# ANEXO 4: BIBLIOGRAFÍA CONSULTADA Y OTRA DOCUMENTACIÓN DE INTERÉS

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# Divergencias de color en Black Cherry aumentan

## Escasez de troncos adecuados para chapa – divergencia de color sólo se puede influenciar de manera limitada en proceso de cocción

Por ingeniero maderero Ingo Mayer[1] y catedrático no titular Dr. Gerald Koch[2], Hamburg

**El cerezo negro americano „Black Cherry" (*Prunus serotina* Borkh.) es una de las maderas de importación europeas de mayor importancia para la industria del mueble y la decoración interior de alta calidad. La madera es muy apreciada especialmente debido a su agradable color marrón rojizo y su estructura fina para las máximas exigencias decorativas en el mercado norteamericano y europeo. La gran demanda de Black Cherry es el motivo, que las calidades adecuadas para la producción de chapa en la forma del tronco y color han descendido notablemente en las áreas de distribución naturales (noreste de EEUU) y cada vez llega más madera al mercado europeo que presenta variaciones importantes en el color.**

La explotación maderera americana de la especie nativa *Prunus serotina* Ehrh. (Black Cherry) es [illegible] debido a su bajo [illegible] ción y las dimensiones pequeñas del tronco. Durante la transformación y elaboración de Black Cherry hay cada vez más reclamaciones por modificaciones de color irregulares, que conducen a pérdidas económicas altas en la industria de chapas y del mueble. En el marco de un trabajo de investigación se estudió la formación de color en el árbol vivo, los motivos para los defectos de color así como el comportamiento del color en el proceso de producción de fabricación de la chapa.

### Material de investigación

Para la investigación se usaron troncos para chapa de las áreas de distribución naturales de Black Cherry en el noreste de Norteamérica. Se trata de troncos con calidad de chapa [illegible] de las áreas de crecimiento de Pensilvania (17 troncos) y West Virginia (10 troncos), con diámetros entre 40 y 60 cm y una edad de entre 60 y 90 años (Figuras 1 y 2). Se tomaron muestras de los segmentos de los troncos durante el almacenamiento después del transporte en contenedores, véase Koch y Zampe 2005) y en el proceso industrial de la producción de chapa entre las fases individuales del proceso (despiezado, cocción de la madera, corte horizontal de chapas, secado técnico), y después del secado técnico se tomaron muestras de hojas de chapa de madera de troncos escogidos. De esta manera fue posible estudiar tanto la distribución como también las reacciones cromáticas de las sustancias contenidas durante todo el proceso de transformación y elaboración. Algunas muestras de los troncos así como las hojas de chapa correspondientes muestran divergencias cromáticas rayadas y manchas (formación de goma) claras en los cortes transversales y tangenciales (Figuras 2 y 3).

### Color de la madera

Para el estudio de la formación del color en el árbol vivo así como los diversos procesos cromáticos que se producen se llevaron a cabo investigaciones macroscópicas extensas con microscopía óptica y espectroscopía UV-Vis celular y químicas (cromatografía RP-HPLC, unida a espectroscopía UV y de masa). Adicionalmente se hicieron mediciones de los valores cromáticos mediante un espectrofotómetro de superficie según el CIE (Lab-sistema) en el espacio cromático $L^*a^*b^*$ con los ejes $L^*$ (claridad), $a^*$ (rojo-verde) y $b^*$ (amarillo-azul) para determinar cuantitativamente las características cromáticas de la madera con inclusión de la estructura de los tejidos de chapa.

### Contenido en sustancias accesorias

Estudios con microscopios ópticos y espectroscópicos UV comprueban la presencia de agregados cromóforos aumentados en las células de almacenamiento (lugar de síntesis de las sustancias contenidas) así como en los vasos del duramen formado de Black Cherry (figura 4). Además estudios espectroscópicos en el área visible de la luz ilustran la importancia central de estas sustancias para el color del duramen. Sobre todo al observar, sin embargo, una [illegible] de las sustancias en las paredes celulares del tejido (duramen de base). Para estudiar las sustancias accesorias (cromóforas) estas se extrajeron del tejido de madera mediante solventes. El extracto de albura tiene – como también la albura misma – solo un color leve. Sin embargo fue posible determinar altas concentraciones de sustancias en el interior de la albura (aprox. 6 % referido al peso seco) (Mayer et al. 2006). En este caso se trata de sustancias accesorias preliminares de sustancias del duramen, que son metabolizadas durante la formación de este. El contenido en sustancias del extracto (extracción acetona/agua) en la zona de la madera alcanza un máximo en la zona de transición de la albura al duramen (aprox. 10 %). En esta zona las sustancias preliminares formadas en el área de la albura se transforman en sustancias en parte cromáticas del duramen durante el proceso natural de la formación cromática del duramen. Extractos del duramen tienen un color rojizo debido a las sustancias cromáticas del duramen. El contenido del extracto del duramen se encuentra entre 4 y 6 %. En total se pueden detectar aprox. 50 sustancias diferentes en los extractos acetona/agua (Mayer et al. 2006).

Todas las sustancias identificadas tienen una estructura base tipo flavonoide. Flavonoides son colorantes que se encuentran en la naturaleza con frecuencia y comprueban el carácter cromático de las sustancias contenidas en Black Cherry. Por oxidación se pueden convertir en compuestos y luego en sustancias de mayor grado de agregación y son responsables del color (por ej. Hathway 1962). Así por ej. en la biosíntesis de colorantes la sustancia identificada catequina es una etapa preliminar del colorante y contribuye al color de la madera oxidándose y formando sustancias poliméricas cromáticas, los taninos condensados (proantocianidinas), descritos para muchos tipos de madera. Estos procesos se pueden comprobar por la reducción clara de la concentración de catequina en el límite albura/duramen de los segmentos de tronco Black Cherry que se estudiaron. Otras sustancias identificadas (por ej. la taxifolina y naringenina) también se forman en el límite albura/duramen y solamente se puede comprobar su presencia en el duramen (Mayer et al. 2006).

### Motivos de la divergencia cromática

Los colores de la madera de duramen dependen de la concentración y distribución de las sustancias identificadas y descritas contenidas en el tejido de la madera. Esto vale sobre todo para la catequina. En áreas del duramen de color oscuro intenso la concentración de esta sustancia es claramente superior a la concentración en el duramen de color normal de color marrón claro o en áreas especialmente claras (Mayer et al. 2006).

Los motivos para la síntesis irregular de las sustancias y su concentración en el duramen de Black Cherry se basan en factores exógenos, por ej. el clima, localización, condiciones geológicas de suelo y la estructura del suelo (valor pH, disponibilidad de elementos nutritivos). Ciertos oligoelementos como por ej. hierro y manganeso adquieren una importancia particular, debido a que son parte importante de las reacciones controladas por enzimas en la biosíntesis del núcleo (por ej. Hillis et al. 1950) y porque a través de su efecto formador de complejos pueden ligar ciertas sustancias fenólicas formando complejos cromáticos (Hillis [illegible] 1969).

Mediante investigaciones analíticas de elementos (espectroscopía óptica de emisión, ICP-OES) fue posible comprobar diferencias claras entre troncos de diferentes áreas de crecimiento. La comparación de estos valores con resultados de las mediciones de valores cromáticos demuestra que divergencias elevadas en la concentración de hierro y manganeso en el tejido de la madera de los troncos de chapa corresponden a divergencias mayores del color de la madera. También el valor pH del duramen de Black Cherry varía más en troncos con mayores divergencias de color. Habitualmente el valor pH en el tejido de madera de Black Cherry disminuye durante la formación de un pH de aprox. 5 (zona de albura) hasta aprox. pH 4 (duramen), debido a la formación de sustancias duramen ácidas. Divergencias del valor pH en el duramen señalan una síntesis irregular de las sustancias en el duramen con los efectos cromáticos descritos.

### Comportamiento cromático en el proceso de cocción

Durante el proceso industrial de producción de chapa la cocción de los troncos para chapa (tratamiento térmico de la madera en baños de agua bajo condiciones específicas para el tipo de madera, duración 24 h hasta varias semanas, temperatura 40 hasta 95 °C) se hace para reblandecer la madera y disminuir la tensión presente en este (por ej. Teichgräber 1966). Simultáneamente se puede lograr, específicamente según el tipo de madera, una modificación y homogeneización selectiva del color de la madera. Las modificaciones cromáticas posibles en el tejido de la madera se basan fundamentalmente en reacciones de la lignina (por ej. Wegener und Fengel 1986), de las sustancias del núcleo (por ej. Charrier et al. 1995, 2002, Burtin et al. 2000) y de carbohidratos (reacciones según el principio Amadori-Maillard (McDonald et al. 1997). Para la cocción de madera de Black Cherry se escogen condiciones de proceso comparativamente suaves, y los troncos se calientan por un período de tres días a menos de 70 °C, obteniéndose un color marrón rojizo muy claro. Un color demasiado rojizo y oscuro de chapas de Black Cherry a resultas de esto no es deseado en el mercado.

Mediante ensayos cercanos a la práctica en dimensiones industriales se estudió el comportamiento cromático de Black Cherry en el proceso de cocción con temperaturas variables y la influencia de tiempos de espera tiempos de parada entre cocción, corte y secado técnico en el proceso de producción posterior. La cocción de la madera a 60 °C induce un cambio de color rápido en el duramen de Black Cherry (figura 4). A medida que aumenta el tiempo de cocción, la claridad ($L^*$) disminuye y se intensifica la parte roja del color (parámetro $a^*$ positivo). La elevación de la temperatura de cocción a 70 °C activa este proceso. Los cambios de color en este caso se deben a modificaciones cromáticas (oxidación y/o polimerización) de las sustancias identificadas. Mediante HPLC-MS y estudios celulares espectroscópicos UV se pueden determinar procesos de polimerización de las sustancias flavonoides contenidas durante la cocción de madera del duramen de Black Cherry (Mayer et al. 2006), que comprueban que las modificaciones cromáticas durante la cocción de la madera (a temperaturas hasta 70 °C) se deben principalmente a reacciones de las sustancias contenidas en la madera.

Las modificaciones cromáticas de la madera de Black Cherry que se encuentran condicionadas de la temperatura y del tiempo requieren ajustes de proceso exactos en el tratamiento térmico en todos los sectores de la elaboración de la madera. Solamente condiciones de reacción homogéneas posibles a través de la sección transversal del tronco (duración e intensidad de la acción de la temperatura) permiten un desarrollo homogéneo del color durante el tratamiento térmico. Para los tiempos de espera en el proceso de producción después de la cocción de la madera de hasta 8 horas (entre cocción de la madera y corte horizontal así como antes del secado técnico) no se pudo determinar una influencia significativa en el color de la madera. Probablemente esto se debe a la temperatura en el tejido de la madera que en este momento ya ha disminuido (60 °C), temperatura en la que ya no se inician nuevas reacciones de color. La influencia de las condiciones

Sigue en la página 21

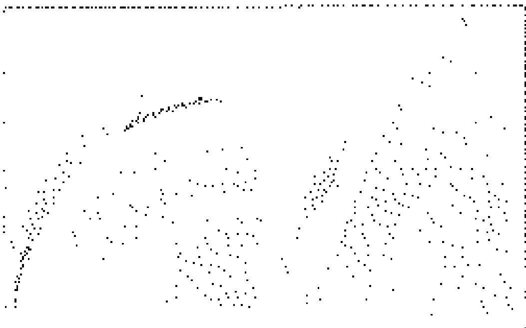

Figura 2 – Color homogéneo (izquierda) e inhomogéneo (derecha) [illegible] de Black Cherry (Fotos: vTI)

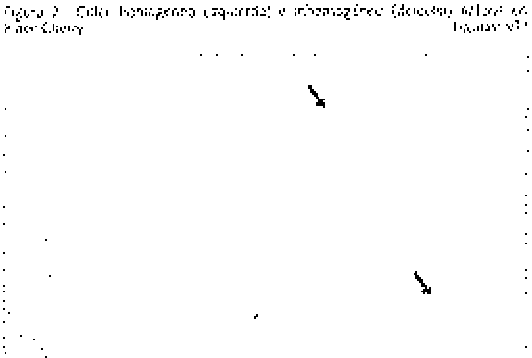

Figura 3 – Sección de una hoja de chapa de Black Cherry con fuertes divergencias de color en forma de rayas (formación de goma, véase flechas)

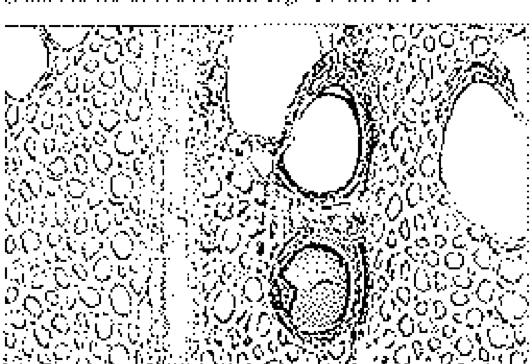

Figura 4 – Sección transversal del tejido de Black Cherry en la zona del duramen con enlaces de sustancias cromáticas llamativas en parénquimas (flechas amarillas) y en los vasos (flechas azules)

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[2] Prof. Dr. Gerald Koch es catedrático científico en el Instituto para Biología y Protección de la Madera del Instituto de investigación de Gestión de Bosques y Madera (vTI), Hamburgo.

En el marco de un proyecto de investigación (DGfH/AiF 14427 N) se llevaron a cabo estudios biológicos y químicos de la madera así como de procedimientos técnicos relevantes sobre los motivos y divergencias de color que reducen la calidad en el cerezo americano.

# Divergencias de color en Black Cherry aumentan

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[illegible]

### Envejecimiento natural por luz

[illegible]

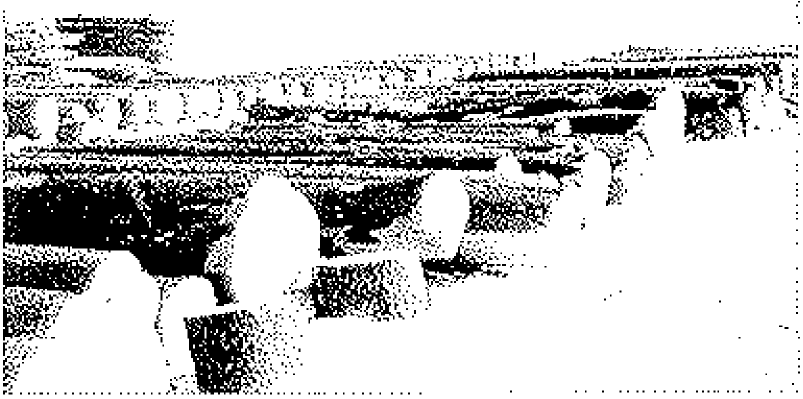

Figura 6 – [illegible] Black Cherry [illegible] (Pennsylvania/EE.UU.)

[illegible]

### Resumen

[illegible]

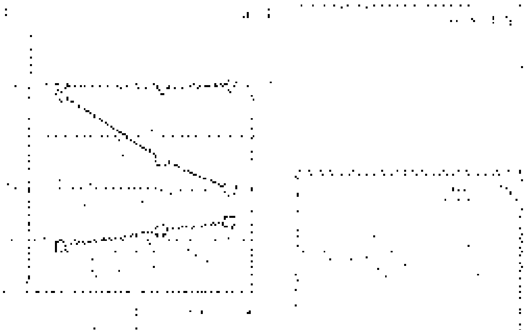

Figura 7 – Desarrollo de los valores cromáticos L* [illegible] a* [illegible] b* [illegible] de superficies de chapa [illegible]

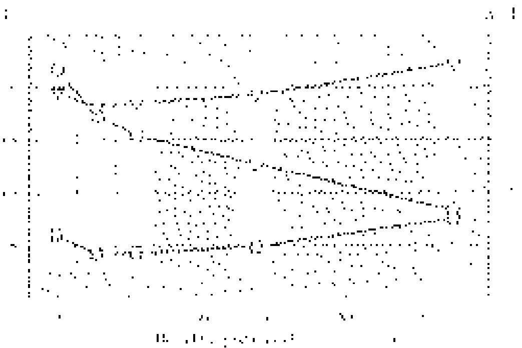

Figura 8 – Desarrollo de los valores cromáticos L* [illegible] a* [illegible] b* [illegible] de superficies de chapa bajo la acción de la luz [illegible]

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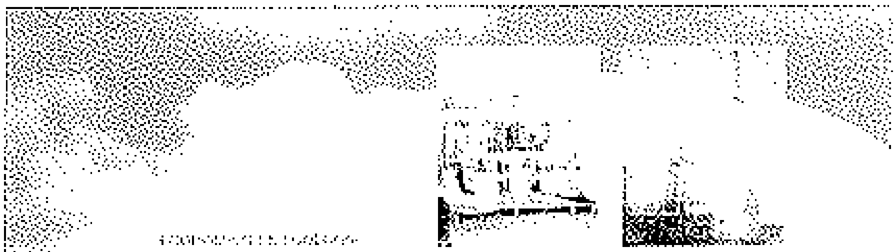

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**Wood characterization of clones selected for valuable timber production: the case study of Italian wild cherry**

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**Keywords:** *Prunus avium*, valuable broadleaved, clonal test, breeding programme.

**Abstract** – As regards the valuable broadleaved tree species, the quality of wood production is a much more important topic than quantity. Therefore the comprehension of what "valuable timber" is, it is a matter of crucial importance. The work wants to summarize what is helpful to care about during an improvement programme aimed to high quality wood production. Afterwards, the case of wild cherry in Italy is illustrated, briefly describing the importance and the use of its wood in the Italian industry; the production in the Italian plantations; and, finally, the past genetic improvement programmes and the actual researches.

The selection of plus trees started in Italy during the decade of 1980 and followed mainly growth and tree architecture criteria; clones were then tested in plantations.

One of the first field tests aimed to investigate the variability of wood quality of cherry clones focused on the wound cicatrisation after pruning. Significant differences between clones were noticed.

Currently, a further investigation on wood characterization of cherry clones previously selected for timber production is ongoing in two trials. To date, physical and mechanical properties of wood have been measured and a significant clone effect was found out for all the studied traits.

## Introduction

The importance of plantations in the industrial wood supply is growing in the last decades. While the global demand of wood (high quality timber as well as wood for energy) is constantly rising, the costs of natural forest wood is increasing because of the higher logging costs, the more restrictive regulations and the recent environmental costs.

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Plantations produce about the 34% of the earth industrial wood demand but they could reach the 75% in 2050 (Sedjo 2001a). Therefore, the wood production in plantation could reduce the logging pressure in natural forest and help the environmental conservation such as ecosystem and biodiversity preservation and climate change mitigation.

Moreover, the genetic improvement of species used in the plantations to timber production can have many benefits that can be grouped in economical and ecological benefits. The economic benefits relay to the possibility to achieve higher productivity by the selection of major trees for growth rate and disease resistance, but higher quality timber may be obtained as well, if the desired wood traits are included in the improvement programme. The ecological benefits are the possible reduction of wood harvested in natural forests, as already stated, and the increasing of carbon sequestration, but also the possibility to plant *ad-hoc* selected trees in areas that have been degraded and characterised by stressing micro-climate conditions (cold, water deficit and frost) (Sedjo 2001b).

For such reasons it becomes important to explore the new opportunities of wood production in plantations; mainly as concerns the genetic tree improvement.

In the peculiar case of the valuable broadleaved tree species, the quality of wood production carries more weight than quantity. Therefore the comprehension of what "valuable timber" is, it is a matter of crucial importance.

In the following paragraphs we will try to summarize what is helpful to care about during an improvement programme aimed to high quality wood production. Afterwards, we will illustrate the case of wild cherry in Italy, briefly describing the importance and the use of its wood in the Italian industry; the production in the Italian plantations; and, finally, the past genetic improvement programmes and the actual researches.

**The "valuable timber"**

At the beginning of a breeding programme it is necessary to understand and to decide what traits are to be improved. Reasonably, the adaptation to specific environment conditions, the growth rate and the tree architecture (trunk straightness, branch number, dimension and angle), followed by the disease resistance are the most used traits in the forest tree breeding programmes. But it is not assured that such selection strategy might lead to improvement of wood characteristics as well. So, if the timber production is the final objective of the plantation, especially when we deal with valuable tree species, wood traits should be studied on trees previously selected following different criteria (Nocetti 2008).

First of all, the meaning of the term "wood quality" has to be clarified. It can vary amongst forestry and wood industry sectors and it can be defined as the whole of characteristics that makes the timber suitable for a particular end use. It includes the properties that influence the performance of the end product and, moreover, the features which have an effect on the cost and the efficiency of the entire working process (log dimension and shape; presence of defects such as knots; and strict wood properties such as anatomical, physical and mechanical characteristics of wood) (MacDonald and Hubert 2002).

Therefore, the breeders should be aware of the genetic control of desirable timber traits to meet the needs of the industry; their correlation with the commonly recognised as "positive" traits (i.e. tree growth and architecture, disease resistance); and if and how the wood trait measured in the young tree can predict the same characteristic of the adult tree (Rozenberg and Cahalan 1997).

Up to now, the most studied species by the wood traits point of view are softwood. Among hardwoods various investigations can be found in the literature on *Populus* and *Eucalyptus*, whereas very little is known about the valuable broadleaved species (Zobel and Van Buijtenen 1989; Zobel and Jett 1995).

Finally, a further indispensable remark. It is necessary to keep in mind that the characteristics of the timber harvested in plantations represent the result of the close interactions of three key factors: the environment, the genetic factors and the cultural practices. All of them must be considered at the same importance level. The plantations of improved genotypes will not produce automatically high quality timber if not properly managed. It makes essential that breeders and silviculturists will work together in a thick collaboration (Hubert and Lee 2005).

**The cherry wood in the Italian industry**

In table 1, the main benefits and requirements for wild cherry cultivations are summarized. Besides the positive carbon-sink functions, the wide geographical range that makes it a native species in the most European countries, and the high landscape value due to the pleasant blooming, wild cherry provides an highly appreciated timber, used to lasting product manufacture.

It is considered in every respect a valuable species by the European timber market, particularly in Italy where the furniture industry is extremely important. The cherry timber is, in fact, mainly used for furniture, both as solid wood and veneer; cabinet making, flooring, decorative joinery and turnery.

At present, Italy is one of the main European users of cherry timber, but it has to be pointed out that the term "cherry timber" includes wild and sweet cherry (the last from trees for fruit production), but also black cherry (*Prunus serotina*), imported from North America to meet the high European demand of cherry wood.

The major problems of cherry wood, which can reduce the processing yield and the quality of the final product, are the numerous knots (cherry is characterized by high pruning needs), the presence of green streaks (green vein) mostly in the European cherry, and the gum pockets, mainly in the American provenances.

The prizes of cherry timber can vary considerably due to the end-use (destination), wood quality (presence of defects, log dimension and form), but they are usually very high, reached (and sometimes exceeded) only by walnut.

In the following some examples of the prizes of roundwood, boards and veneer of both European and American cherry are reported. They are the result of personal interviews with Italian manufacturers.

Roundwood

| | |
|---|---|
| European: | from 300 to 550 Euro/m$^3$ (sawlogs) |
| | from 800 to 1000 Euro/m$^3$ (veneer logs) |
| American: | from 600 to 700 Euro/m$^3$ |

Boards

| | |
|---|---|
| European (green): | from 600 to 700 Euro/m$^3$ (3° selection) |
| | from 800 to 1000 Euro/m$^3$ (2° selection) |
| | from 1000 to 1100 Euro/m$^3$ (1° selection) |
| American (edge): | from 1300 to 1500 Euro/m$^3$ |

Veneer (0.5-0.6 mm thick): from 2 to 5 Euro/m$^2$

As regards the cherry wood production in Italy, data on the overall amount are difficult to find, but the importance of the species has been raised since the last decades thanks to the EEC Reg. 2080/92 and the following rural development programmes, which gave considerable incentives to afforestation of agricultural lands with tree species for wood production.

From 1994 to 2000, 104141 ha have been planted in Italy with public incentives and about 75% of them consisted of broadleaved species (Colletti 2001). A large part of these new cultivated areas were planted with wild cherry. We can mention here the example of Piemonte, one of the north Italian regions where the arboriculture had a large development and where the wild cherry occupied the 48% (2000 ha) of the land planted with valuable broadleaved species, against walnut (1200 ha), pedunculate oak (500 ha) and ash (450 ha) (Licini 2007). The material used in the plantations was mainly of seed origin.

So it becomes evident the importance of the studies aimed to select and to improve the planting material to be used in the production of high quality cherry wood and the research on the best cultural practices. Furthermore, the study of the wood properties of the improved planting materials is essential to complete the breeding programmes and it is surely useful when it becomes available to the arboriculturists by means also of the inscription of new cherry clones to the national Forest Clone Register.

**Wild cherry breeding programmes in Italy**

In the last years numerous breeding programmes have been developed for wild cherry in as many European countries, the greatest of which were in France and Germany (Kobliha 2002), and various studies on growth and morphological traits are available (Santi et al 1998, Muranty et al 1998, Cumel et al 2003, Martinsson 2001).

In Italy the genetic variability of wild cherry natural populations was investigated (Ducci and Proietti 1997). By means of electrophoretic analysis and some phenological traits, the size of the natural sucker groups of wild cherry was estimated and a minimum distance of 100 m between trees selected for improvement was assessed by Ducci and Santi (1997), in order to guarantee the genotype heterogeneity.

The selection of plus trees started during the decade of 1980 and followed mainly growth and tree architecture criteria. Clones were then tested in plantations established mainly by the Istituto Sperimentale per la Selvicoltura of Arezzo (CRA-SEL) and by the Dipartimento di Colture Arboree of Bologna University.

Minotta *et al.* (2000) in two clonal plantations situated in the Northern Apennine Mountains found out a general higher growth rate of the clones (except for one) in respect to the seedlings used as witnesses and a significant influence of the genotype to determine tree diameter and tree height. Ducci *et al* (2006) reported the estimation of broad sense heritability of growth traits in 4 cherry clone plantations in central Italy and their correlation with architecture traits (stem form; branch size, number and angle). The main results were:

- the broad sense heritability can be very high for traits useful to selection;
- the broad sense heritability is higher when environment and soil conditions are homogeneous and clones can express their real potential;
- the *genotype x environment* interaction was generally low;
- the correlations between growth and architecture traits were generally low.

(for major details see Ducci *et* al 1990 and Ducci *et al* 2006).

Further investigations worked on the cherry clone resistance to *Phytophtora* sp., adjusting early screening tests for resistance selection (Barzanti *et al* 2004).

**The variability of wood quality of wild cherry clones: the Italian research**

One of the first field tests to investigate the variability of wood quality of cherry clones was carried out in the plantation located in the Northern Apennine Mountains, in order to examine the wound cicatrisation after pruning (Baldini *et al* 1997). A quick and effective wound closure is very important to protect the tree from pathogen attacks and, therefore, to keep the good properties of the timber.

The trail consisted of 4 clones (2 selected by CRA-SEL and 2 by the Bologna University) and some seedlings. The trees were pruned in February and the wound area covered by new wood tissues was measured in the following months.

The figure 1 shows the differences of percentage of covered wound area by clones and seedlings. As results of the analysis of variance, significant differences were noticed between clones, so it can be state that the genotype can have an important role to determine the cicatrisation process.

A further investigation on wood characterization of cherry clones previously selected for timber production is ongoing in two trials established by CRA – ISS. The sites description is reported in table 2.

The plantation in Marani was established in 1986; the plantlets were planted at a 3 x 3 m spacing and systematically thinned in 1995. In Forestello, because of the nitrogen and phosphorus poor soil, the cherry clones were planted mixed with Italian alder (*Alnus cordata* Lois.), in order to facilitate improvement in nutrition, thanks to the nitrogen-fixing ability of alder.

At the first site, 6 cherry clones, 8 ramets per clone, were sampled in spring 2006; at the Forestello site 2 of the 6 clones were not available, so only 4 clones, 4-7 ramets, and 3 witness trees (seed origin) were sampled in the following year (spring 2007).

In the field, the main dendrometric quantities were measured (diameter at breast high and every 2 m to calculate the trunk volume, total tree height). After felling, 1 m long log was cut and processed in the laboratory, where the following wood properties were determined:

- heartwood percentage area
- basic density
- maximum shrinkage
- shape factor (radial and tangential shrinkage ratio)
- wood hardness
- bending, compression and shear strength.

Small (transversal section of 20x20 mm) and clear (free of defects) specimens were used in the tests, according to ISO Standards. They were cut from the four radial planks of the log, both from heartwood and sapwood in order to investigate the intra-tree variability as well. A total of 990 specimens were collected for the physical properties determinations and 530 specimens for the mechanical tests.

Finally, microdensitometric measurements were carried out on thin radial sections and observations of the presence of the green vein were effected on each log.

Some results from the first trail (Marani) were presented during the workshop on wild cherry held in Italy the last year (Nocetti and Brunetti 2007).

Briefly, it was found out a significant clone effect for all the studied traits (growth and wood traits) from the analysis of variance (fig. 2), while the ramets inside each clone were quite homogeneous. Currently, the investigation is becoming deeper thanks to the further analysis on the second site (Forestello), which will allows us to compare the same clones in two different locations.

High presence of green vein was noticed in the samples of Marani site, where clear differences between clones were also observed. On the contrary, in Forestello site the presence of green vein was not so frequent in the trees. It leads to presume an apparent genotype effect on the incidence of the green vein in the wood, but also the environmental conditions seem to play a very important role. Obviously all these speculations need further specific investigations.

Finally we can cite in a few words the study of Signorini (2006), that , in the framework of his PhD Thesis, analysed the colour of the wood in the same trees at Marani site. Some results of his work are published in Ducci et al (2006) where they reported a greater genetic influence on sapwood colour than in heartwood, probably because of the stronger environmental effect on the heartwood formation.

**Conclusions**

The valuable broadleaved species are so called because of the "valuable timber" that they can produce; therefore, it is essential to understand what valuable timber is, so that the proper way to produce it can be found out.

Studies on the genetic control of the wood traits and the correlation between them and the growth and architecture characteristics of the tree can be very helpful to breeders.

The rich Italian experience on genetic variability and breeding programmes of broadleaved species allows further investigations on the wood of the selected genotypes.

Finally, breeding programmes are extremely useful and they can provide improved genotype to wood production, but it must be emphasized again the importance to combine the improved genotype with the correct silviculture treatments.

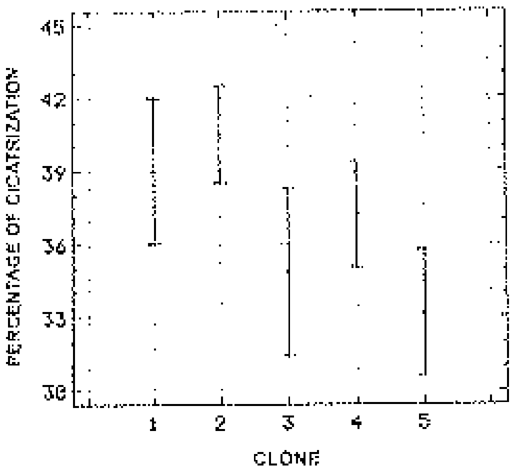


Figure 1 – Mean values of percentage of covered wound area and confidence intervals (95%) by clone (2-5) and seedlings (1).

| Site characteristic | Forestello | Marani |
|---|---|---|
| Latitude | 43° 34' N | 44° 27' N |
| Longitude | 11° 29' E | 12° 12' E |
| Altitude | 250 m a.s.l. | 5 m a.s.l. |
| Soil | loam (44% silt, 30% clay) | silt loam (64% silt, 27% clay) |
| Mean annual Temperature | 14 °C | 13 °C |
| Annual precipitations | 870 mm | 650 mm |

Table 2 -- Description of Forestello and Marani sites.

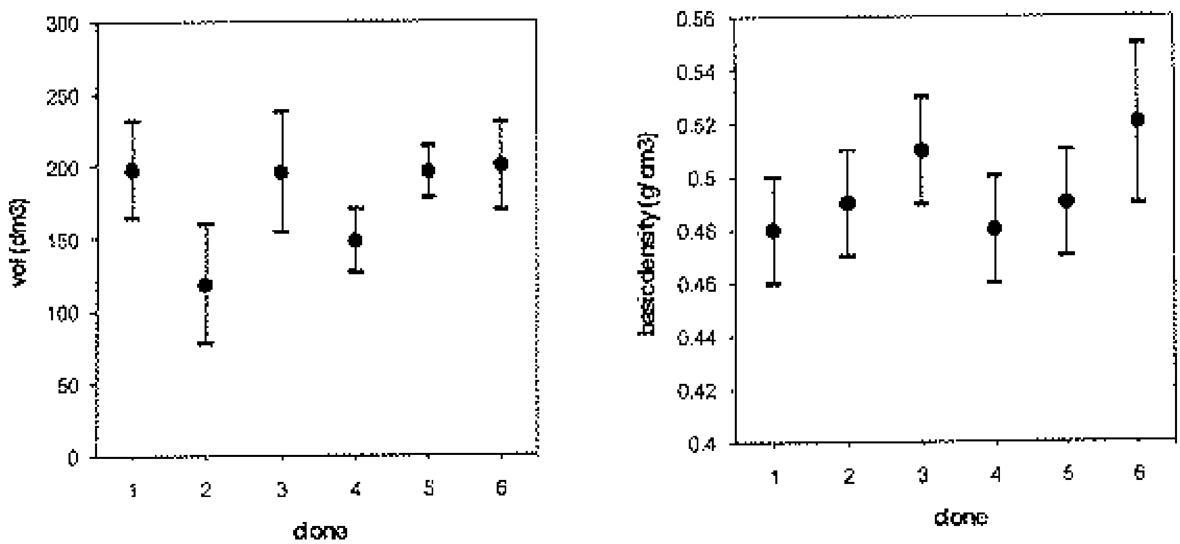


Figure 2 -- Mean values and standard deviation of trunk volume and basic wood density by clone (Marani site).

## Small-Diameter Hardwood Utilization with Emphasis on Higher Value Products

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### Abstract

A significant portion of our hardwood forests are eligible for timber removal treatments that will yield small-diameter timber. Between 1995 and 1999, roundwood receipts by manufacturers of composite panels, primarily the oriented strandboard (OSB) industry, increased more than for any other primary wood processing sector in the southern United States. OSB manufacturing trends are important because OSB utilizes both softwoods and lower density hardwoods in diameters ranging from 24 inches down to 4 inches. The financial incentive for conducting timber stand improvement and uneven-aged management should increase if smaller diameter logs can be profitably processed into hardwood lumber for use in higher value products such as kitchen cabinets, mouldings, and furniture. But, because smaller diameter trees often are younger trees with a relatively large juvenile wood zone, lumber cut from these trees usually is of lower grade and value. The current study looks at the volume recoveries and lumber-grade distributions for both the green and dried lumber from black cherry, red oak, and sugar maple. In the initial test on cherry, problems associated with drying lumber produced from small-diameter logs were evident as only half of the boards in the two highest quality (grade) classifications before drying remained high-quality boards after drying.

### The Hardwood Resource: Today and Tomorrow

In the hardwood forests of the eastern United States, the small diameter problem is not a problem of fire risk associated with biomass buildup as it is in the coniferous forests in the Rocky Mountain and West Coast regions. Rather, it is a problem of markets -- markets are needed to promote sound forest management so that healthy and productive forests become more abundant in this region. Careful removal of small-diameter timber can improve the structure, vitality, quality, appearance, and disease resistance of the residual stand without degrading other ecosystem functions.

The positive effects of thinning and timber stand improvement on the quality of the eastern hardwood resource become evident when one contrasts tree-grade distributions measured on USDA Forest Service research plots with those measured in comparable forest inventory plots. For example, of the white oak trees 12 inches and larger sampled in Kentucky-wide inventory plots in 1998, only 40 percent of the trees were grades 1 and 2. By contrast, more than 72 percent of the white oaks on Forest Service research plots in Kentucky were grades 1 and 2. Similarly, for cherry trees 12 inches and larger sampled in West Virginia-wide inventory plots in 1999, only 41 percent were tree grades 1 and 2 while 80 percent of the trees located on Forest Service research plots were grades 1 and 2.[1]

A significant portion of our hardwood forests are eligible for timber-removal treatments that will yield small-diameter timber. It is estimated that 10 percent of the hardwood acreage in five southeastern states is in need of thinning and timber stand improvement. This acreage could be a significant source of small-diameter hardwood roundwood (Bumgardner et al. 2001). An additional 34 percent of the hardwood acreage in these states may yield small-diameter timber as a secondary product from stand harvesting, regeneration, and salvage operations (Bumgardner et al. 2001).

**Current Small-Diameter Hardwood Markets**

Sawlogs and pulpwood were the two principal markets for hardwood and softwood roundwood in the South in 1999. Each of these sectors accounted for nearly 43 percent of the 13-state region's total roundwood manufacturing inputs (Bentley 2003). Thirty-six percent of the pulpwood roundwood consumed in 1999 was hardwood roundwood but only 27 percent of the sawlog roundwood consumed was hardwood. Overall, hardwoods accounted for 29 percent of industrial roundwood production in the South.

A comparison of industrial roundwood production statistics in the South from 1995 to 1999 revealed the following production results: 1) hardwood sawlogs increased 5 percent (on a volume basis); 2) hardwood pulpwood decreased by 11 percent; 3) hardwood veneer logs increased by 10 percent; and 4) hardwood roundwood for use in composite panels increased by 38 percent (Bentley 2003). Roundwood receipts by manufacturers of composite panels, primarily the oriented strandboard (OSB) industry, increased more than for any other primary wood processing sector during this period (Bentley 2003). Three new panel manufacturing facilities went into production betwen 1995 and 1999 and two additional plants are being constructed in Oklahoma and Arkansas. In 1999,

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[1] These results are from a not yet completed study in which the quality of timber located on multiple study sites is being reevaluated and compared to inventory data compiled by the Forest Service's Forest Inventory and Analysis surveys. The results will be published in a final report to the National Hardwood Lumber Association which funded this study. The authors of this report are J. Baumgras, G. Miller, and C. Gottschalk of the Northeastern Research Station.

nearly 10 percent of consumption of industrial hardwood roundwood in the United States was used in OSB production (Bumgardner et al. 2001).

OSB manufacturing trends are important because OSB utilizes both softwoods and lower density hardwoods in diameters ranging from 24 inches down to 4 inches. In fact, maximum size limitations are more critical than are those for minimum size. Lower grade stems also are efficiently utilized in OSB manufacturing except that log sweep, crook, forking, and limbs are limited. Yellow-poplar, hard and soft maple, basswood, beech, sweetgum, birch, aspen, white pine, and southern yellow pine stems are commonly used in OSB production.

Local demand for OSB roundwood should provide considerable financial incentive for the forest landowner to extract smaller diameter material from his or her forests compared to that provided by local demand for pulpwood. We estimated that the average delivered hardwood pulpwood price in the South in 1993 was nearly $14 per ton. This compares to an average delivered price of nearly $22 per ton for OSB hardwood pulpwood.

The incentive for conducting stand improvement thinnings and sound uneven-aged management would be even greater if smaller diameter logs could be profitably processed into hardwood lumber for use in higher value products such as kitchen cabinets, mouldings, and furniture. The average delivered price for hardwood sawlogs is at least 25 percent higher than that for hardwood roundwood for OSB. However, because smaller diameter trees often are younger trees with a relatively large juvenile wood zone, lumber cut from them usually is of lower grade and value. Thus, it would not be profitable to manufacture lumber from smaller diameter logs so long as standard practices and equipment are used. The expected lumber volume and value from a grade 3 red oak trees having 10, 13, and 20-inch d.b.h. respectively, are 31 board feet (bf) and $18, 67 bf and $39, and 339 bf and $208! Because log size has such a dramatic impact on the volume and value of lumber recovered in sawing, the typical hardwood sawmill stipulates that the small end log diameter must be at least 12 inches. This number differs slightly depending on log species, mill equipment, log quality, and current market conditions.

**Studies in Small-Diameter Hardwood Utilization**

In an early study of lumber grade yields from small-diameter logs (8 to 11 inches diameter at the small end of the log), 20 red oak logs removed in thinnings produced 30 percent grade 1 Common and Better lumber (higher grade) with a 25 percent overrun based on the International ¼-inch log scale (Emanuel 1983). Twenty small-diameter hard maple logs produced 19 percent grade 1 Common and Better lumber with a 12 percent overrun. Twenty small-diameter yellow-poplar logs produced only 15 percent grade 1 Common and Better lumber with a 20 percent overrun (Emanuel 1983).

In a more recent study of small-diameter log yield, 134 small-diameter logs of several species and a range of sizes produced 28 percent overrun (International ¼-inch scale) and a lumber recovery factor of 7.2 (Hamner et al. 2002). The average overrun for the three species studied by Emanual (1983) was 19 percent. It is the lumber-grade distributions that are of particular concern. The lumber-grade distributions for larger diameter grade 3 logs typically are 30 to 40 percent grade 1 Common and Better (Hanks et al. 1980). Since higher grades of lumber command a considerably higher price than lower grades in most markets and for most species, the production of a high proportion of lower grade boards makes it difficult to process small-diameter logs profitably.

The two small-diameter log studies mentioned were concerned only with yields of green (i.e., not yet dried) lumber. As it loses moisture, lumber can develop a variety of severe defects. For example, wood splits, warpage, and holes frequently result from a combination of drying forces across different zones within a piece of wood. If a board is cut from a peripheral location on a larger log, the annual growth rings will have less curvature than those from a board cut from a peripheral location on a smaller diameter log. A board that has more growth-ring curvature will have a higher likelihood of warping, all other things being equal, than will the board that has less curvature. In Figure 1, the board represented by the right-most rectangle is less likely to warp than is the board represented by the rectangle that lies within the inner (shaded) region of the log. The inner region of the larger log has many wood properties in common with the peripheral region of a small-diameter log, so the potential product recovery from small-diameter logs/trees should be based on the volume and grade recovery of dry lumber.

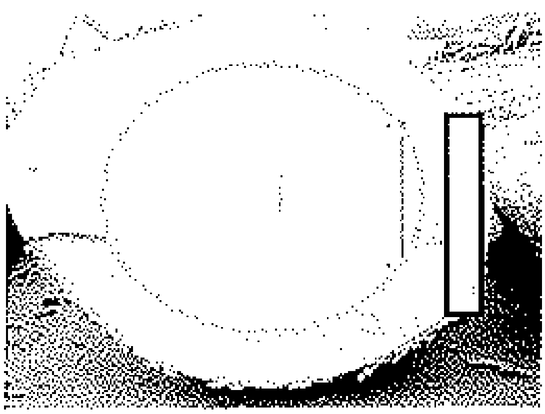

**Figure 1.** Log end showing the wood zone where wood quality and strength properties are diminished due to cellular changes and proximity to the pith (the two rectangles represent board locations). A board whose grain has less curvature is less likely to warp than a board with greater grain curvature.

## A New, More Comprehensive Study

Our current study looks at the volume recoveries and lumber-grade distributions for both the green and dried lumber from black cherry, northern red oak, and sugar maple. Because one of the greatest challenges associated with processing small-diameter logs is related to lumber degrade that results in value loss during drying, this study examines the effect of conventional and alternative lumber drying schedules on lumber yield and value.

The lumber-grade distributions for the cherry that we obtained from small-diameter logs and then dried using a conventional, T8B4 cherry drying schedule (for 1-inch-thick lumber) met our expectations based on a comparison with studies conducted during the 1970's (Hanks et al. 1980). Table 12 in Hanks et al. (1980) reveals that yields from sawing thirty-four, 8-inch diameter, and fifty-two 9-inch diameter grade 3 cherry logs were, respectively, 2.3 and 3.2 percent Selects grade lumber and 4.2 and 10.1 percent 1 Common grade lumber. In our initial control study with cherry we recovered 2.2 percent Selects grade and 4.5 percent grade 1 Common lumber. The average log diameter for our 37 study logs was 9 inches (range: 8 to 12 inches). Volume recovery was lower than expected with a 7 percent underrun compared to Hanks et al.'s overrun of 8.5 percent for 9-inch-diameter logs. The fact that 13 of the 37 logs in our sample were not of sufficient form and quality to make the lowest Forest Service sawlog grade, grade 3, is worth noting. For cherry, the Hanks et al. (1980) results are the only prior study results available for comparison. Although their lumber grade distributions were not based on direct measurements of dry lumber, adjustment factors were applied to grade recoveries for green lumber, so the percentages presented here are comparable.

The initial red oak and sugar maple lumber samples sawn from small-diameter logs were dried using standard schedules for those species (T4D2 and T8C3), and the quality of the dry lumber exceeds that for the cherry sample. Data collection for this study is such that we can test many numerous potential relationships between log characteristics, sawing and drying approaches, and value recovery for dry lumber. The log data sets include age, grade, small- and large-end diameters, length, position in tree, crook and sweep, and position in log from which each board was sawn. The data sets for green and dry lumber include grade, defect identification and marking, slope of grain, warpage measurement, and cutting sizes and locations.

## Summary

Facing periodic log shortages that may become more severe in coming years due to continued forest fragmentation, many sawmill owners are beginning to consider small-diameter log processing. Small "sawlogs" that may be allocated to lumber mills often contain a relatively high proportion of juvenile wood that usually is of lower intrinsic wood quality. Optimizing the potential quality of lumber sawn from small-diameter trees and the upper bole sections of larger diameter trees has become an important concern. In studies of lumber recovery from small-diameter hardwood logs, the volume of green lumber recovered has been acceptable. The quality (grade) of the lumber recovered from small-diameter hardwood logs is the larger issue, particularly with respect to the grade yield of dry lumber. Initial study results indicate that the yield of grade 1 Common and Better (dry) lumber from small-diameter cherry logs is less than 10 percent. Alternate drying schedules designed to reduce warp and other drying defects should increase grade yields.

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# Factors Affecting the Quality of Hardwood Timber and Logs for Face Veneer

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## Introduction

Hardwood veneer logs command a premium price in comparison to sawlogs and other fiber products of the forest. As an example, Hoover and Gann[1] report that the prices paid for the highest quality delivered white oak sawlogs in Indiana averaged $634 per thousand board feet, Doyle Scale in 2002. In the same report, several diameter categories and two quality classifications are used to report delivered veneer log prices. For the lower quality classification and the smallest DIB class (13-14 inches), the price for white oak veneer logs was $770 per MBF but increasing to nearly $2940 per MBF for 28 inch DIB logs of the highest quality. Thus, it usually makes good economic sense to market high-quality logs of the appropriate species to the face veneer industry rather then processing them for the green wholesale lumber market.

In addition to the increased economic value, the use of hardwood timber for veneer has other positive attributes. Processing a log into veneer ranging from 1/36 to 1/50 inch in thickness greatly extends the resource in comparison to cutting standard 4/4 lumber, which is somewhat over 1 inch thick. Veneering also allows for the production of matched grain patterns, inlays, and other artistic designs. Veneer can now be wrapped around profiles made of reconstituted wood, thus reducing the need for long, thick clear moulding blanks. It can also be formed over machined panels of reconstituted products for raised panels in cabinet doors.

Veneering is a fascinating industry, and successful marketing of veneer quality logs or trees is dependent upon the seller knowing what constitutes veneer quality logs and an understanding of the marketing process. Unfortunately, most landowners and many individuals who market timber are not aware of the basic requirements for trees or logs to be considered "face veneer quality." In some instances, sellers do not understand why some logs or trees are not acceptable, others are worth little more than good sawlogs, and still others command a substantial premium. Buyers will likely not spend much time visiting tree or log offerings if they detect the seller does not understand the quality levels needed and the material is over or misrepresented due to the sellers lack of knowledge. This paper will provide insight into what constitutes veneer log quality.

## Methods

The hardwood face veneer industry is composed of only 33 slicing operations in North America. Within this industry, there are no scientific studies and very few current publications that have attempted to define log and veneer quality from an appearance aspect. These companies purchase the quality of logs as dictated by their customers, cut them into flitches (log halves or quarters) and slice them into fancy face veneers (Figs. 1, 2A, B). Rotary cut veneer constitutes a different industry, for the most part.

[1] Hoover, W.L. and R.W. Gann. 2002. 2002 Indiana forest products price report and trend analysis. FNR-177-W, 19 pages.

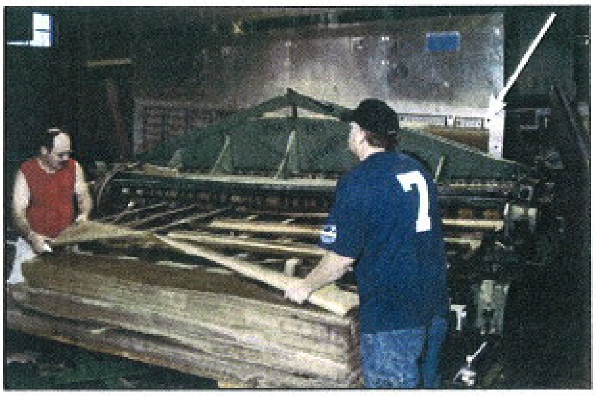
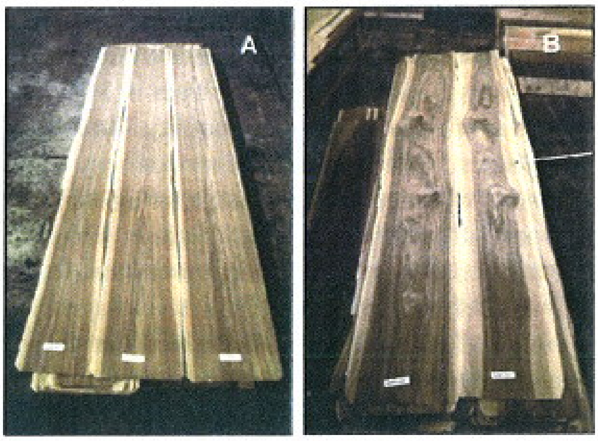


*Figure 1. Veneer slicing operation showing the flitch or log half (back and right) being moved up and down against a stationary knife and the individual veneer sheets being stacked in the order that they are sliced.*




*Figures 2A, B. During processing for the domestic market, three sample sheets are taken from each flitch. These sample sheets are shown to potential buyers. Considering the left flitch, the sheet on the left is from the outside of the log and the one on the right is from near the heart. Note the absence of defects, excellent color and uniformity, and cathedral patterns in the first two sheets on the left of this high quality flitch. A much lower quality flitch with an irregular color, knots, and excessive sapwood is shown on the right. Each flitch is bar coded as to origin, log buyer, square footage, grade and value.*

The Department of Forestry and Natural Resources at Purdue University has held numerous workshops on the subject and developed written materials on log quality. In these workshops the head log buyer for different companies will show, by using logs, what characteristics are important and the range in quality which can be accepted. Veneer sample sheets are used to demonstrate how the various log characteristics affect the appearance and value of the resulting veneer. Quality standards and species desirability vary among companies and change over time. This report is based on information gained from these workshops.

## Basic Requirements for All Species

There are certain basic requirements that any tree or log intended for the face veneer industry must meet. In addition, there are specific features that are unique to each species. Bark surface irregularities such as overgrown branch stubs, insect damage, old mechanical damage, etc. will likely disqualify the log as potential veneer. It is generally assumed that no surface indicators of interior defects are present in a quality veneer tree or log. It has four clear faces.

Veneer logs or the trees from which the logs are produced should be straight and well rounded. Bow and crook in a log creates an aesthetic problem by causing the cathedral pattern in flat sliced veneer to run in and out of the sheet. Tension wood is frequently present in leaning trees, and buckle can occur when the veneer is dried. Logs which are not well rounded or have an off-center pith also result in veneer with less than a desirable grain pattern and are also likely to result in veneer buckle (Fig. 3).

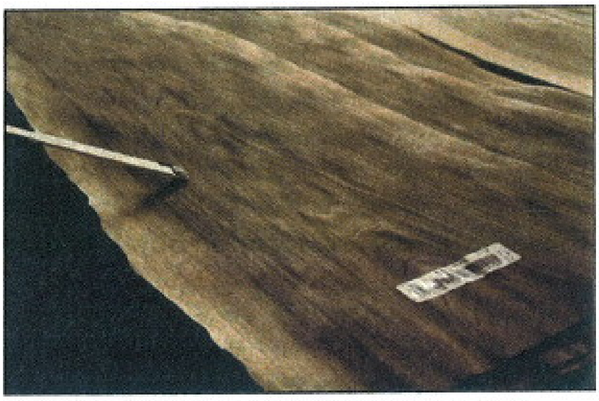


*Figure 3. Buckle or irregular surface in walnut veneer. Note the irregular appearance of the tag.*

Ideally, growth rates (and thus ring width) need to be uniform across the entire cross section of the log. Thinning to encourage faster growth of potential veneer trees is not desirable. Growth rates of six to nine rings per inch are usually acceptable. Fast growth or very slow growth rates are not preferred.

Veneer quality trees should be healthy, well-formed trees on good well-drained timber sites. A past history of grazing and or fire will reduce the quality and value of any potential veneer trees.

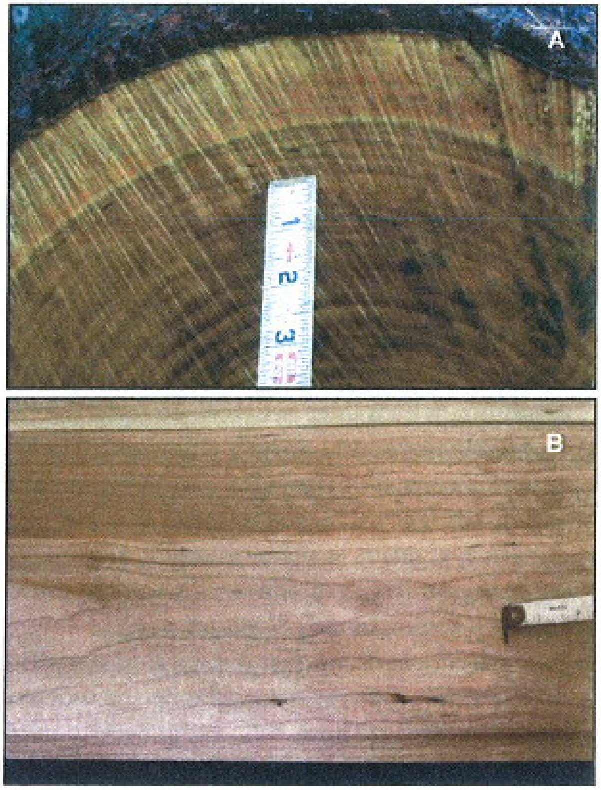
Most hardwood species grow over a wide geographic range. As such, climatic conditions, soil types, elevations, insect and disease potential, and other factors vary. Within the geographic range of each species, there are certain specific areas where buyers feel the highest quality trees generally originate. With the exception of pecan, most veneer quality timber is cut in the upper Midwest, lake states and northeast section of the country. Buyers will indicate that high-quality trees can come from other regions as well but the probability is much reduced.

Cherry is currently one of the most valuable hardwood veneer species and an excellent example of the importance of geographic location. Figure 4 shows two 19 inch DIB by 10 foot logs each containing 141 board feet Doyle Scale. The log on the left is from Indiana with an estimated value of $300; the one on the right is from Pennsylvania and valued at about $1200. The Indiana log has irregular, darker reddish color and numerous gum spots. The Pennsylvania log has a lighter pink color and is much less prone to gum spots. On the other hand, walnut from Indiana and Iowa would likely command a premium over that from other states, and hard maple from Michigan and the Northeast would be preferred.

*Figure 4. Geographic origin can be very important in determining veneer log value. The cherry log on the left has an estimated value of about $300 while the one on the right is valued at $1200. Both are the same diameter and length.*

## Cherry

Gum in cherry (Figs. 5A, B) is probably the most serious defect affecting veneer quality. Gum not only disfigures the veneer, but clear finishes tend not to bridge over the spots. In addition to small spots, gum can be found in large patches, probably as a result of wounding,



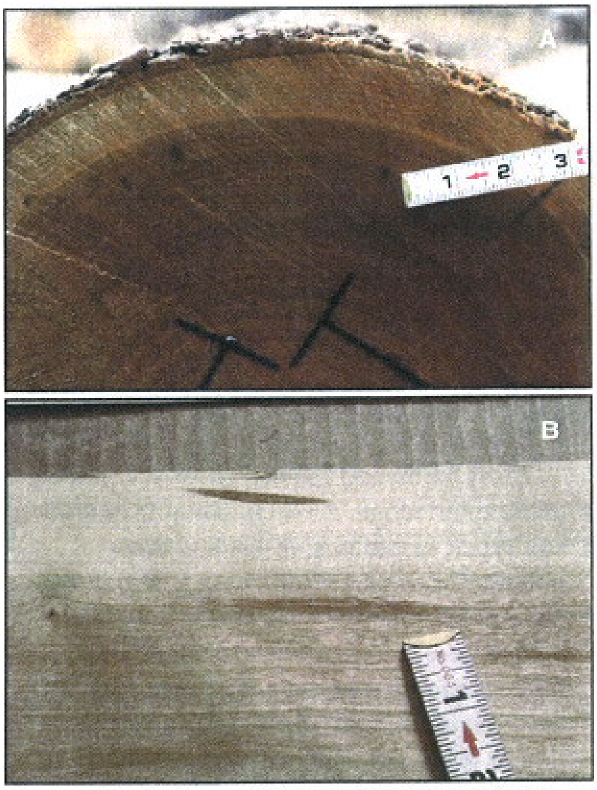

*Figures 5A, B. The small dark spots on the end of this cherry log are gum spots. They disfigure the otherwise clear veneer shown to the right.*

or even in a ring completely circling the stem. The presence of gum cannot be detected in standing trees unless a surface residue happens to be present. Buyers prefer to purchase cherry timber in those parts of the country where gum spots are least likely to be found or at least fewer in number. These include the higher elevations in Pennsylvania and parts of New York and West Virginia. Cherry grown in other parts of the country almost always has some gum deposits present.

Most gum deposits are caused by at least two different groups of insects. The most common insect is the peach bark beetle. These beetles occur throughout the range of cherry and sometimes actually kill relatively large trees. The beetle can be found in the gum exuded from the trees. The beetles attack the cambium layer, and the gum is formed in response to the insect. Unfortunately, it appears that peach bark beetles may build up in large numbers in tree tops after a timber harvest. The beetles then emerge and attack the residual crop trees, causing permanent gum spots in the main tree bole. Therefore, it would appear that cherry veneer which is relatively free of gum spots from peach bark beetles would come from undisturbed stands which also have had little natural mortality or damage.

Cambium miners can also cause gum deposits in cherry. By carving its galleries, the cambium miner destroys a portion of the cambium, which later becomes covered over by healthy cambium growth and wood. These galleries consist of damaged parenchyma cells and insect feces. The cell damage can, but does not always, result in the production of gum. The parenchyma flecks or damaged parenchyma cells are seldom a defect in themselves. Parenchyma cells are just one type of several different cell types which make up the wood of hardwood trees. These cells are generally used for food storage and are relatively thin-walled compared to wood fibers.

"Tear drops" or brown oval to round spots (Figs. 6A, B) can also be found in the ends of cut cherry logs. These tear drops cause a brownish streak in the veneer itself and are objectionable.



*Figures 6A, B. Cherry log showing dark spots or "Tear Drop" which cause a brown streak in the veneer sheet.*

A light reddish brown heartwood color is preferred in cherry. A dark red color, variable color, or a greenish cast which can develop at the heartwood-sapwood interface and wide sapwood are objectionable.

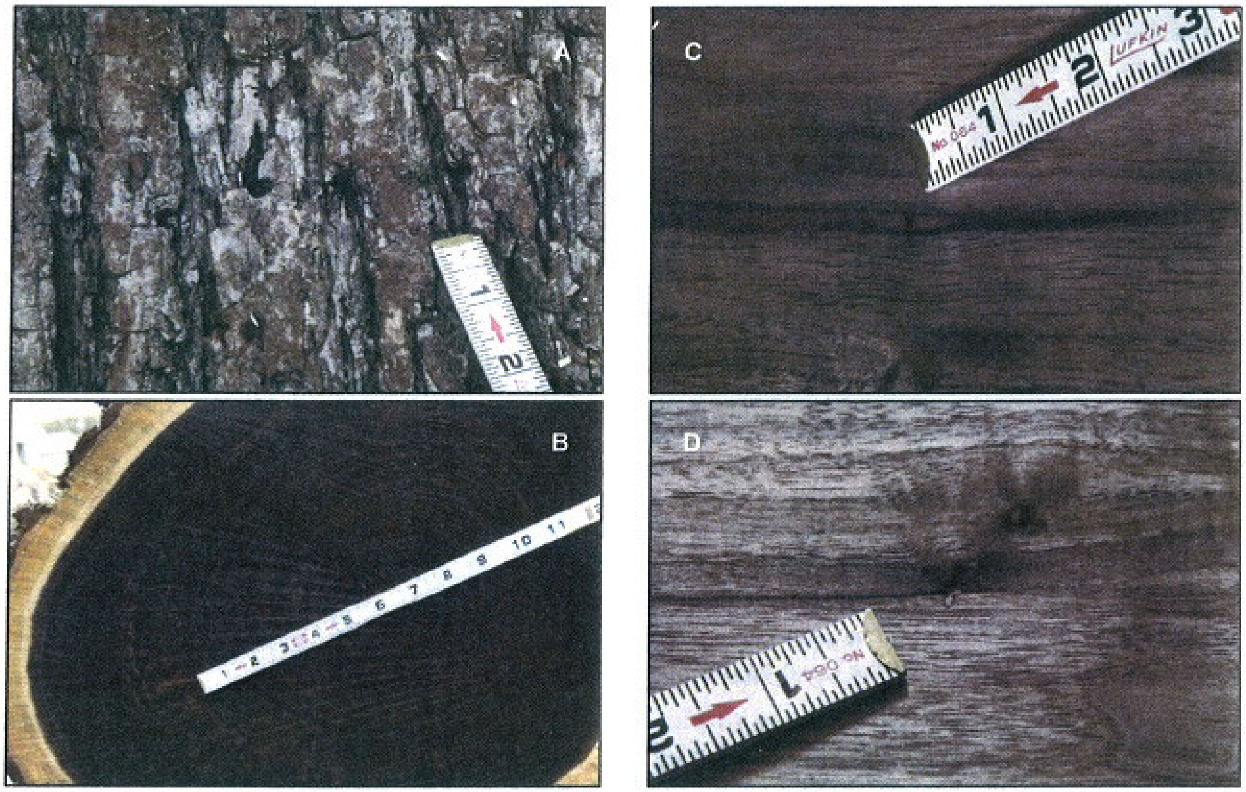
### Walnut

Black walnut was the premier domestic North American species since the beginning of the sliced veneer industry. Due to increased costs, over cutting, and consumer preference, its popularity declined in the 1980's. Now, it is once again in good demand, and the availability of logs is also good.

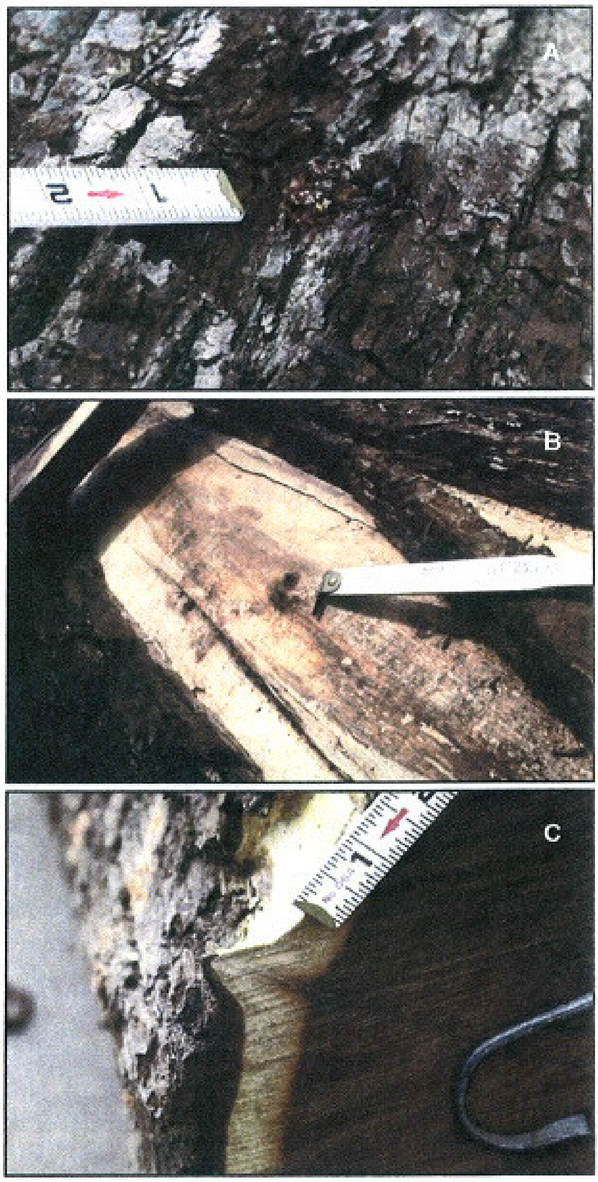
Total color as well as uniformity of color in walnut is an important factor. The best colored walnut when first cut is light greenish or mint color. As the wood is exposed to the air, it turns a gray or mousy brown color (Figs. 2A, B), which is considered ideal. Unfortunately, the color can vary, or it can lack uniformity. Muddy walnut, that which is dark or splotchy, is objectionable. The color of walnut can also be affected by manufacturing variables such as cooking schedules and processing time before drying.

Bird peck, also called worm by the veneer industry, is an important defect in walnut (Figs. 7A, B, C, D). Yellow-bellied sapsuckers probably cause most of the bird peck. Sapsuckers over winter in Indiana but nest further north. It is generally believed that the bird pecks a hole to cause the flow of sap. The peck mark penetrates the bark and cambium. It sometimes penetrates the wood but not deeply. The peck marks are often in circles going around the tree. Insects are attracted to the sap, and the bird then feeds on them and perhaps the sap as well. A small hole plus stain or flagging can result in the veneer.

Pin knots (Figs. 8A, B, C, D, E) like bird peck can be hard to recognize in standing walnut trees, especially when only a few are present. These defects are the result of suppressed dormant buds which persist for many years as a bud trace or pin knot. As the name implies, the buds may not actually break through the bark, so in some instances they cannot be easily detected. However, sometimes, due to a stimulus such as thinning and light, the bud may sprout. The sprout may develop into a small limb that often dies, but normally the bud trace continues to form. Pin knots are best observed on the ends of the log after the tree is cut or where the bark has peeled loose, and they appear as sharp spikes. On flat-sliced veneer, they appear as pin knots, but on quartered surfaces they appear as a streak or "spike" across the sheet of veneer.




*Figures 7A, B, C, D. Bird peck or worm is a serious problem in walnut. A shows peck marks on the bark and B shows the damage confined to certain rings in the end of a log. C shows a "worm hole," or more likely the slight indentation of the peck mark into the wood and associated discoloration, and finally, D shows two peck marks with included bark.*





*Figures 8A, B, C, D, E. Pin knots in black walnut are another troublesome defect. A shows a pin knot or cluster of knots in the bark. B shows the same type of defect with the bark removed. C shows a pin knot on the end of a log. D shows a pin knot on a flat slice of veneer, and E shows the flash or grain deviation for a pin knot on a quartered surface.*

Growth rate is important in walnut. The industry uses the word "texture" to define growth rate. Soft texture refers to a slow growth rate while hard texture refers to a fast growth rate. Many buyers will find eight to nine rings per inch of diameter in walnut the most desirable.

Fast growth trees also tend to have a wide sapwood zone (Fig. 9). The sapwood is the light colored wood to the outside of the darker heartwood. Sapwood is usually discarded in high quality walnut veneer. Deeply furrowed bark which is not patchy tends to be faster growth and

*Figure 9. Fast growth trees tend to have a wide sapwood (left); slow growth trees tend to have a narrow sapwood (right).*

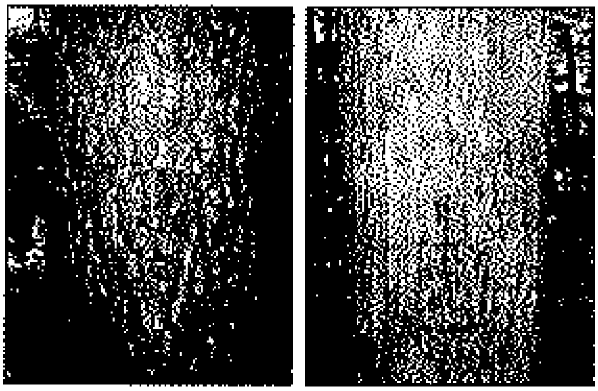


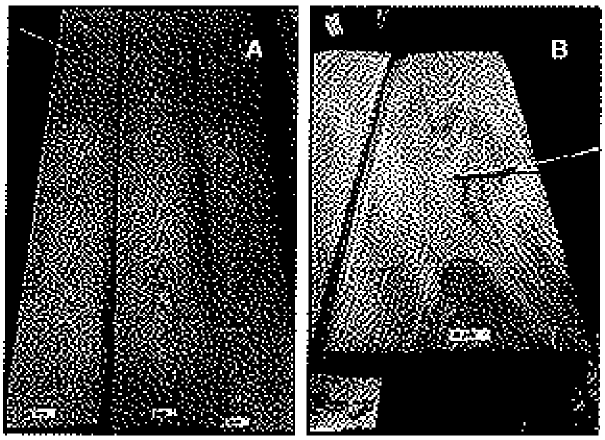
*Figure 10. Bark of slow growth (left) and moderate growth (right) walnut trees.*

have a wide ring of sapwood. Figure 10 shows the bark on fast growth and slow growth trees.

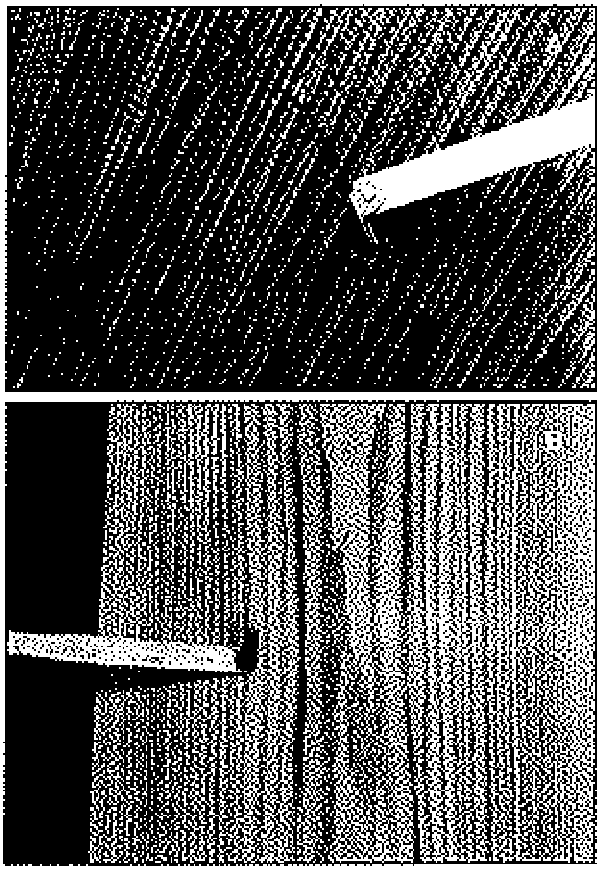
## White Oak

White oak is another very important veneer species, particularly in the export market.

True white oak, especially trees with large patches of flaky bark in the upper portions, or "forked leaf" white oak, are the most desirable in the white oak group. Chinkapin oak sometimes is used, but the resulting veneer has a greenish to brownish cast. Bur oak is also used, but careful selection is required to avoid its more common dark brown color and possible "scalloped" appearance of the growth rings which can be seen on the ends of the logs. The scallops result in shiny spots on the veneer sheets.



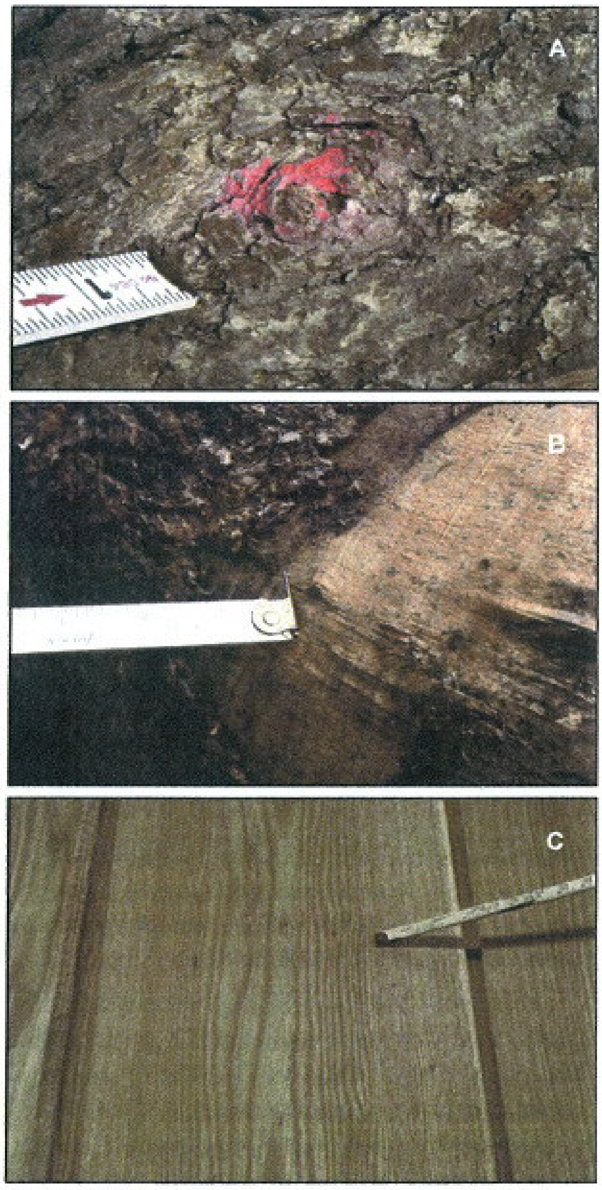

*Figures 11A, B. Note the perfect light color and centered uniform cathedral of the white oak flitch on the left compared to the coarse, irregular sheet on the right.*



*Figures 12A, B. Mineral stain following a growth ring on the end of a white oak log and appearance of mineral stain in white oak veneer.*

Color in white oak, like all veneer species, is critical. Current markets prefer a very light, uniform-colored white oak. Contrast in color and dark colors are objectionable (Figs. 11A, B). Obviously, color cannot be judged in standing trees. Buyers do, however, develop preferences for certain geographical areas and site characteristics because their past cutting experience has taught them that those areas produce the desired color and quality of veneer. Also, very old and slow-growth white oak trees tend to be pink in the center and brown to the outside. Mineral streaks are also a common defect (Figs. 12A, B).

Epicormic branching or sprouting from latent buds is a common defect in white oak (Figs. 13A, B, C). Several buds may form a cluster. The resulting veneer will have a small pin knot or cluster of pin knots.



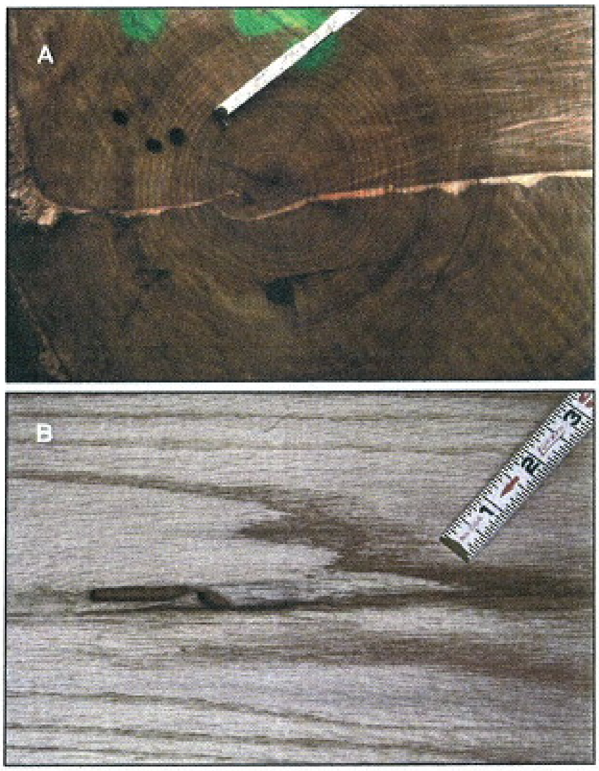

*Figures 13A, B. C. Pin knots in the bark and log surface of a white oak log as well as in the oak veneer.*

Stump worms and the surrounding dark flagging or mineral stain is associated with white oak grown in areas which are poorly drained or have been pastured. This defect is generally concentrated in the bottom two feet of the butt log, and it is often impossible to detect until cutting occurs (Fig. 14).

A number of different species of borers can affect white oak. White oak borers attack trees less than about eight inches in diameter (Fig. 15).

*Figure 14. Stump worms and associated stain in white oak.*

Thus, they are generally not detectable in veneer-sized trees, nor do they damage the outer more valuable portion of the tree. Other borer species also attack white oak, but normally the damage is restricted to declining trees. Bore damage is difficult to see in standing trees. Consequently, when it is found, buyers will assume that more damage is present than what can be seen and will severely degrade the tree.




*Figures 15A, B. Bore damage in the butt of white oak. This log also exhibits slow and fast growth rate, ring shake, and very poor color. Bore damage in red oak veneer is also shown (B).*

Some large white oak trees will have a "bulge" (Fig. 16) near the base of the tree that resembles an old time soda bottle. This is not considered a defect for veneer logs.

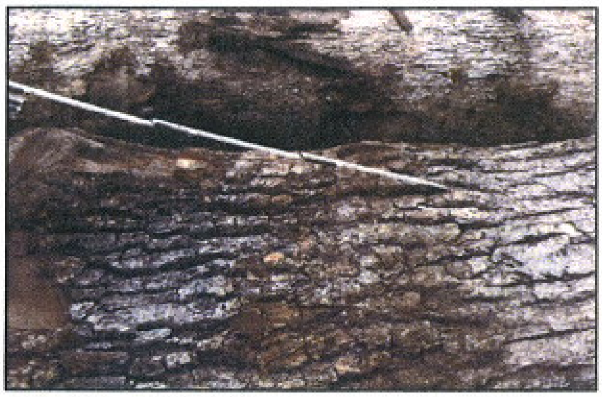


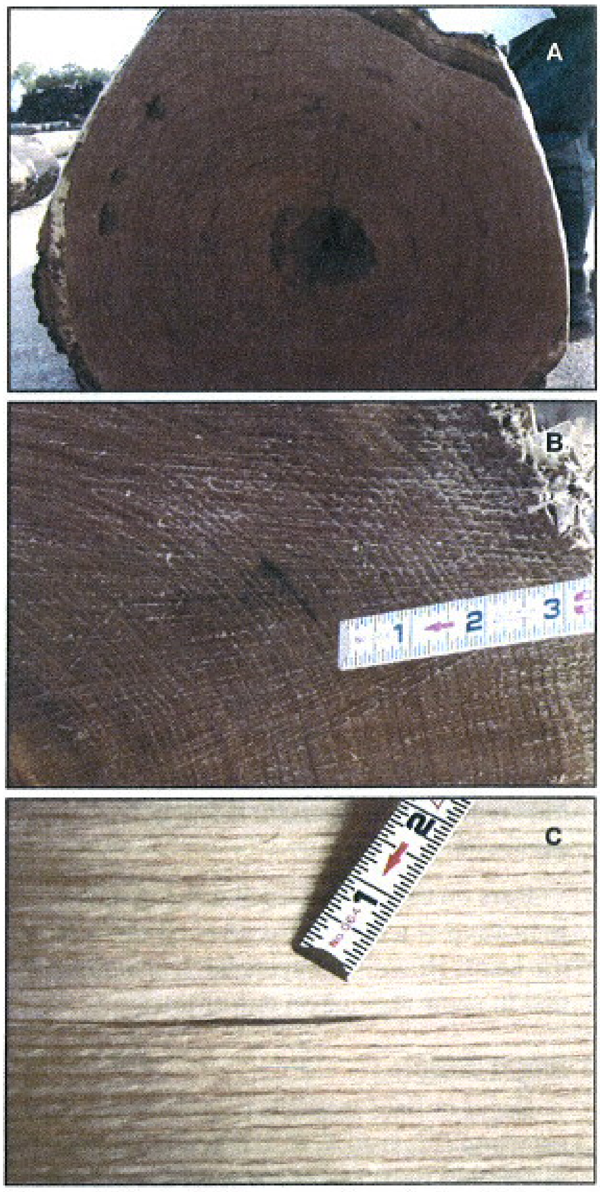
*Figure 16. Bulge at the base of some large white oak, also called "soda bottle effect" are not considered defects.*

## Red Oak

Red oak is also commonly veneered. Color and mineral stain are two of the most common problems associated with red oak veneer, in addition to obvious defects such as overgrown limbs, borers, wounds, etc. Again, the premium material demanded by the market is a very light-colored veneer. Mineral stain is common in red oak and may take the form of isolated spots or follow along the annual rings (Figs. 17A, B, C). It is objectionable in most finished products. In addition, the wood often tends to split or break apart when mineral stain is present.

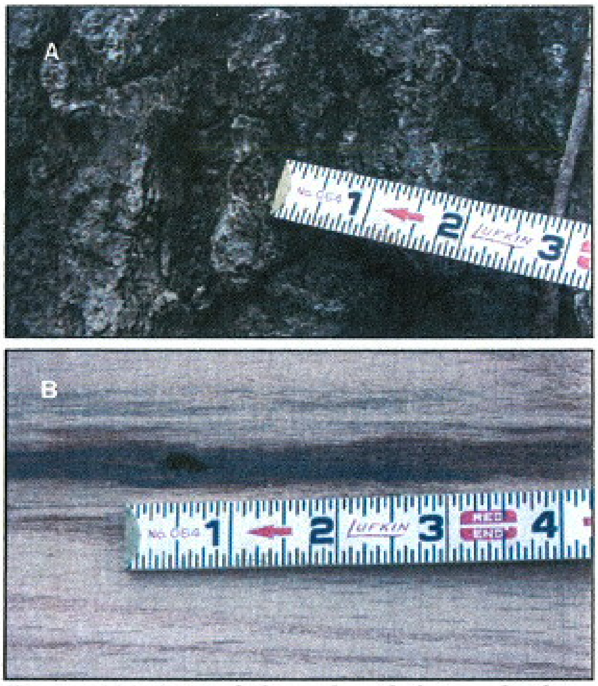
Mineral-free, light-colored red oak is more commonly found in certain regions of the country such as lower New York, Pennsylvania, northern Indiana, and southern Michigan. Therefore, it would seem that site or soil might also be a factor. Regardless of the cause, the presence of mineral in a particular area will result in veneer log buyers offering reduced prices for standing trees of potential veneer quality. In addition to the mineral stain, Figure 17A shows the dark red color characteristic of black oak.

There are three major types of borers which attack red oak. Borer holes can range from




*Figures 17A, B, C. Two examples of mineral stain in the end of two different red oak logs and in the veneer.*

1/100 to 1-1/2 inch in diameter. Smaller borer damage is nearly impossible to detect. Larger borer holes that have healed over can be seen by experienced people and if "sap wet" are easily detected. Carpenter ants often enter trees through large borer holes and keep the hole open and further damage the tree. Old trees or stressed trees are more prone to damage (Figs. 18A, B).




*Figures 18A, B. Healed over bore hole in red oak and resulting damage with mineral stain in wood.*

Since most borer damage is hard to detect, buyers will be very cautious if any borer holes are found.

Bars on the bark of a red oak log may be indicative of a defect that goes all of the way to the heart. However, buyers have also indicated that in some regions no defect results.

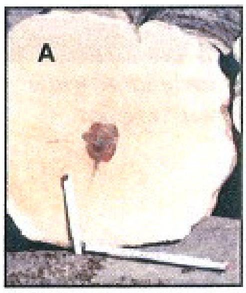
### Sugar Maple

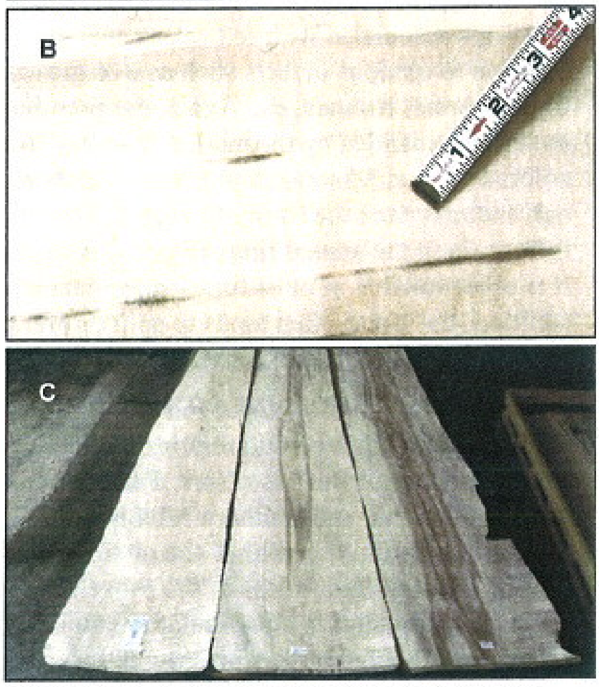
Sugar or hard maple is prized for its white sapwood (Figs. 19A, B, C). The whitest maple is reported from Michigan and the northeast. However, maple from other regions is also veneered. The color of maple sapwood is also affected by the season of the year and length of log storage as well as processing variables. From a uniform color perspective, it is a very difficult wood to process.

The heartwood in sugar maple is a brown color and is considered "false" heartwood. False heartwood is normally caused by a wound or opening in the bark of the tree such as a broken or dead limb stub.

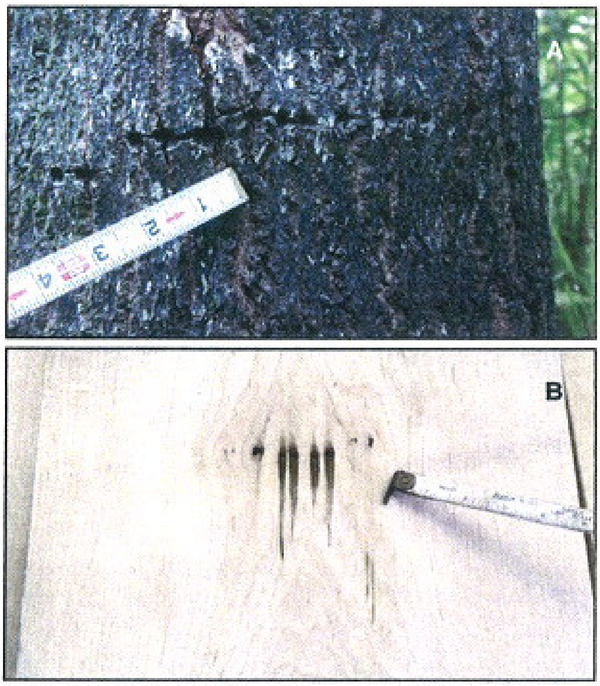
The extent and intensity of false heartwood depends on the vigor of the tree, the severity of the wound, and the time that the wound is open. Discoloration continues to advance as long as the wound is open and is often irregularly formed throughout the stem. If the wound heals, the entire cylinder of wood present when the tree was wounded may not become discolored. The cambium continues to form new growth rings that are free of discoloration. Thus, vigorous fast growing trees with few branch stubs or wounds will produce the widest sapwood.

Mineral streaks ranging from 1 inch to several feet long are a common defect in maple and result from wounds such as broken or dead branches, bird peck, and mechanical damage (Figs. 20A, B). After a wound occurs, the living cells in the wood surrounding the injury react by forming materials that inhibit the infection. These materials




*Figures 19A, B, C. The end of a hard maple log shows a very small heartwood which is good. The log end also shows two or more "black lines" or mineral streaks in the lower left quadrant. These black lines result in streaks in the veneer (B). The veneer from a different log shows the objectionable brown heartwood in contrast to the white sapwood (C).*



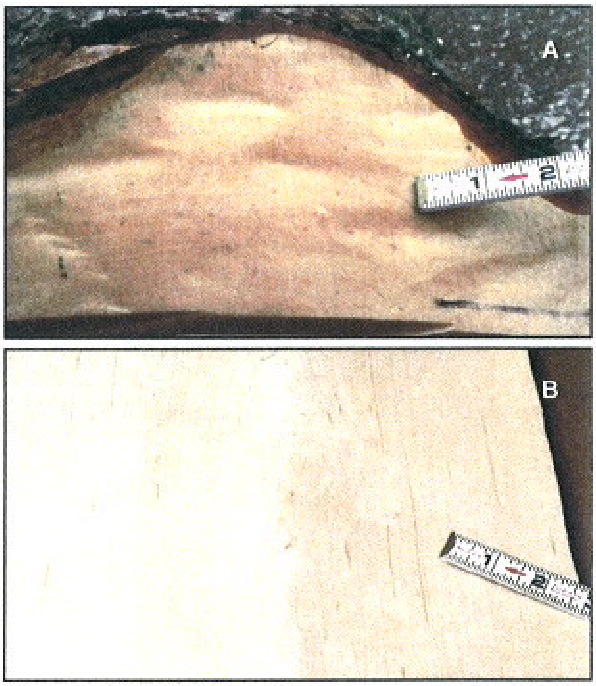

*Figures 20A, B. Bird peck on a young hard maple tree and resulting defect in veneer.*

are deposited in the cells and may appear green initially but later turn different shades of brown. High percentages of mineral, especially potassium, are found in the cells. Some of the wood is very hard and difficult to machine, and cutting tools can be damaged.

Sugar streaks or flecks, narrow brown-colored marks about 1/4 to 1 inch long, can also occur in sugar maple (Figs. 21A, B). The streaks are caused by cambium miners. Cambium miners attack and disrupt the cambium or growth layer of the tree. The tree plugs the gap in response, but the grain pattern has been disrupted. Cambium miners may bore from the soil all of the way to the top of the tree before they exit.

### White Ash

White ash is sliced into veneer. It is also the white sapwood of this species that is preferred. Like hard maple, white ash has a false brown heartwood. With this species it is not uncommon for the heartwood to be very small at the butt of the tree but then expand to a significant portion of the tree diameter further up the stem.




*Figures 21A, B. This under cut on a sugar maple log shows light brown spots which appear as sugar streaks in the veneer.*

Unfortunately, the extent of objectionable heartwood in the top of the butt log is not known until after it is crosscut often to a shorter length veneer log as compared to a longer sawlog.

Glass worms, "turkey tracks" or "worm tracks," also occur in white ash (Figs. 22A, B, C). This zig zag pattern of light-colored wood is caused by the cambium miner. In some cases the wood associated with the glass worm damage turns nearly black. The characteristic is objectionable because it will not accept stain and finish like normal ash. Turkey tracks are likely caused by a cambium miner and are very similar to sugar streaks in hard maple.

## Other Species

There are several other central hardwood species all of which are processed into veneer at various times. In terms of volume and or value, they are relatively minor species and thus not included in this limited discussion.