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IDENTIFICATION OF IRANIAN COMMERCIAL WOOD WITH HAND LENS

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Abstract

Anatomical studies of 14 commercial important tree species from Iranian Hyrcanian forest are carried out. Cross sections of wood species were surfaced and photographed, using different magnifications. Wood samples were grouped into, A- Diffuse-porous woods, including, *Fagus orientalis*, *Acer insigne*, *Carpinus betulus*, *Alnus glutinosa*, *Diospyros lotus*, *Juglan regia*, *Tilia rubra*, *Sorbus torminalis*, *Prunus avium* and *Parrotia percia*. It is shown that these species can be identified on the basis of distinct/indistinct annual growth boundaries, real/false rays, its visibility and presence and absence of axial parenchyma. B- Ring-porous woods, i-e *Ulmus* glabra, *Quercus castaneaefolia*, *Gledistschia caspica* and *Fraxinus excelsior*. Apart from colour and texture of species, distinct/indistinct rays, vessel arrangement in late wood and presence/absence of tyloses in earlywood are the indicator characteristics on which these types of woods can be identified. Density values of above mentioned wood species belonged to both groups are also presented.

Introduction

The correct usage of wood and reduction of residuals are the most important strategies in wood industry. Identification of wood is the first step which is very complicated due to the apparent similarity of various Iranian tree species. In addition, dendrochronologist also collect scattered wood, logs, stumps and buried wood. Identification of these wood specimens are also very important. Due to the dry weather and anthropogenic factors in western region, Iranian forests are restricted to the humid regions in the northern parts of Iran and called Hyrcanian forests (Sagheb-Talebi, *et al*., 2004).

In addition of above mentioned commercially important tree species, these forests also support *Alnus subcordata*, *Prunus divaricata*, *Pterocarya fraxinifolia*, *Buxus hyrcana*, *Platanus orientalis*, *Zelkova carpinifolia*, *Ulmus campsrtris*, *Celtis australis*, *Mours alba*, *Robinia pseudoacacia*, *Poplus caspica*, *Albizia julibriss*, *Taxus baccta*, *Cupressus sempervirens* etc. (Sabati, 1947, Sagheb-Talebi *et al*., 2004, Parsapajouh & Schweingruber, 1993). Iran does not export wood and import softwoods from Russia, hardwood from Africa and plywood from China. Although, Iran has joint border with Pakistan but the type of forests between two countries are different, Iranian forests are dominated by *Fagus orientalis*, while most of the Pakistani forests are dominated by coniferous trees. Pakistani forests like Iranian forests have hardwoods, including *Alder*, Ash – Beech – Cherry - Hornbeam – Maple – Walnut - Oak etc, but they are not as predominant as Iran (Ahmed *et al*., 2006).

Hejazi (1978) described gross and microscopic structure of Iranian timber species. Niloufari (1985), Aghajini & Poor-moradi (1995) also presented characteristics of native and exotic tree of Iran, including odor, color and texture of wood. Parsapajouh & Schweingruber (1993) worked on some Iranian wood microscopically; however seldom observed any anatomical characteristics which are visible with lens. Brumer *et al*., (1994) developed timber identification methods in South America while Panshin & Zeeuw (1980) and Deseh & Dinwoodie (1996) presented specific key for identification of wood with hand lens.

On the basis of fiber length and thickness, presence/absence of resins ducts, presence of vessels or tracheid, shape and arrangement of vessels and kind of parenchyma, Indigenous properties of wood have been recognized by various worker, viz., Desch & Dinwoodie (1996), Hoaldy (1980, 1990), Niloufari (1985), Wilson (1986) and Parsapajouh and Schweingruber (1993).

Many workers like Wheeler *et al*., (1986, 1987) and Toghraie *et al*., (1999) developed computerized database of wood anatomy to identify the timber species but this is beyond the scope of present study. The characteristic of wood cross-section which is visible with lens is very handy and useful tool in timber identification, have not been paid proper attention. Therefore in present paper we are describing key anatomical characteristics using various loupes of magnifications to identify various timber species of Iran.

Materials and Methods

Cross-sections from breast height were obtained from 14 commercially important tree species during logging operation at Hyrcanian forest of Iran. Only healthy, sound tree with no sign of injury, were selected and one cross-section per tree species was brought to the laboratory. Leaves and fruit of each species were also shifted to herbarium of Azad University of Iran (Karaj branch) for designation of species and genus.

In the Laboratory, these samples were brushed with paraffin and stored under shaded area to prevent cracks. After six months from each section 2*2*2 cm sample were obtained. These samples were be sound surface, without reaction wood, juvenile wood, knots, decaying and spiral grain (Hoaldy 1980 and 1990). The samples with fast growth, wide rings, false rings or two rings in magnifications of 10X not visible, are not suitable for macroscopic study and were rejected.

Before using the hand lens, the surface of samples were cut cleanly with new razor blade to produce a smooth, flat and clean surface devoid of cell damage. For surface polishing, sand paper was avoided, since wood texture specially vessels filled with saw dust and cannot be seen under binocular. In each surface, the razor cut was made in a single stroke and consequently the prepared surface rarely exceed 5mm (Desch & Dinwoodie 1996). The surface of the block was kept wet with water or alcohol. Light wood was sectioned without special treatment, but their surface should be wet with sponge or brush. If sectioning is done without any treatment, the hardness and softness of cut is one of the identification key. For more exposure of parenchyma and ring boundaries, a blackboard chalk was drawn on cross-section and cleaned with sponge. The samples were photographed using different magnification, (10X, 20X, 30X and 40X). Tree were identified and grouped according to vessel classification i.e., Diffuse-porous and Ring-pours woods. Then the indigenous characteristics of each timber tree belonging to these groups were investigated. Wood density of tree species were obtained following Desch & Dinwoodie (1998) method.

Result

Anatomical characteristics and wood density of 14 timber species are described. Photographic representations are presented in Figs. 1 to 14. Family of each timber tree is given in bracket, followed by common English names. Nomenclature was followed according to Mozaffarian (1988).

a. Diffuse porous species

1. ***Fagus orientalis*** **Lipsky** (*Fagaceae*) Beech

Beech can be identified by gross feature, it has large and fairly numerous rays that are easily visible on any surface. Its average wood density is 0.49 (gr/cm^3). Growth rings are distinct due to unusual lighter color of latewood, intersection of wide rays and indent ring boundary. Pores, small, solitary and in irregular multiples and clusters, numerous and evenly distributed thought most of the growth ring and hardly visible with loupe of 10x. Latewood zone was evident by light color and fewer small pores. Rays easily visible without lens on all surfaces, appearing uniform in size and evenly spaced on transverse and tangential surface, producing conspicuous dark ray fleck on radial surface (Fig. 1).

2. ***Acer insigne*** **Boiss. et Buhse (***Aceraceae***)** Maple

Like Beech it can be identified with gross feature. Rays are visible in all sections but, it is not as large as Beech and Oak. Its wood density is 0/68 gr/cm^3. Pores are small, solitary, in radial multiples (2-3) and very evenly distributed. Wide rays are visible easily in cross section (Fig. 2).

3. ***Carpinus betulus*** **L.** *(Betulaceae)* Hornbeam

Hornbeam is fine-textured and its average wood density is 75gr/cm^3, Pores are small, solitary and in mostly radial multiples (2-6), or irregular radial chains. Rays are wide and narrow. Wide rays have scattered conspicuous aggregate rays which totally seem one united rays (false rays). In high magnification the space between rays are completely definite. One of the most prominent characters in cross section is sinuous ring boundary and it is caused by intersection of false rays and ring boundary. In high magnification thescalariform axial parenchyma are seen in tangential band (Fig. 3).

4. ***Alnus glutinosa*** **G. A. Mey.** *(Betulaceae)* Elder

The cross section characteristic of Elder is identical with hornbeam. The difference between two species is just in average wood density. Elder is much lighter (0.41 (gr/cm3)) and softer than hornbeam. The color of hornbeam is pale yellowish or brownish white, commonly with grayish cast, while Elder is light reddish brown. Ring boundaries are sinuous but sinuous intensity in elder is milder than hornbeam (U form) (Fig. 4).

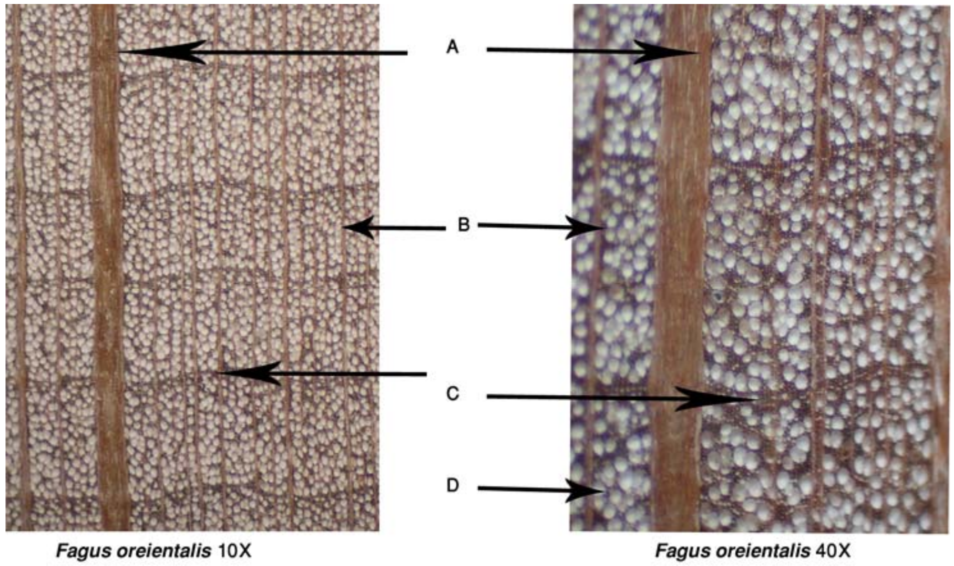
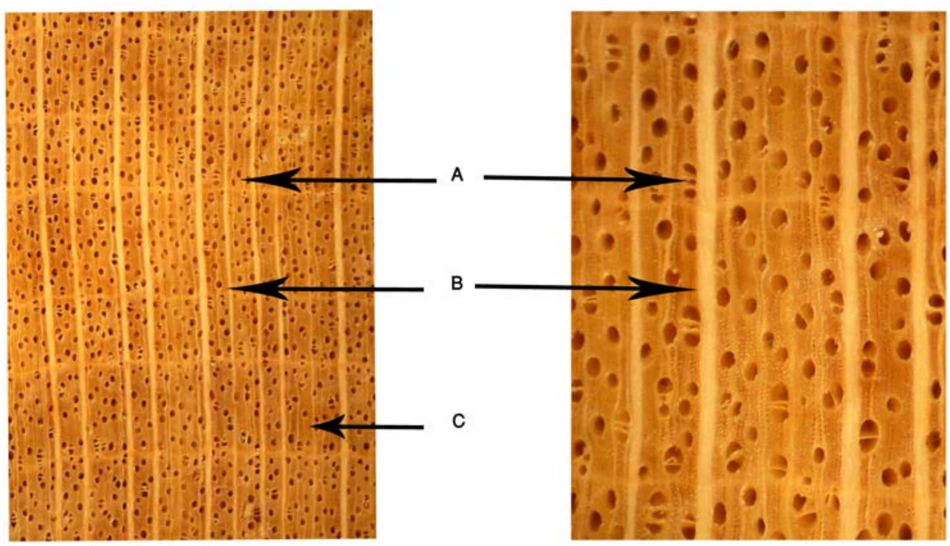


Fig. 1. Cross section of Beech (*Fagus orientalis*), Diffuse – porous wood. (A) Wide ray which is visible easily without lens (B) Narrow rays which is not visible without lens (C) Sinuous growth ring (the intersection between rays and growth rings) (D) Most pores are clusters form.



***Acer insigne* 15X** ***Acer insigne* 40X**

Fig. 2. Cross section of Maple tree (*Acer insigne* Boiss), Diffuse – porous wood. (A) Pores are small and solitary and in radial multiples (2-3), uniform in size and quite uniform in distribution (B) Rays are variable in size and wide ones are conspicuous with eye (C) Narrow rays which is not visible without lens.

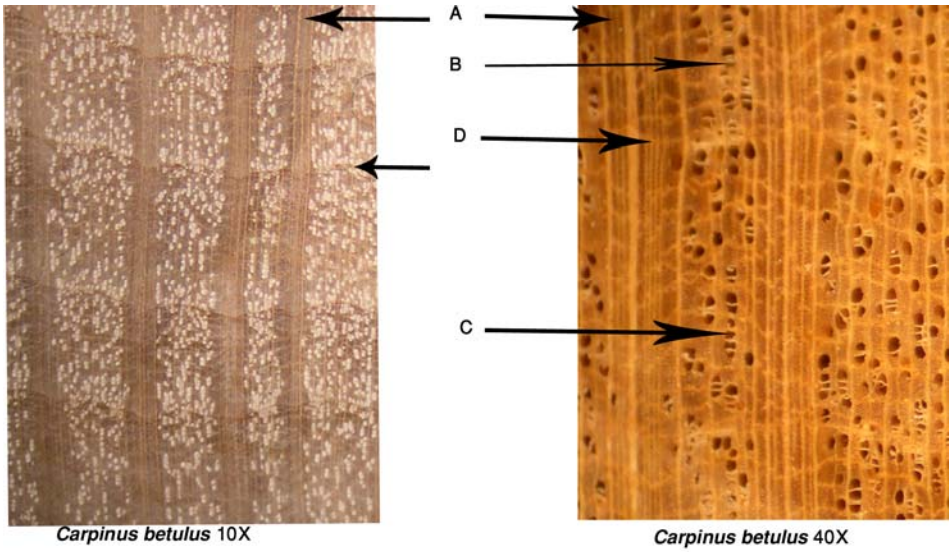


Fig. 3. Cross section of Hornbeam (*Carpinus betulus*), Diffuse – porous wood. (A) False ray which is visible easily without lens (B) Scaliform axial parenchyma which is visible in high magnification (C) Sinuous growth rings and intersection between ray and ring width is nodded (D) Most pores are radial multiple (2-6).

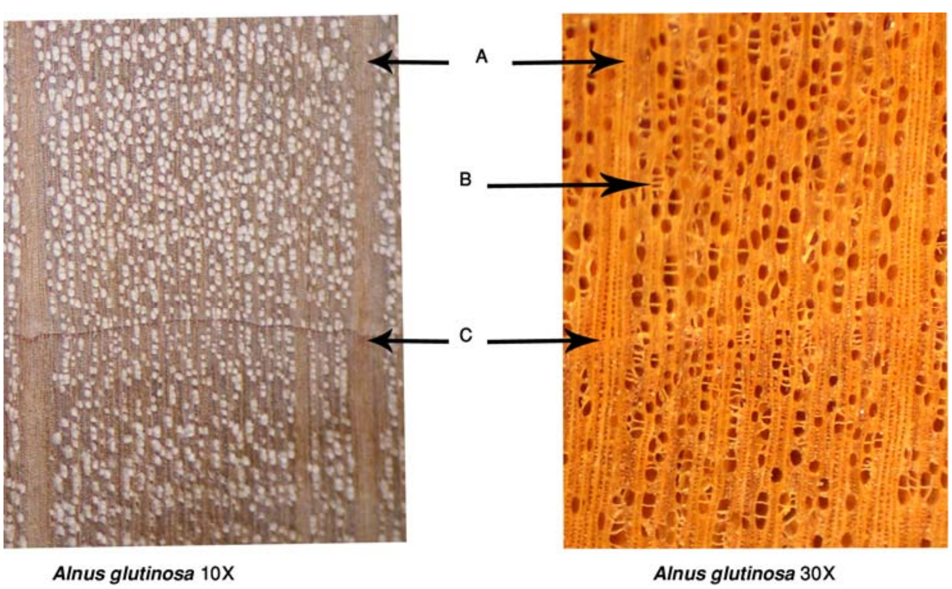


Fig. 4. Cross section of Elder (*Alnus glutinosa*), Diffuse – porous wood. (A) False ray which is visible easily without lens (B) Most pores are radial multiple (2-6) (C) The intersection between ray and ring width is nodded (U form).

5. *Diospyros lotus* L. (*Ebenaceae*) Persimmon

Persimmon is a fairly soft low-density hardwood with an average wood density of 0.52 (gr/cm^3). Growth rings are not conspicuous to the eye. In cross section, the pores of some trees are distinct without handy lens and some other with the hand lens. Vessels are oval and very thick-walled, occurring as radialy oval solitary pores or in radial multiples of two or three. Overall, the pores appear to be in number against the uniform fiber mass. This fiber mass forms a back ground against the fine rays and fine lines of banded parenchyma can be seen with a hand lens (Fig. 5).

6. *Juglans regia* L. (*Juglandaceae*) Walnut

It is moderately dense species; average wood density is 0.68gr/cm3. Earlywood vessels fairly large, distinct without lens with decreasing gradually to quite small in outer latewood. Pores solitary or in radial multiples of two to four (mostly 3). Tyloses present in vessels of heartwood. Axial parenchyma in short wavy tangential lines and scalariform and more visible in latewood fibre mass. Rays fines and not visible without lens (Fig. 6).

7. *Sorbus torminalis* (L.) Crantz ((*Rosaceae*) Wild service Tree

Wild service tree is a moderately dense hardwood with average wood density of 0/64 gr/cm^3. Growth rings sometimes distinct because of narrow zone or row of numerous slightly larger pores along initial early wood. Most of the pores through growth ring are solitary and somehow cluster. Vessels are very fine and even with lens of 20X magnification are hardly visible (Fig. 8).

8. *Prunus avium* L. (*Rosaceae*) Wild cherry

Wild cherry like wild service tree belongs to *Roseacea* family and cross sections appearance and average wood density of two species are similar. At the first glance, shape of growth ring and gathering of numerous slightly pores along growth ring can be confused with Wild service tree. Pores are clusters and radial multiple (2-5). The rays are more visible than Wild service tree and distinct without lens (Fig. 7).

9. *Tilia rubra* DC. (*Tiliaceae*) Bass Wood

Basswood is a fairly soft low-density hardwood with an average wood density of 0.37 gr/cm^3. Pores are small, angular shape, fairly evenly distributed and visible with lens with at least 20X magnification. Some trees, however, are more numerous at the beginning of the growth ring, and then sparse and smaller toward the outer margin of the ring, and seems to be semi-ring porous wood. Some pores are solitary, but most occur in irregular multiples and clusters. In some samples there are small, blurry whitish spots along the growth ring boundary. Rays are fine and distinct with lens, the intersection between rays and growth ring is nodded (Fig. 9).

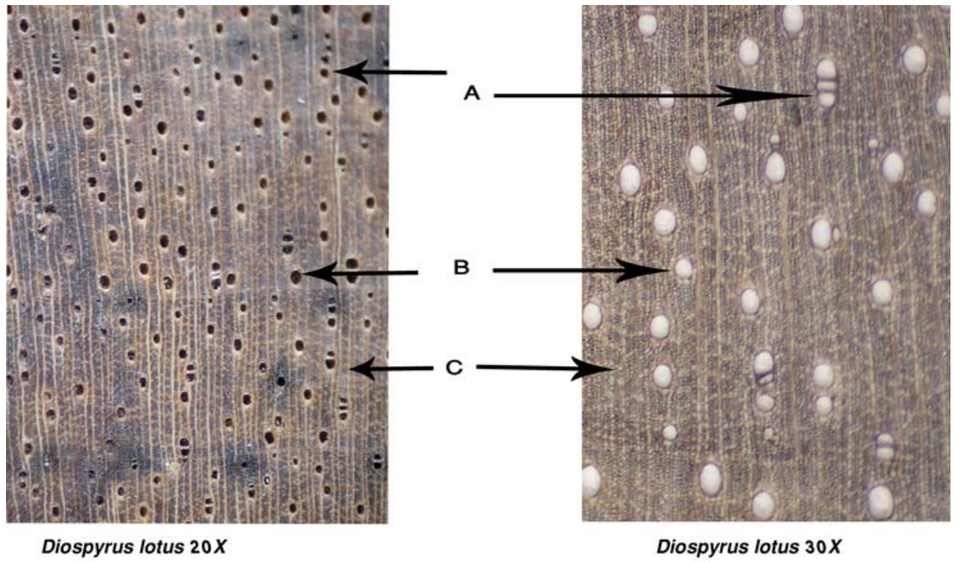


Fig. 5. Cross section of Persimmon (*Diospyros lotus*), Diffuse – porous wood. (A) Pores solitary or in radial multiples (2-3) and with thick-walled (B) Vasicentric parenchyma which is visible with high magnification in chalky surface (C) Rays fine, visible with lines.

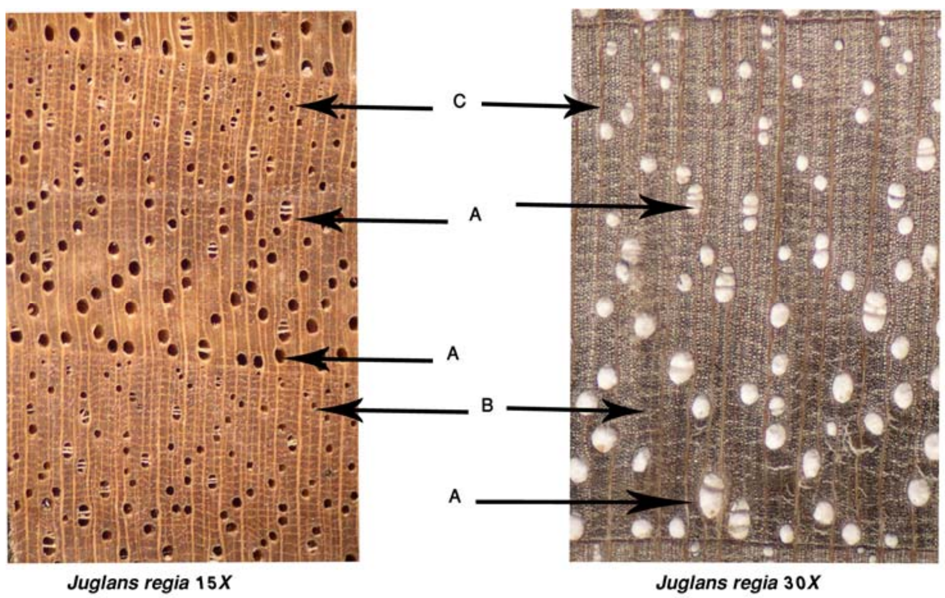


Fig. 6. Cross section of Walnut (*Juglans regia*), Semi – porous wood. (A) Earlywood pores fairly large, decreasing gradually to quite small in outer-latwood; pores solitary or in radial multiples (2-3) (B) Short tangential wavy lines of banded or parenchyma visible with lens (C) Rays fine, visible with lens.

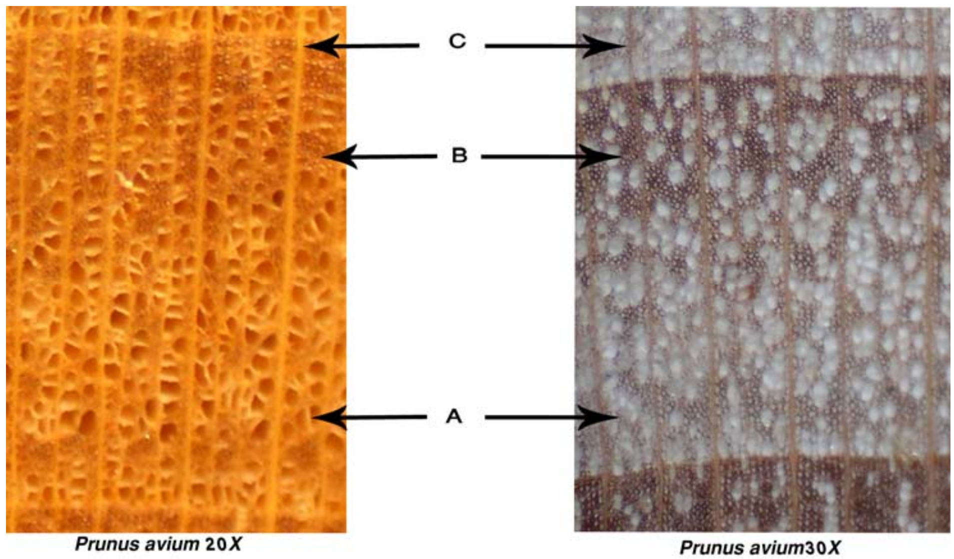


Fig. 7. Cross section of Wild cherry (*Prunus avium*), Diffuse – porous wood. (A) Fairly large vessels have been gathered along initial early wood and quantity of vessels get much more lower in latewood, pores are clusters and multiple (2-5) (B) The number of vessels in latewood lower than earlywood (C) Rays are visible without lens.

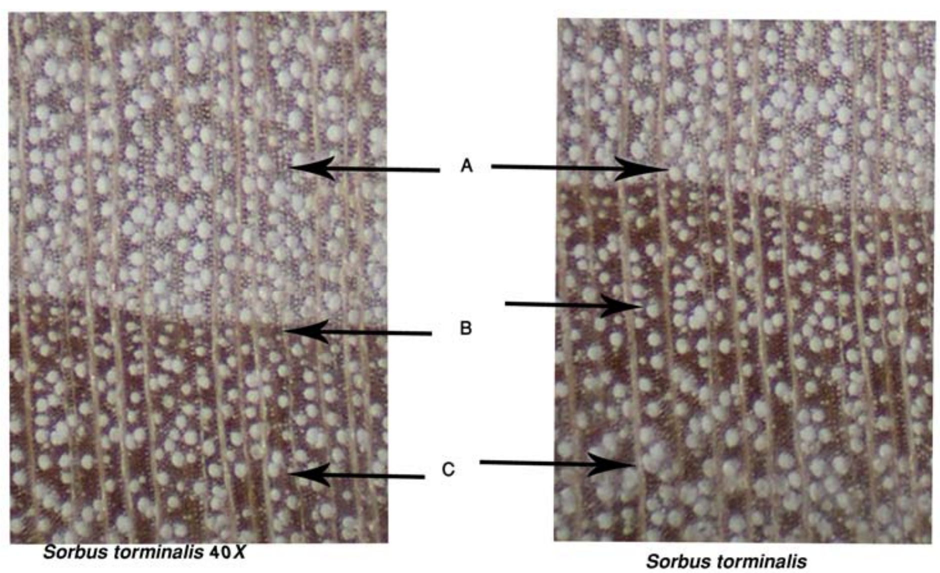


Fig. 8. Cross section of Wild service tree (*Sorbus torminalis*), Diffuse – porous wood. (A) The number of vessels in earlywood are much more than latewood, pores are solitary and clusters and some how radial multiples (B) A number of vessels in latewood lower than earlywood and most solitary, very fine and is not visible even with lens of 30X (C) Rays fine and visible with the lens.

10. *Parrotia persica* (DC.) C. A. Mey. (*Hamamelidaceae*) Persian Iron Wood

It is one of the indigenous species of Hyrcanian forest and it is very heavy and dense. Due to its hardness it is used for fire wood and production of charcoal. Its average wood density is 0.87gr/cm3. In cross section numerous and evenly distributed fine pores are hardly visible with lens even with 20X magnification. Most of vessels are solitary and many of them attached together in irregular direction. Tangential lines of banded parenchyma which is visible in high magnification. Rays are very thin and uniform in size and evenly spaced on transverse section (Fig. 10).

b. Ring porous species

11. *Quercus castaneaefolia* C. A. Mey (*Fagaceae*) Oak

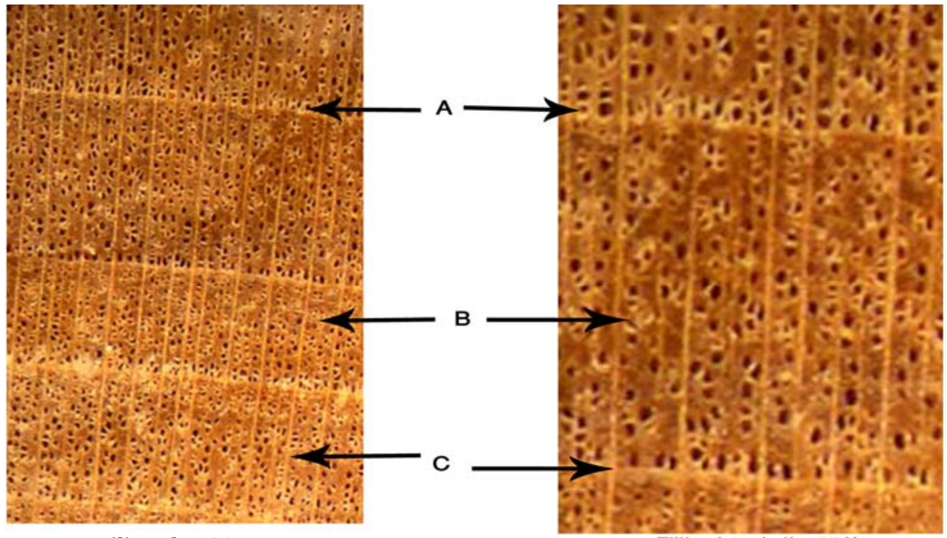
Like beech this tree can be identified by gross feature. It has large and fairly numerous rays that are easily visible on any surface. Its variable wood density (0.65 – 0/85 gr/cm3), depends on site quality. Early wood pores are very wide (more than 200 um) and its shape is circle and oval. The earlywood pores and the radial arrangements of latewood pores are surrounded by lighter colored tissue. This tissue is a mixture of parenchyma and vasicentric tracheids. Faint tangential lines of banded parenchyma as well as uni-seriate rays are visible across the fiber mass. In Iranian ring -porous wood, just oak has solitary latewood vessel. Early wood vessels are full of tyloses. It is solved in boiled water and can't be seen in small samples. Late wood vessels are solitary in radial lines few and Dendritic or flame like. Like beech largest rays are conspicuous, but narrow rays (uniseriate) are visible with hand lens (Fig. 12).

12. *Ulmus glabra* Hudson (*Ulmaceae*) Mountain Elm

Average wood density is 0.49 (gr/cm^3). In *Ulmaceae* family this tree species has biggest early wood vessels and the growth boundary is easily visible. Earlywood vessels are1-3 pores wide (3 is more common). The important and clearly distinguishing feature of the elm group is the arrangement of latewood pores in wavy bands (ulmiform). Typically, these wavy bands are more than one pore wide, continuous well established across the entire latewood. Rays of Elm is hardly visible and not distinct without lens (Fig. 11).

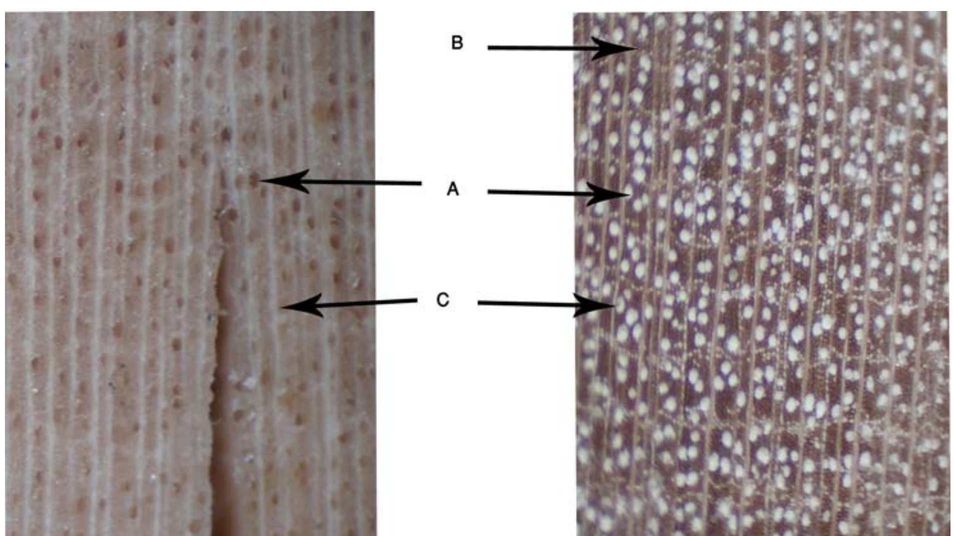
13. *Gleditschia caspica* Desf. (*Leguminosae*) Caspian Locust

Like Ironwood it is another indigenous species of Hyrcanian forest. It is moderately heavy wood and its average wood density is 0.75 (gr/cm^3). Earlywood vessels are 3-5 large, pores wide with vasicentric parenchyma, and seldom have tyloses. Toward the middle latewood, vessels are solitary and seldom 2 radial multiples, vessels are surrounded by aliform and winged aliform axial parenchyma. These vessels in the outer latewood are in nestlike groups and connected into bands by confluent parenchyma which cause to more distinctly of growth ring. In parenchyma there is increasing tendency for aliform parenchyma to developed and intergraded with confluent parenchyma, which connects the pores laterally. Rays are variable in size, the largest conspicuous to the eye (Fig. 13).



***Tilia rubra* 20X** ***Tilia rubra* 30X**

Fig. 9. Cross section of Basswood (*Tilia rubra*), Diffuse – porous wood. (A) Growth rings distinct, some times with blurry whitish spots along the growth ring boundary (B) Some pores are solitary, but most occur in irregular multiples and clusters (C) Rays fine and distinct with the lens.



***Parrotia persica* 40X** ***Parrotia persica* 40X**

Fig. 10. Cross section of Persian Ironwood (*Parrotia persica*), Diffuse – porous wood. Growth rings because of invariability of vessel size is not distinct. (A) Most of vessels are solitary and many of them attached together in irregular direction (B) Scaliform, tangential band of axial parenchyma which is visible in high magnification (C) Rays fine and visible with the high magnification lens.

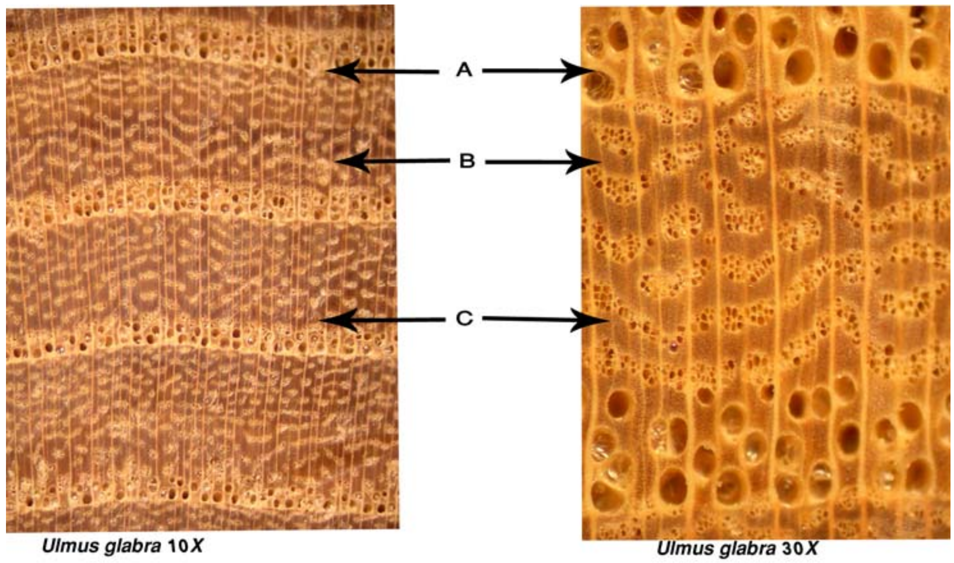


Fig. 11. Cross section of Mountain Elm (*Ulmus glabra*), Ring – porous wood. (A) Early wood vessels are very large and ring width is wide, tyloses present (some open) (B) Latewood vessels are in wavy bands (ulmiform arrangement) (C) Rays variable in size and not distinct without lens.

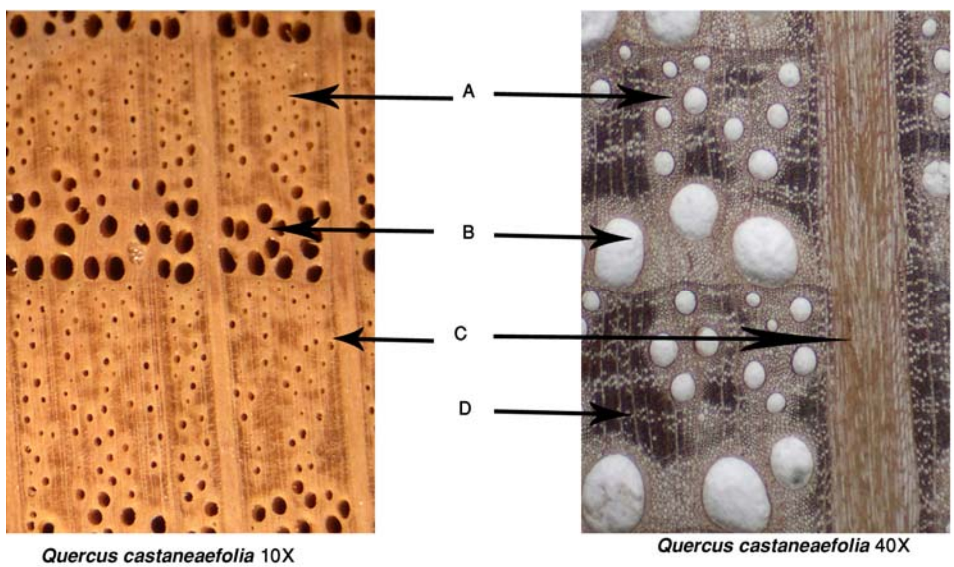


Fig. 12. Cross section of Oak (*Quercus castaneaefolia*), Ring – porous wood. (A) Latewood vessels which are exclusively solitary and flame like, surrounded with lighter tissue which is axial parenchyma (B) Earlywood vessel which is surrounded with lighter tissue which is vasicenteric tracheid and axial parenchyma (C) Wide rays which is easily visible without lens (D) Axial parenchyma in tangential bands.

14. *Fraxinus excelsior* L. Subsp**.** (*Oleaceae*) Ash

The wood density of Ash is (0.65 – 0/85 gr/cm^3). Earlywood vessels are 2-3 pores wide, and solitary and radial multiples. Tyloses are fairly abundant and some of them are open. The ring width is distinct and visible without lens. The early woods are surrounded by a sheath of lighter tissue of vasicentric parenchyma. The first formed latewood are usually solitary and surrounded by lighter tissue which is vasicentric parenchyma, toward the outer latewood. Like Caspian locust there is also increasing tendency for aliform parenchyma to developed and intergraded with confluent parenchyma, which connects the pores laterally. The result is variable-length interrupted tangential or wavy bands, especially in the outermost latewood (Fig. 14).

Discussion

Among diffuse porous wood, beech timber (*Fagus oreintalis*) could be easily recognised by its wide rays. Maple and Beech both has large rays, but rays in Beech are larger than Maple. Pores in Maple are uniform in size and distribution. They are solitary and radial (only 2-3) multiples with distinct rays which is unique characteristics. Two species Elder and Hornbeam showed distinct ray like Beech and Maple, however their large aggregate rays could easily be seen without lens. Therefore Elder and Hornbeam could be separated and identified on the basis of wood density and the number of aggregate ray in a millimetre. The number of false rays in a unit area is higher in Elder. The difference between real and false ray could be seen under loupe. Walnut and Persimmon both have similar scalariform axial parenchyma and radical pattern of vessels. Apart from colour and texture, the distinction of growth ring, visibility of axial parenchyma and difference in vessel size from earlywood to latewood are most clear differences between two species. Axial parenchyma in Persimmon is not visible like Walnut, while in chalky cross-section, the tangential band of axial parenchyma is fairly evidence in Persimmon wood. Vessels diameter in Walnut gradually changes from earlywood to latewood and behaves like semi-ring porous wood, while the size in persimmon remain same, showing diffuse-porous wood character. Ring boundaries in Persimmon are not evident or distinct.

Three species Basswood, Wild services and Wild cherry showed row of numerous and slightly large pores along the initial earlywood. However the vessel arrangements and visibility of rays are different in these species. The Wild cherry has most distinct rays while rays of other two species could not be seen with lens. Vessels in Basswood are small, mostly in irregular multiples and in cluster while prominent vessels are solitary in Wild service wood samples. In addition, among the three species, nodded intersection (between rays and growth ring) was recorded in only Basswood.

Persian Iron wood is characterised by numerous solitary vessels or in a group of two in irregular direction. Rays are very small and even not visible by magnification of 20X.

In ring-porous woods, Oak could be easily identified by its large rays and solitary vessels. The identical identification character of Ulmaceae family is the presence of vessels in wavy band. Though Ash and Caspian locust look similar due to net like group of vessels in outer latewood and connected into bands by confluent parenchyma, but presence of large quantities of tylosses in earlywood vessels of Ash separate it from Caspian locust. Further more rays in Caspian locust could be seen without lens while in Ash these are visible with lens only.

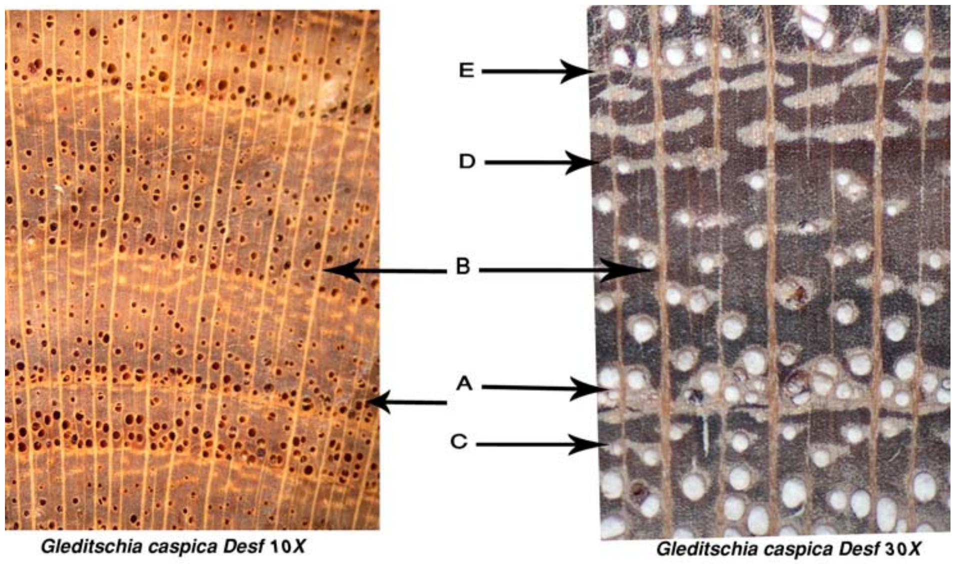


Fig. 13. Cross section of Caspian Locust (*Gleditschia caspica*), Ring – porous wood. (A) Earlywood, tyloses absent (B) Rays are variable in size, the largest conspicuous to the eye (C) Aliform parenchyma (D) Aliform confluent parenchyma (E) Aliform confluent parenchyma in outer in last part of latewood.

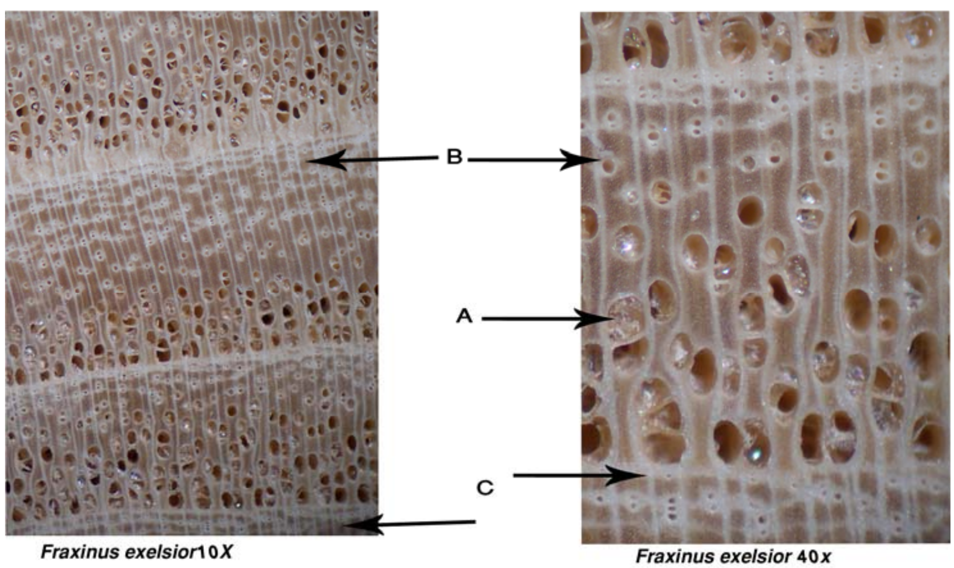


Fig. 14. Cross section of Ash (*Fraxinus exelsion*), Ring – porous wood. (A) Earlywood, 2-4 pores wide; pores large and surrounded by lighter tissue, tyloses fairly abundant (some vessels open) (B) Pores are solitary and most are radial multiples (2-3) and with vasicentric and aliform parenchyma (C) Confluent parenchyma in outer latewood (D) Rays not distinct with eye but clearly visible with hand lens.

Highest values of wood density (0.85-0.87) were recorded in Persian Iron wood, Oak and Ash, while lowest average wood density was observed in Bass wood. Some species like wild service, wild cherry (0.64), Beech and Mountain Elm (0.49) have similar wood density. It is suggested that due to wide variance and similar values, wood densities could not be used alone to identify various Iranian wood.

Above discussion show that though above mentioned timber samples show similarities in their anatomical structure, it is still possible to identify wood logs using above simple technique

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