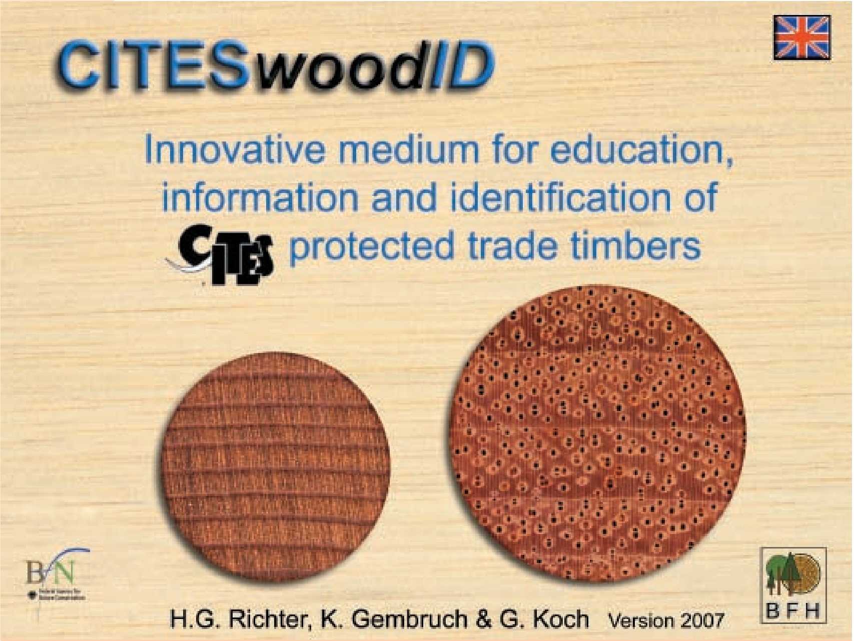
Computer-aided identification and description of CITES protected trade timbers

G. Koch, H. G. Richter, U. Schmitt

Institute of Wood Technology and Wood Biology
Federal Research Institute for Rural Areas,
Forestry and Fisheries
Leuschnerstr. 91
D-21031 Hamburg
Germany



CITES*woodID* contains descriptions and an interactive identification system for 8 CITES-listed trade timbers and one proposed timber currently under CITES observation, and 43 trade timbers which can be easily mistaken for CITES-protected timbers.

The recognition of CITES protected wood species is of prime importance for controlling trade and enforcing regulations pertaining to protected species. A valuable support for computer-assisted wood identification based on macroscopic features is now available from a database developed in the DELTA-INTKEY-System. CITES*woodID* contains descriptions and an interactive identification system for 8 CITES-listed trade timbers (7 hardwoods, 1 softwood) and 1 proposed timber currently under CITES observation, all known for their potential for the production of lumber and downstream processing into products. For comparison, 43 trade timbers are also included, which can be easily mistaken for CITES-listed timbers due to a very similar appearance and/or wood anatomical structure. The database is primarily designed for institutions and persons involved in controlling imports as well as exports of wood and wood products covered by CITES regulations. It also serves as a useful tool for all primary and secondary educational facilities teaching wood anatomy and wood identification.

Introduction

The computer-aided identification program CITES*woodID* was developed in response to a proposal by the German CITES Scientific Authority at the former Institute for Wood Biology and Wood Protection of the then Federal Research Centre for Forestry and Forest Products (BFH), Hamburg (as of January 1st, 2008), reorganised and renamed the Institute of Wood Technology and Wood Biology (HTB) of the Federal Research Institute of Rural Areas, Forestry and Fisheries (vTI). The program is available in four languages: German, English, Spanish and French.

CITES*woodID* enables the user to identify trade timbers covered by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) by means of macroscopic wood anatomical characters. Macroscopic characters are all those, which can be observed or perceived, respectively, with the unaided eye or a hand lens of approximately 10-fold magnification.

Table I.
List of CITES protected trade timbers in the database.

Botanical name	Trade name	CITES Appendix
Caesalpinia echinata	Pau Brasil, Brazil wood	CITES II
Cedrela odorata	Cedro	CITES III
Dalbergia nigra	Brazilian rosewood	CITES I
Fitzroya cupressoides	Alerce, Patagonian cypress	CITES I
Gonystylus spp.	Ramin	CITES II
Guaiacum spp.	Lignum vitae, Guaiacum wood	CITES II
Intsia spp.	Merbau	"under CITES observation"
Pericopsis elata	Afrormosia, Kokrodua	CITES II
Swietenia spp.	American mahogany	CITES II

Every effort has been made to provide high quality colour photographs with the database to illustrate both the characters used for identification and the timbers comprising the database. The photomacrographs of transverse sections were taken at a magnification commensurate with that of a hand lens (ca. 10x). Illustrations of wood surfaces are reproduced in actual size. These illustrations provide an excellent means for visualizing certain character expressions and directly comparing the results of a previous identification with the unknown object to be identified. Furthermore, nearly all characters used for description and identification are accompanied by explanatory notes with definitions, examples, procedures, etc.

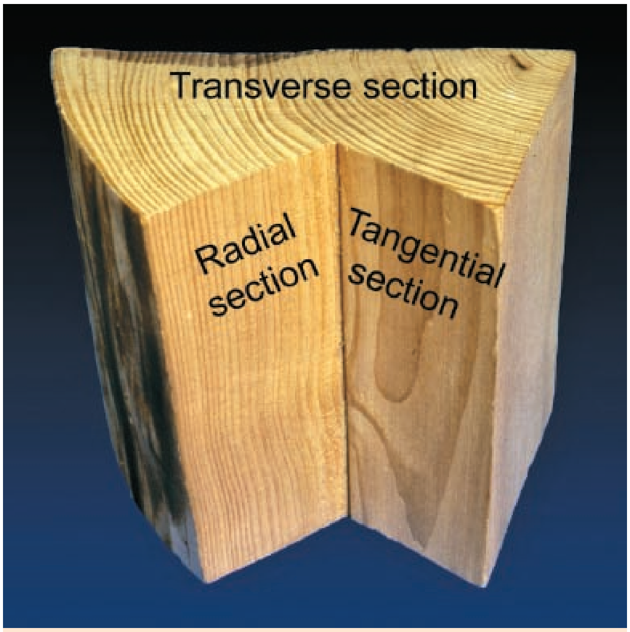


Photo 1.
Illustration of wood anatomical sections (planes) for macroscopic wood identification.
Photo C. Waitkus (vTI).

Objectives of the database

CITES*woodID* serves as a visual (illustrations) and textual (descriptions) identification tool for all institutions and persons involved in verifying imports as well as exports of wood and wood products under particular provisions of CITES regulations. It can also be employed by all primary and secondary educational facilities teaching wood anatomy and wood identification.

The database contains (Table I) a) 8 CITES-protected timbers (7 hardwoods, 1 softwood) and one commercial timber at present under observation by the CITES authorities, all known for their potential for the production of lumber and downstream processing into products, and b) 43 trade timbers which can be easily mistaken for CITES-protected timbers due to a very similar appearance and/or wood anatomical structure.

Basics on macroscopic wood identification

Wood identification is based on observations (photo 1) of three planes:
- transverse plane (perpendicular to the stem axis);
- radial plane (parallel to the stem axis);
- tangential plane (parallel to the stem axis).

The planes are often also referred to as "face", "section" or "surface".

Observations made on these different planes add up to a three-dimensional picture of the gross wood structure. Observed differences in structure between the various timbers can be described, attributed to certain characters, and used for wood identification with the help of reference material for comparison.

Macroscopic structure of hardwoods

Hardwoods are composed of the following main tissues:
- vessels (conduction of water);
- fibres (mechanical support);
- parenchyma (storage and transport of nutrients), and, more rarely,
- resin canals (secretory tissue).

The vessels of hardwoods are the principal passageways in the living tree for axial transport of water from the roots to the crown. On cross sections, they are visible as pores (openings) arranged in a variety of distinctive patterns, and on longitudinal sections as shallow grooves (vessel lines). Vessels are the only cells that expand to dimensions (diameter, length) visible to the unaided eye or with a hand lens (photos 2).

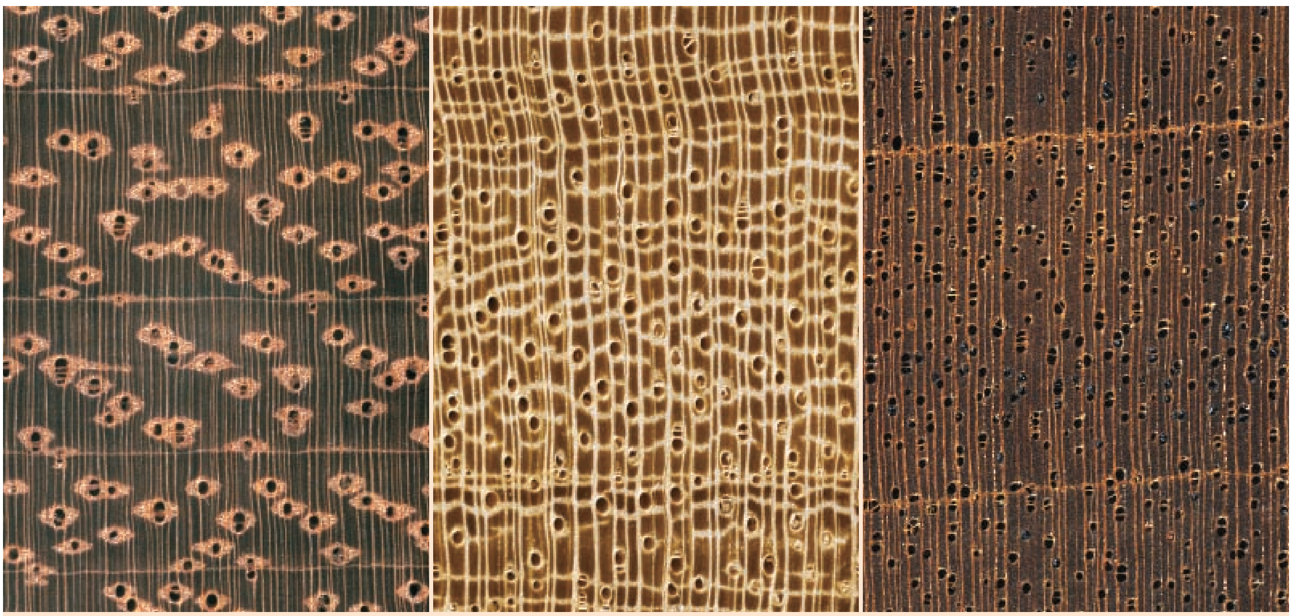
Photos 2.
Distribution of vessels in hardwoods: Ring-porous in oak (*Quercus rubra*, left); semi-ring-porous in walnut (*Juglans regia*, center); diffuse-porous in Marupá (*Simarouba amara*, right). Photos C. Waitkus (vTI).

Fibres provide mechanical strength. They are responsible for resisting the many dynamic and static stresses in the living tree and in wood under load. Fibres usually make up the largest part of the wood volume. They are among the cells with the smallest diameter and, because of their often thick walls, appear as darker areas when seen ?en masse? in a cross section. At the macroscopic level they simply form a (usually darker) background for pores, parenchyma, rays and, if present, resin canals.

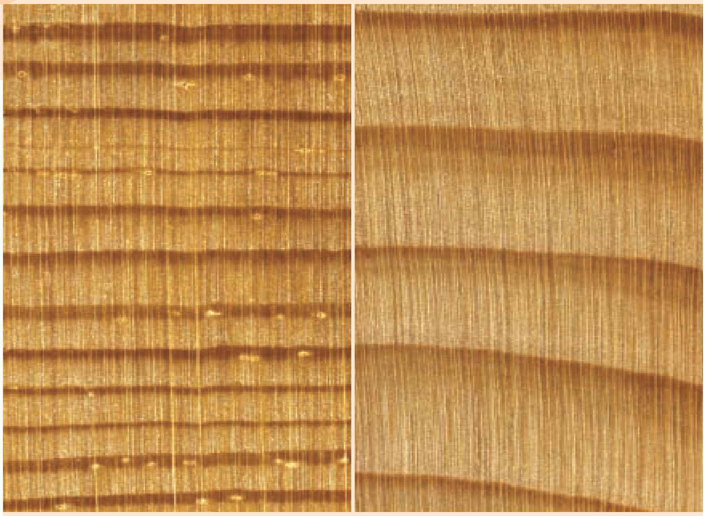
Parenchyma cells are responsible for axial/radial transport and storage of nutrients in the living tree and serve for synthesis and deposition of accessory compounds during heartwood formation. Parenchyma tissues are orientated axially (parallel to the stem axis = axial parenchyma) or horizontally (perpendicular to the stem axis = rays). Parenchyma cells are nearly always thin-walled and become visible macroscopically only when they form larger agglomerates. In hardwoods, the axial parenchyma can be very conspicuous and its various expressions are of high diagnostic value (photos 3).

The rays also have an important role in macroscopic wood identification, particularly as regards size (width and height) and arrangement on tangential surfaces (storied vs. not storied).

Few hardwoods also possess longitudinal and/or radial (forming part of a ray) resin canals. These are tubular passages in wood, which are actually intercellular spaces surrounded by specialized secretory cells. Resin canals are a characteristic feature of some tropical timbers, for instance in the large Dipterocarp family. Presence vs. absence, size and arrangement of axial resin canals are often of high diagnostic value. On cross sections, resin canals are difficult to distinguish from the vessels/pores unless they are still exuding resin (dark irregular patches around the openings) or if they contain crystallized dry resin of a brilliant white colour.



Photos 3.
Patterns of axial parenchyma in hardwoods: aliform and confluent in Afzelia/Doussie (*Afzelia* sp., left); reticulate pattern with rays in Koto (*Pterygota* spp., center); marginal parenchyma bands in American mahogany (*Swietenia macrophylla*, right). Photos C. Waitkus (vTI).



Photos 4.
Macroscopic structure of softwoods: transverse plane of spruce (*Picea abies*) with resin canals (left); transverse plane of white fir (*Abies alba*) without resin canals (right). Photos C. Waitkus (vTI).

Macroscopic structure of softwoods

Conifers, here referred to as softwoods, evolved prior to the angiosperms (hardwoods), and have a relatively primitive wood structure compared to the more specialized and complex structure of hardwoods. Macroscopic identification of softwoods is much more difficult due to the lack of distinctive features. Essentially, softwoods are characterized by only three cell elements or tissues:

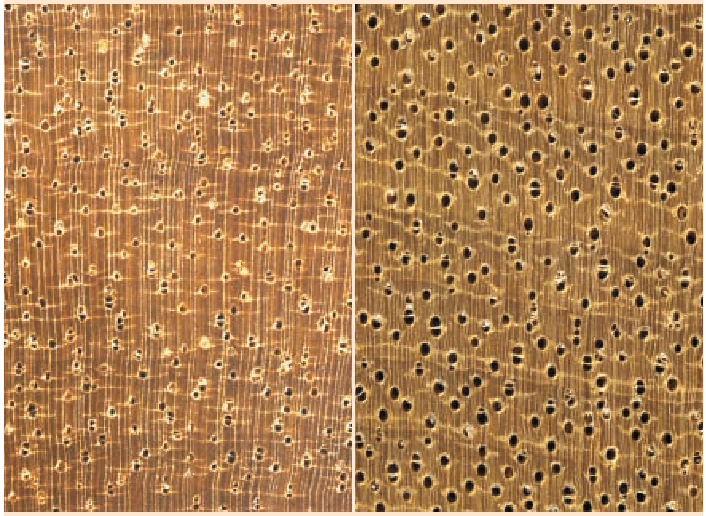
- tracheids (combined mechanical and conductive functions);
- parenchyma (storage tissue);
- resin canals (secretory tissue), restricted to the Pinaceae family .

The tracheids of softwoods combine the functions of mechanical strength and conduction. Their diameter is highly variable and rarely large enough to become visible under a 6x-12x magnifying lens. Nevertheless, tracheids produced in the early and late growing season of a tree may differ in size and, particularly, in cell wall thickness, thus forming lighter coloured earlywood and darker coloured latewood. Latewood width and the appearance of the transition of earlywood to latewood within a growth ring is, in some instances, a useful feature in macroscopic softwood identification (photos 4).

Axial parenchyma cells, though present in many softwoods, never form large enough agglomerates to become macroscopically visible. Rays in all softwoods, composed of radial parenchyma cells and, in some taxa also of radial tracheids, are generally uniseriate (narrow) and low, and therefore cannot help to distinguish between individual softwood timbers. Rays containing radial resin canals (“fusiform rays”) are the exception to the rule and, when large enough, may also be a useful feature in softwood identification.

Resin canals occur in all species of several genera within the pine family (*Pinaceae*), including pine (*Pinus* spp.), spruce (*Picea* spp.), larch (*Larix* spp.) and Douglas fir (*Pseudotsuga* spp.), which contain both axial and radial resin canals. The presence of resin canals thus provides an initial basis for separating pine, spruce, larch and Douglas fir from the remaining softwoods. Size, frequency and arrangement of axial resin canals can be helpful for distinguishing between and within these four taxonomic groups.

Photos 5.
American mahogany (*Swietenia* spp., CITES Annex II, left) is very similar to African mahogany (*Khaya* spp., right) in appearance. The two timber groups differ significantly in the lack of macroscopically visible axial parenchyma in African mahogany. Photos C. Waitkus (vTI).



Photos 6.
Ramin (*Gonystylus* spp., CITES Annex II, left) and limba (*Terminalia superba*, right) are similar in appearance and structure. However, limba has much larger and fewer vessels. Furthermore, the limba wood is darker with a greenish hue. Photos C. Waitkus (vTI).

Photos 7.
Alerce (*Fitzroya cupressoides,* CITES Annex I, left) and Western Red Cedar (*Thuja plicata,* right) are virtually indistinguishable given their similar structure. The aromatic odour and yellowish hue of Western Red Cedar, however, is of much help in distinguishing between the two timbers. Photos C. Waitkus (vTI).

How to use CITES*woodID* for wood identification

When initiating the identification process, the user has several options to follow. The program starts in the *normal working mode*, i.e., the available features are listed in a sequence of “best characters” with, at the top of the list, the character which is best suited for distinguishing between the (remaining) taxa in the database. Working in the normal, highly automated mode is the approach recommended for inexperienced users. However, if a user is sure of the detection of a certain character, it can immediately be chosen with the help of the search function in the toolbar. A further option is to use the natural order of the characters as represented in the original character list. An *advanced working mode* offers many additional options for handling the program and for information retrieval, but requires more manual input.

Each character is accompanied by notes with information on definitions, explanations as to how observations can be correctly interpreted, procedures concerning specimen preparation for certain purposes, examples of timbers with a very typical expression of the character in question, cautionary notes on how to avoid misinterpretation, information on specific wood characters not covered by the character list, etc.. In addition, the characters and timbers in the database are accompanied by high quality colour images illustrating important macroscopic features on both transverse and longitudinal faces. These images can be of considerable help in finding a character and using it in an appropriate way. Images are also very useful when it comes to confirming identification results by visual comparison (photos 5, 6 and 7).

CITES*woodID* also offers full program-generated wood descriptions. These encompass all relevant information contained in coded form in the database, converted into natural-language text and saved in a single (all descriptions) file or in individual descriptions which can be called upon interactively for consultation and/or printing at any point in an identification run.

As a word of caution, it must be quite clear to the user that the possibilities of macroscopic wood identification are much more limited than those of a detailed microscopic study. Firstly, the number of characters available for observation is considerably lower. Secondly, in macroscopic identification one has to rely frequently on characters that are subject to high variability due to different growing conditions of the tree (e.g., formation of growth rings) or exposure to oxygen and UV radiation (e.g., wood colour). This may lead to subjective judgements from the user, and errors that result may lead to wrong decisions. In fact, in cases where trade timbers are closely related, the use of macroscopic characters will end with a choice of several likely matches that can only be safely distinguished by microscopic studies performed by one of the many qualified scientific institutions that have the necessary equipment and experienced staff, such as the Institute of Wood Technology and Wood Biology, Hamburg, Germany (www.vti.bund.de), Musée Royal de l’Afrique Centrale (www.metafro.be), CIRAD-Forêt (www.cirad.fr), Royal Botanic Gardens, Kew (www.kew.org), National Herbarium Nederland (www.nationaalherbarium.nl), just to name a few.

References

CITES*woodID,* 2005. Descriptions, illustrations, identification, and information retrieval. In English and German. Version: November 2005.

KOCH G., 2005. Holzanatomie –Anatomischer Aufbau und chemische Zusammensetzung des Holzes. *In:* Holzschutz im Hochbau. Hrsg. J. Müller, Fraunhofer IRB Verlag Stuttgart, Germany, 15-23.

KOCH G., 2007. Eigenschaften und Verwendung von Austauschhölzern für den Außenbereich –Marktentwicklungen und CITES-Schutzmaßnahmen. *In:* Proceedings 25. Holzschutz –Tagung “Wege zu geschütztem Holz im modernen Holzbau”. Hrsg. Deutsche Gesellschaft für Holzforschung, München, Germany, S. 21-27.

KOCH G., RICHTER H. G., SCHMITT U., 2006. Topochemical investigation on phenolic deposits in the vessels of afzelia (*Afzelia* spp.) and merbau (*Intsia* spp.) heartwood. Holzforschung, 60, 583-588.

SCHMITZ-KRETSCHMER H.-J., KOCH G., KRÄMER G., 2006. Lupe, Notebook und die Software CITES*woodID*. Holz-Zentralblatt, 132, 484-485.