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Wood Anatomy and Relationships of *Betula uber*

W. JOHN HAYDEN and SHEILA M. HAYDEN

ABSTRACT

Wood anatomy of *Betula uber* (Ashe) Fernald is described and compared with woods of other birches belonging to series *Humiles* and series *Costatae*. Anatomically, wood of *B. uber* is typical of birches in general. On the basis of pore size and frequency, fiber characteristics, axial xylem parenchyma distribution, and absence of aggregate rays, it is argued that *B. uber* is properly classified in series *Costatae*. Resolution of its relationships within series *Costatae* is not apparent from wood data.

INTRODUCTION

For the most part, birches are common and abundant trees of temperate zone forests, well known to botanists, foresters, and wood anatomists. The enigmatic Virginia Round-leaf Birch, *Betula uber* (Ashe) Fernald, is a notable exception. This rare tree is known only from a small population of currently ca. 20 individuals in southwestern Virginia, U.S.A. (Sharik 1982). Discovered in 1914, W.W. Ashe (1918) named and described his novel round-leaved birch as a variety of the Sweet Birch, *Betula lenta* L. Prior to its rediscovery in 1975 (Ogle & Mazzeo 1976), *B. uber* was known solely from two collections (Mazzeo 1974), despite several attempts to relocate it (e.g., Johnson 1954). Nevertheless, Fernald (1945) elevated its status to that of a distinct species which he transferred from series *Costatae* to series *Humiles*. Its rediscovery was especially dramatic since, at the time, this unusual birch was presumed to be extinct (Smithsonian Institution 1974, U.S. Department of Interior 1975). Its continued existence in the wild is, of course, precarious.

Since the relationships of taxa which are rare or in danger of becoming extinct are often imperfectly known, the need for information on their morphology and anatomy can be critical. As such data clarify relationships they contribute to the bases for rational decisions on management and preservation. Many fundamental questions about the biology of *Betula uber* remain unanswered (Sharik 1982), including the nature of its relationships with other birches. External bark morphology and sympatry with *B. lenta* and *B. alleghaniensis* Britton (*B. lutea* of authors) suggest relationship with series *Costatae*, yet leaf, floral, and seed morphology led Fernald (1945) to classify *B. uber* with series *Humiles*, a group of northern shrubby birches. Anatomically, woods of series *Costatae* and *Humiles* differ in a number of respects (Hall 1952); therefore, a study of the wood of *B. uber* was initiated as a contribution towards a better understanding of the relationships of this distinctive rare birch.

MATERIALS AND METHODS

Because of the small population size of *Betula uber*, only one wood sample was available for study. This sample came from an individual designated as "Tree No. 2," and is vouchered by *Mazzeo et al. 2850* (NA). "Tree No. 2" is no longer extant, having been uprooted by stream erosion.

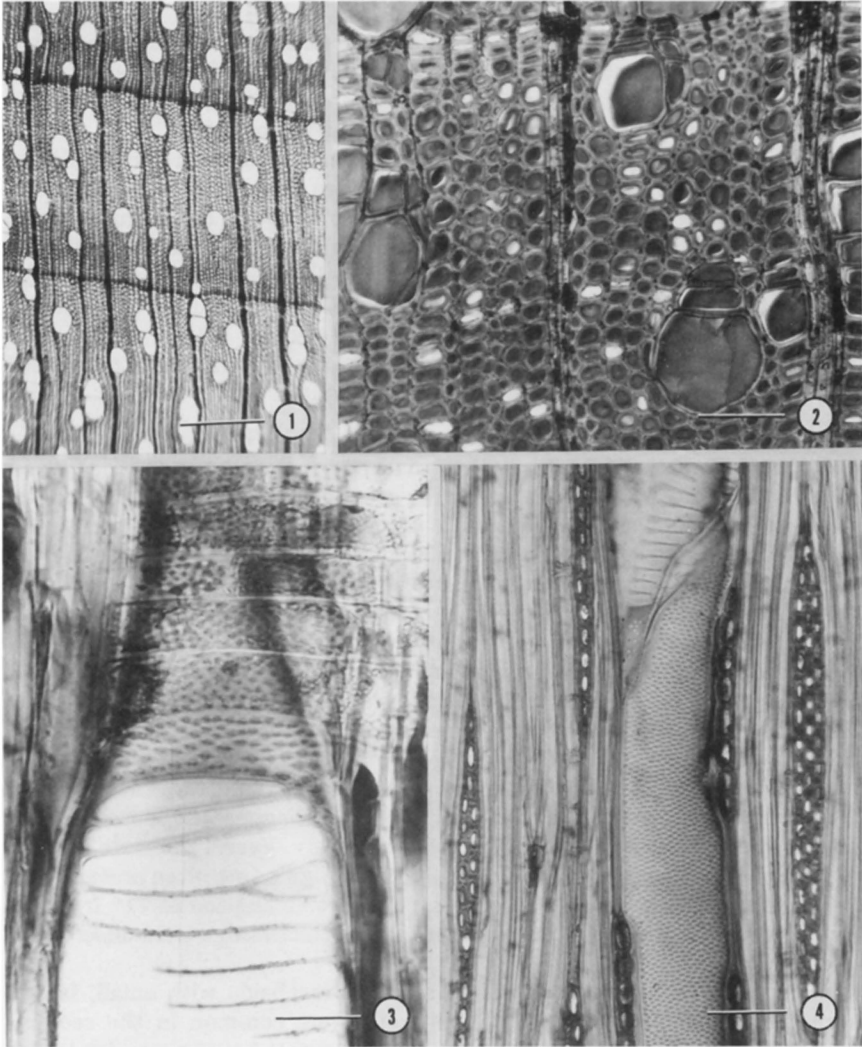
Macerations were prepared according to the technique of Jeffrey (Johansen 1940). Prior to sectioning, wood samples were embedded in celloidin (Wetmore 1932); after sectioning, celloidin was either dissolved out (Figure 1) or retained (Figure 2) with chloroform during dehydration. Sections were cut at 20 μm on a sliding microtome and stained with Delafield's hematoxylin and safranin O. Reported dimensions are based on: 50 measurements of pore diameters, vessel element length, and imperforate element length; 30 measurements of vessel element end wall angle; 30 counts of perforation plate bars; and 10 counts or measurements of all other features.

ANATOMICAL DESCRIPTION

Wood. Growth rings are present, marked by narrow bands of latewood; the sample studied possesses eccentric growth rings. The wood is diffuse porous (Figure 1). Pore distribution is 68 percent solitary, 22 percent radial multiples, and 10 percent clusters; radial multiples consist of 2–8 cells, most frequently 2 or 3 cells; clusters consist of 2–9 cells with less than 5 cells per cluster most frequent. On the average there are 42 pores per mm^2 which constitute an average pore area of 0.131 mm^2 per mm^2 of wood surface. Pore outlines are circular to slightly angular. Vessel elements have an average wall thickness of 2.7 μm . Pore diameters range from 28–97 μm with an average of 63 μm (measured tangentially). Perforation plates are scalariform (Figure 3); the average number of bars per plate is 20 with a range of 10–35. The minute intervascular pits (Figure 4) average 2.4 μm (vertical diameter); these pits are circular to elliptic in outline with horizontally or diagonally oriented slit-like inner apertures; these pits are arranged alternately. Vessel elements have an average length of 516 μm (ranging 255–745 μm); ligules are often present. End wall angles range from 58–85° with an average inclination of 71° from the horizontal. Neither tyloses, deposits, nor spiral thickenings were observed in vessel elements.

Imperforate tracheary elements are fiber-tracheids with small, faintly bordered pits. Fibers with gelatinous walls were common in the sections studied (Figure 2). The imperforate tracheary elements have an average length of 893 μm and a range of 420–1235 μm .

Rays are numerous, there being an average of 9 per mm. Rays are 45 percent uniseriate and 55 percent multiseriate (Figure 4). Uniseriate rays have an average width of 9 μm ; multiseriates are 2–4 cells wide with an average measured width of 22 μm . Uniseriate rays range from 3–20 cells tall, or 48–324 μm ; average height is 10 cells, or 170 μm . Multiseriate rays range from 9–34 cells tall, or 159–455 μm ; average height is 21 cells, or 303 μm . Rays are essentially homocellular, consisting mostly of procumbent cells with a few square cells at the margins, or occasionally, in the body of the ray. Vessel-ray pitting is circular, alternate, and about the same size as the intervascular pits (Figure 3).



Figures 1-4. Wood anatomy of *Betula uber* (Mazzeo et al. 2850). 1. Diffuse arrangement of pores, cross section. Scale = 200 μm . 2. Gelatinous fibers, diffuse axial xylem parenchyma, and celloidin-filled vessels, cross section. Scale = 50 μm . 3. Portion of scalariform perforation plate and vessel to ray pits, radial section. Scale = 25 μm . 4. Intervascular pits, uniseriate and multiseriate rays, tangential section. Scale = 50 μm .

Axial xylem parenchyma is predominantly diffuse apotracheal (Figure 2), with boundary cells consistently present and a few scanty paratracheal cells. Individual cells are rectangular except at the ends of strands. Strands of axial xylem parenchyma have an average length of 768 μm and may consist of 8–15 cells, averaging 12 cells per strand. Since paratracheal parenchyma is not

abundant, pits between vessels and axial parenchyma are not common; those observed were circular and alternate to widely scattered.

Bark. Inner bark consists of patches of hard bast scattered amongst the soft bast. Secondary phloem rays dilate somewhat. Sieve tube elements possess scalariform sieve plates; plates with 4–12 sieve areas were observed. Druses are present infrequently in parenchymatous cells of the soft bast. Hard bast consists of masses of sclereids many of which contain prismatic crystals in their lumina; druses are present in some sclereids and some sclereids contain dark amber-colored deposits. Periderm consists of dense layers of uniform cells with tangential dimensions 10–20 times greater than the radial.

DISCUSSION

According to Ogle & Mazzeo (1976), known specimens of *Betula uber* “form a sub-canopy layer, and are generally bent at an angle, presumably to fill open spaces in the canopy above.” These are conditions which one would expect to lead to the formation of reaction wood. Presence of eccentric growth rings and the abundance of gelatinous fibers in the specimen examined are thus readily explained.

From Table 1 it can be seen that wood of *Betula uber* closely matches that of series *Costatae* (which includes *B. lenta*); in contrast, wood of series *Humiles* is strongly divergent from that of *B. uber*, *B. lenta*, and other species of series *Costatae*. Relationship with series *Costatae* is thus more likely than with series *Humiles*. Wood data cannot, however, resolve the status of *B. uber* within series *Costatae*, i.e., it cannot indicate whether it should be maintained as a distinct species or relegated to varietal status under *B. lenta*. From the data of Hall (1952), wood structure of series *Costatae* is too homogeneous for resolution of this question.

Given the above-mentioned limitation, wood structure is consistent with several other preliminary findings reported by Sharik (1982) which suggest a close relationship between *Betula uber* and *B. lenta*. Other relevant similarities

Table 1. Selected Wood Features of Various Birches¹

Feature	Series <i>Humiles</i> ²	<i>Betula</i> <i>uber</i>	Series <i>Costatae</i> ²
Pores per mm ²	268	42	43
Pore diameter (μm)	30	63	71
Vessel element length (μm)	352	516	820
Tracheids	+	—	—
Fiber-tracheids	s	+	+
Aggregate rays	+	—	—
Metatracheal parenchyma	+	—	s, —
Diffuse parenchyma	s, —	+	+
Scanty parenchyma	—	s	+

¹Key to symbols: + = present and characteristic; s = sporadic; — = absent.

²Data from Hall (1952).

between these two taxa include: arborescent habit; dark, smooth, aromatic bark; fruit morphology (fruits of *B. uber* are, however, somewhat smaller than those of *B. lenta*); and a chromosome number of $2n=28$. Further, breeding studies have shown that first generation hybrids are possible, and, moreover, seeds collected from *B. uber* often produce seedlings with leaf morphology of *B. lenta* (Sharik 1982). Nevertheless, the distinctive leaf morphology and presence of rhododendrin in the bark of *B. uber*, coupled with its absence in *B. lenta* (Santamour & Vettel 1978), suggests that *B. uber*, whatever its status, is a distinct entity from *B. lenta*.

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