

# Control of Internationally Traded Timber - The Role of Macroscopic and Microscopic Wood Identification against Illegal Logging

Gerald Koch\*, Volker Haag, Immo Heinz, Hans-Georg Richter and Uwe Schmitt

Thünen Institute of Wood Research, Hamburg, Germany

## Abstract

As a contribution to global forest protection international laws and timber regulations are currently enacted, such as the USA Lacey Act, the European Timber regulation (EUTR) and, most recently, the Illegal Logging Prohibition Act in Australia. All such regulations prohibit the import and trade of illegally forested wood and wood products. Regarding these new regulations wood traders are required to exercise "due diligence" including the correct declaration and origin of wood species. The identification of the timber is also important for the assessment of product properties (viz. consumer protection) as lower-grade substitute timbers are imported at a distinctly increasing rate.

In the context of these new challenges wood anatomy provides the most valuable support for practical wood identification and is routinely applied in the daily control of wood and wood products. Using light microscopic techniques, up to 100 anatomical characters can be used following the internationally standardized IAWA lists of "Microscopic Features for Hardwood and Softwood Identification". Overall, the microscopic descriptions of about 8,700 taxa of hardwoods are currently available and documented in several computerized databases, e.g., InsideWood or Commercial timbers (Delta-Intkey-System). By using these important references, the Thünen Centre of Competence on the Origin of Timber, Germany has answered more than 1,000 official requests (including approx. 5,000 specimens) for microscopic wood identification since the implementation of the EUTR in Germany (March 2013).

**Keywords:** Timber regulations; Illegal logging; Wood identification

## Introduction

Illegal logging is one of the chief causes of worldwide deforestation and, by releasing green-house-relevant gasses, contributes to climate change. Moreover, trade with illegal timber and wood products creates market disadvantages for products from sustainable forestry [1]. As a contribution to global forest protection international laws and timber regulations are currently enacted, such as the USA Lacey Act, the European timber regulation (EUTR), and most recently the Illegal Logging Prohibition Act in Australia. These regulations prohibit the import and trade of illegally forested wood and require that timber and timber products have to be produced in accordance with the respective national legislation [2]. Controls are based on a due diligence system. Its key element is to minimize the risk of placing illegally logged timber or products derived from such timber on the market. A general point is to obtain all pertinent details on the product including wood species and origin of the timber. The doubtless identification of the timber is also important for the assessment of product properties in the context of "consumer protection" as lower-grade substitute timbers are imported at a distinctly increasing rate [3].

Considering this background, wood anatomy currently provides the most valuable support for practical wood identification. The methods for the macroscopic and microscopic wood identification are established and have been routinely applied for more than 100 years, more recently supported by computer-aided identification systems based on visual and textual descriptions [4-7]. In the following chapters some principles are presented for the identification of solid wood as well as defibrated wood in pulp and paper.

## Macroscopic wood identification

Macroscopic wood identification is based on observations in the three anatomical planes of a wood specimen: transverse (perpendicular to the stem axis), radial (parallel to the stem axis) and tangential

(parallel to the stem axis) which can be observed with the unaided eye or with the help of a magnifying lens [4]. The method is suitable for a first reliable determination of the declared taxon. For macroscopic wood identification, the transverse planes of the specimens are smoothed using a cutter or carpet knife and examined with a hand lens (recommended magnification 10-12x, Figure 1).

The transverse plane usually offers the most useful diagnostic information about type, distribution, and arrangement of the axially orientated wood tissues (vessels and axial parenchyma), including the important growth-ring characteristics (Figure 2). Observed differences in structure between the various timbers can be described, attributed to certain characters [8], and used for wood identification with the help of comprehensive reference material, e.g., numerous timber atlases or computerized databases *macroHolzdata*, *CITESwoodID* and *XyloTron*, for example [4,9,10].

Macroscopic observation is the fastest method for a first identification or evaluation of the traded timber. In many cases the genus defined by the trade name (comp. EN 13 556 "Nomenclature of timbers used in Europe") can be already determined on the macroscopic level. However, there are limits as to how small a transverse area can be in order to still reveal useful structural details, e.g., in the case of thin

**\*Corresponding author:** Gerald Koch, Thünen Institute of Wood Research, Leuschnerstr. 91, D-21031 Hamburg, Germany, Tel: ++49 40 73962410; E-mail: [gerald.koch@ti.bund.de](mailto:gerald.koch@ti.bund.de)

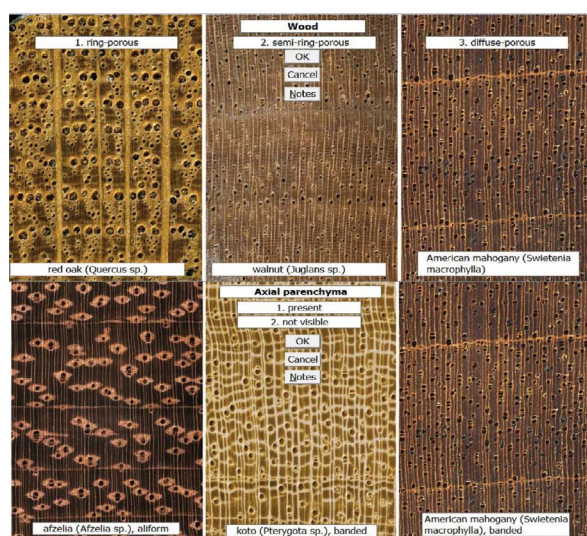
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**Figure 1:** Preparation of the transverse plane and macroscopic observation of the wood structures.



**Figure 2:** Illustration of important diagnostic characters (arrangement of vessel and axial parenchyma) described in the database *macroHOLZdata*

(generally around 0.5 mm thick) veneers on which typical structural patterns cannot be fully recognized.

Furthermore, the characters are subject to high variability due to different growth conditions of the tree (viz. formation of growth rings) or exposure to oxygen and UV radiation (viz. wood colour). This may lead to subjective judgement on behalf of the user, and errors might result in wrong decisions. In fact, in cases of closely related trade timbers, the use of macroscopic characters will end with a choice of several likely matches whose safe separation must be left to microscopic analysis performed by any of the scientific institutions which dispose of the necessary infrastructure and experienced staff [11].

### Microscopic wood identification

For “official” or “judicable” wood identification, microscopic analyses are routinely conducted. Using light microscopic techniques, up to 100 anatomical characters can be used which are internationally standardized according to the IAWA lists of “Microscopic Features for Hardwood and Softwood Identification” [12,13]. The defined microscopic features describe the individual tissue types: vessels, parenchyma, rays and fibres (Figure 3) and provide additional information about mineral inclusions as part of a wood “anatomical fingerprint”. Overall, the microscopic description of about 8,700 wood

timbers (wood genus/species) are currently available and documented in several computerized databases, e.g. *Commercial timbers* (delta-intkey) or *InsideWood* [5,7].

These databases and the comprehensive collections of microscopic slides provide an essential reference material for the routine identification of internationally traded timbers and wood products. For instance, the Thünen Centre of Competence on the Origin of Timber (Hamburg, Germany) has answered more than 1,400 official requests (including approx. 7,000 specimens) for microscopic wood identification since the implementation of the EUTR in Germany (March 2013). In 2015 alone, more than 3,000 wood samples (approx. 2,000 solid wood samples, 500 plywood samples, and 500 fibreboards) were microscopically identified and evaluated for the current survey. Such inquiries come mainly from the timber trade and trade monitoring (customs, conservationists) sectors and increasingly from the authorities. Private consumers also show an increasing interest in knowing whether they have acquired a correctly named product.

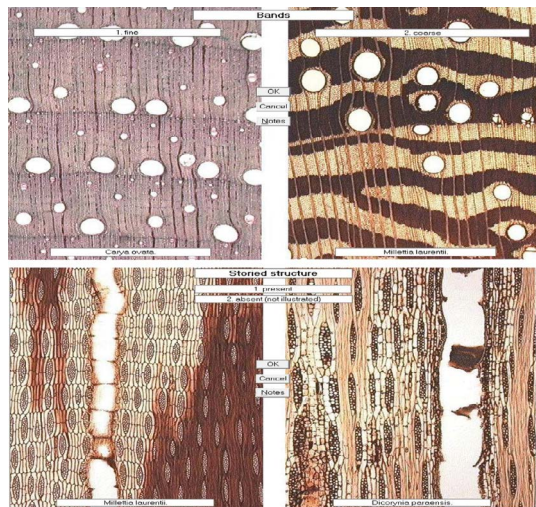
The microscopic analyses enable the wood identification of all solid wood specimens including very thin veneer layers and also individual wood strands and chips. For microscopic wood identification of solid wood specimens, e.g. scantlings, boards, furniture etc., representative samples with a length of approx. 20 to 50 mm and a cross section of 10 to 15 mm are ideal. The minimum size of the specimen required is usually 5-10 mm (cross-section and length) which allows sample preparation without an additional embedding procedure. Smaller specimens, e.g., individual veneer layers or fibre particles can be embedded for the preparation of microscopic slides which requires more time and methodological effort. The number of samples for the wood identification depends on the special request, e.g. different wood species in a window scantling or furniture; in case of doubt, several test specimens should be collected and provided. A separation between sapwood and heartwood is not necessary because the wood anatomical structures are unaffected by the synthesis and deposition of heartwood extractives. For the “normal” light microscopic identification, thin sections (10 to 20 µm thickness) are cut on a sliding microtome from aligned wood blocks. The sections can be stained (standard is double staining with Safranin/Astrablue) to provide a better contrast of the different cell types and tissues. Standard light microscopes (magnification of the objective lens 4-40x) with a polarized light device are regularly employed for microscopic wood identification (Figure 4).

### Fiber analysis

Wood anatomy currently provides the “exclusive” method for the identification of pulp and paper components as well as those of fibreboards which are also subject to the controls of timber regulations. For the identification of the wood taxon in fibreboards, the selected specimens are boiled in water to separate the individual fibres/cells (Figure 5). The cells are usually stained with alcohol-soluble nigrosin and mounted on a slide for morphological analysis. A comparable approach is applied for the identification of pulp and paper components. After defibration in water, the separated cell elements are stained with Alexander’s stain according to the TAPPI Standard T 401 om-08 and microscopically analyzed.

In comparison to the microscopic identification of solid wood blocks, the number of useable microscopic features is severely reduced in the macerated tissue of pulp and paper. In detail, the separated vessel elements provide the best information for a microscopic identification based on typical features like perforation plates, presence of helical thickenings and form of vessel-ray pits (Figure 6). High resolution

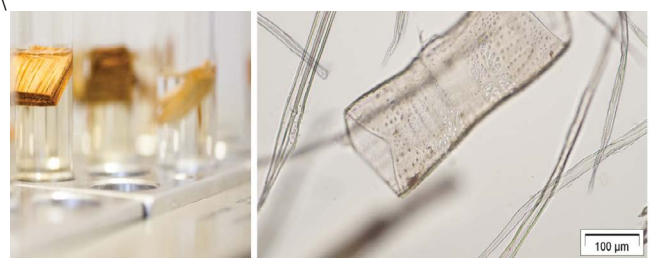




**Figure 3:** Illustration of distinct microscopic characters (occurrence of axial parenchyma bands and storied structures) described in the database Commercial timbers (delta-intkey-system).



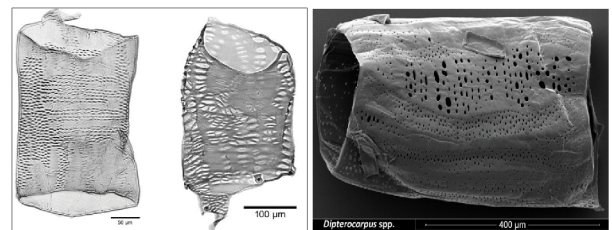
**Figure 4:** Preparation (microtome) and microscopic analysis of wood sections.



**Figure 5:** Maceration: Isolation of individual fibres and vessel elements to analyse structural features (left); isolated fibres and a single vessel element in a fiberboard.

electron-microscopic techniques constitute the most appropriate approach to discern such morphological characters.

The individual morphological information is described in the “Fibre Atlas - Identification of Papermaking Fibers” including the wood anatomical characterization of the most important temperate and plantation-grown species used for pulp and paper production [14].



**Figure 6:** Individual types of vessels for the identification of *Acacia* spp. (left) and *Mangifera* spp. (centre) in pulp and paper. Electron-microscopic image of a *Dipterocarpus* vessel element (right) providing details for the description of diagnostic structural features.

However, the increasing pulp production in Southeast Asia involves the frequent use of tropical tree species (among others Mangrove trees) and requires a defined morphological description of the tissues. It is suspected that the tropical timbers originate from natural forests and that, in some instances, protected tree species are being processed. In order to enable the essential identification of tropical timbers used in pulp production, the morphological characteristics of macerated cell elements (fibres and vessels) of 25 important tropical tree species distributed in Southeast Asia are currently studied and recorded at the Thünen Institute of Wood Research in Hamburg, Germany.

## Conclusions

Regarding the role of wood anatomy in the control of the EU Timber regulation, it can be clearly stated that the microscopic analysis is currently the most feasible and competitive method to identify wood. The microscopic analysis allows access to a large number of references (anatomical description of about 8,700 wood species) including the increasingly traded “lesser known species”. Wood anatomy is routinely employed in the daily control of wood and wood products and false declarations can be revealed in a short time. Particularly, wood structure is currently the most effective means for the identification of CITES-protected timbers, e.g., using the internationally established database CITESwoodID.

However, the important information about the geographic origin of the timbers cannot be determined by wood structure. To obtain this information, an interdisciplinary combination of genetic and microscopic techniques is a very feasible solution. In general, the methods of macroscopic and microscopic wood identification can be easily transferred to international working groups involved in the control of timber trade. Whereas macroscopic techniques require little investment (cutter and hand lens), the reliable identification based on microscopic wood structure requires considerable professional expertise, a rather sophisticated infrastructure, and a well-equipped reference wood collection. Based on these facilities and the knowledge of special wood anatomical (microscopic) characters, e.g. occurrence of septate fibres, tile or sheath cells in rays, laticifers and tanniferous tubes, etc., it is even possible to identify wood samples on the species level which are individually described in the microscopic databases *Commercial timber* (delta-intkey) and *InsideWood*.

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