Table 3. Maximum diameters for common eastern deciduous tree species measured from three sites in the coastal plain of Maryland (MD1, MD2, and MD3) as reported by Zon (1904) and one site in Connecticut (CN) as reported in Anonymous (1901).

Species	Maximum tree DBH (in.)			
	MD1	MD2	MD3	CN
American beech	—	23	25	—
American chestnut	34	44	40	9.8
Ash	—	—	—	3.6
Aspen	—	—	—	4.5
Birch	—	—	—	3.9
Black cherry	—	9	—	—
Black gum	—	12	24	—
Chestnut oak	—	—	—	8.3
Eastern red cedar	—	15	—	—
Hickory	13	20	13	2.6
Mulberry	—	—	6	—
Northern red oak	25	38	42	7.1
Persimmon	—	16	—	—
Pine	18	12	11	—
Red maple	—	13	13	2.3
Sugar maple	—	—	—	5.6
Sweet gum	11	18	12	—
Sycamore	—	—	13	—
Walnut	—	4	15	4.4
White elm	—	—	7	—
White oak	23	26	18	4.3
Witch hazel	—	3	—	—
Yellow-poplar	—	14	34	6.3

The three largest species are shown in bold font for each site. Dashes indicate that there were no individuals of this species measured at the site.

woods of the East” (French et al. 2007, p. 24, Money 2007, p. 1, Ronderos 2000, p. 10) originate? We suggest that postblight literature reports a larger size for this species through three primary mechanisms: perpetuation of errors caused by confusing circumference and diameter measurements, confusion between the size of a typical tree and the size of an exceptional individual, and inability to measure living American chestnut trees to verify reported sizes.

The confusion between circumference measurements and diameter measurements originates with multiple postblight references of an exceptional 17-ft-diameter American chestnut measured in Francis Cove, North Carolina (Table 2). The first published reference to this tree was Illick’s (1914) Bulletin 11, “Pennsylvania Trees,” published by the Pennsylvania Department of Forestry. This document states on page 129, “A [American chestnut] tree with a diameter of 17 ft. has been recorded from Francis Cove, western North Carolina.” Unfortunately, the bulletin does not include a source of this record. However, there is one other tree’s

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Figure 2. A series of photographs taken for an article published in the *American Lumberman* (Anonymous 1910) describing the rich timber resources in Graham County, North Carolina. American chestnut (lower left); northern red oak (upper left); yellow-poplar (upper right); and yellow-poplar, beech, and eastern hemlock (lower right) all achieved a similar maximum size at this unusually fertile site. To provide a reference scale, the nearest yellow-poplar in the upper right photograph was 8 ft in diameter.

description that mentions Francis Cove, North Carolina. Yellow-poplar is described on page 159: “Prof. Guyot recorded a [yellow-poplar] tree in Francis Cove, western North Carolina known as the “Guyot” or “Granny Poplar,” which has a diameter of 16 ft” (Illick 1914). The fact that these are the only two references to Francis Cove, western North Carolina, in the 213-page bulletin does not establish that Professor Arnold Guyot was also the source of the 17-foot-diameter measurement of American chestnut, but it does provide some degree of

circumstantial evidence that these two descriptions came from the same source. Interestingly, the size of the 16-ft-diameter yellow-poplar was challenged by J.H. Elwen (1915, p. 22), who compiled “Record Trees” for the trade journal *American Hardwood*. Elwen doubted that a tree of this stature could have existed in eastern forests and “searched the voluminous writings of Professor Guyot for the purpose of examining his statement at firsthand, but unfortunately, was unable to find it.” We also examined Guyot’s publications (Anonymous

1888, Guyot 1849, 1859, 1861, 1868) and were unable to discover a reference to either a 16-ft-diameter yellow-poplar or a 17-ft-diameter American chestnut. Guyot (1861) spent the summers from 1856 to 1860 making detailed barometric measurements of the highest peaks in the Smoky Mountains of North Carolina; therefore, it is possible that he may have made measurements of tree sizes in Francis Cove, North Carolina during this period. However, Guyot was working during a period (mid-1800s) when all tree girth measurements were recorded as circumference (see footnoted items in Table 1) rather than diameter. The following quote from the same period describing the size of the American chestnut shows the use of circumference rather than diameter: “An old [American chestnut] tree is standing near Meeting-house Pond, in Westminster, which measured fifteen feet two inches in circumference [4.8 ft in diameter] at the ground, in 1839, but diminished rapidly being but ten feet ten inches [3.4 ft in diameter] at four feet” (Emerson 1846, p. 168). We think it is likely that there was an initial error in interpreting Guyot’s circumference measurements as diameter measurements. If our hypothesis is true, then the oft-cited 17-ft-diameter American chestnut from Francis Cove (Table 2) would actually have been a 17-ft-circumference tree, or one with a diameter of 5.4 ft—a size that aligns more closely with preblight descriptions of the diameter of the mature American chestnut (Table 1).

Many sources provide information about the typical size for mature American chestnut trees and additionally reference an individual tree of an unusually large size (Tables 1 and 2). Reporting both typical and maximum trees resulted in errors because subsequent publications interchangeably used these two types of tree measurements. As an example of this type of error, Clarkson (1964, p. 7), states, “Chestnut, one of the most numerous trees of this type, attained a diameter of over 10 ft.” The reference for the source of this measurement is page 116 in Maury and Fontaine (1876). The original source (Maury and Fontaine 1876, p. 116) contained two descriptions (typical and maximum) of American chestnut. The first describing a typical tree states, “This is one of our largest trees, attaining a diameter of seven feet,” and the second statement identifies a specific tree that achieved an unusual size, “A tree thirty-three feet in circumference [10 ft in diameter] has been measured

in Kanawha county.” Clarkson (1964) interpreted the maximum size as the typical size. This same error of using an unusually large individual to represent the typical American chestnut happened with a photograph of a grouping of American chestnut published in the *American Lumberman* and described in the original caption as, “The five large ones in the foreground are chestnut. This growth is unusually heavy” (Figure 2; Anonymous 1910, p. 74). This photograph has subsequently been tagged as a “classic chestnut photo” (Sisco 2010, p. 9), used in numerous sources as representative of the typical growth of preblight American chestnut (Barnes et al. 1998, Ellison et al. 2005), and represents another error of confusing maximum and typical tree size.

More than one author provided conflicting descriptions of American chestnut’s size, probably because postblight authors were unable to verify the size of living specimens. For example, Mathews (1896, p. 106) described American chestnut in his preblight publication as “The tree grows from 50 to 80 ft high In North Carolina there are many specimens whose trunks measure sixteen feet in circumference [5.1 ft diameter].” In his postblight publication, Mathews (1915, p. 132) describes a larger maximum girth of American chestnut: “It is generally 50–70 and occasionally (in woodlands) 120 ft high, with a trunk diameter of 6–9 ft.” As another example, Pinchot and Ashe (1897, p. 109) in their earlier publication state American chestnut “reaches an average height of 50 to 70 ft and an average diameter of 5 ft.” Pinchot’s (1907, p. 1) later description of chestnut has reduced the average diameter but increased the average height: “[American chestnut has] an average height of 80 to 100 ft and a diameter of 2 to 4 ft.” We conclude that these differences are likely because it was no longer possible to measure the size of mature trees, and postblight descriptions became less reliable because of this constraint.

Conclusions

We hope that the results of this project provide a more historically accurate representation of American chestnut in preblight forests—an important dominant and codominant hardwood tree that was similar in stature to oaks, white pine, and yellow-poplar. The common perception that American chestnut was substantially larger than other hardwoods in the eastern deciduous forest can result in scientific errors similar to that

identified by Thomas-Van Gundy and Whetsell (2016) in which a photograph of a redwood (*Sequoia sempervirens* [Lamb. Ex D. Don] Endl.) tree was misidentified as American chestnut—a mistake that may be explained by the large number of postblight sources that erroneously report a 17-ft maximum diameter for American chestnut (Table 2). Accurately quantifying the size of mature American chestnut trees is an impossible task because this species has been lost from our forest, but the preblight sources appear to provide a more accurate representation of American chestnut’s stature than postblight sources. We are in a period in which restoration ecologists look to recreate historical conditions on present-day landscapes as a method of improving ecosystem function (Dalglish et al. 2016). We are also in an era in which there is an unprecedented wealth of historical documents readily available via the Internet (e.g., most citations in this article from the 1800s were electronically available). Our study comparing historical versus more recent descriptions of the size of American chestnut documents the importance of accessing these readily available historical documents as an aid to identify appropriate restoration ecology goals.

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