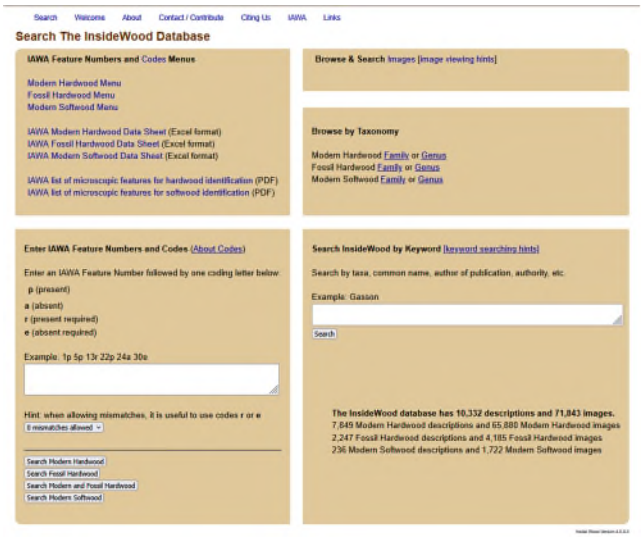
**InsideWood**

Comments and some questions about the Wood Quiz in WoW inspired me to create this PDF in order you can use InsideWood as effectively as possible.

When you visit InsideWood https://insidewood.lib.ncsu.edu/ you will come to the page "Search The InsideWood Database". At the top of the page you will find links to different pages. Both "Welcome" and "About" contain a lot of important information and links.
You can find information about more than 10,000 wood species on the website. Descriptions and the possibilities to identify and compare unknown wood species are the main theme here. Currently InsideWood has more than 71,000 photos and is counting.
Much information about using InsideWood can be found under "Citing Us" in the main menu. IAWA Journal 32(2): 199-211 and IAWA Journal 41 (4): 412-462 provide text and explanations about the use of features and the website. Both PDFs are available for download on the site.

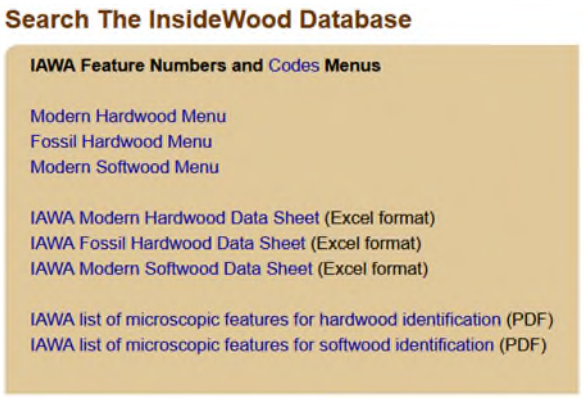
**The menu**

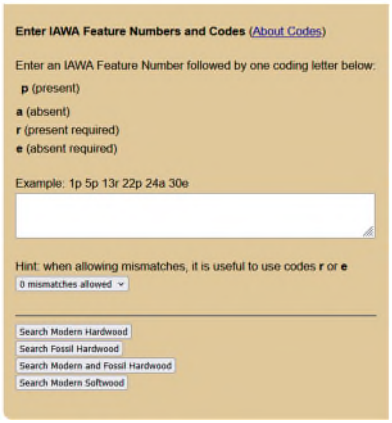



When visiting the website, you will be taken to the “Search The InsideWood Database” page, which is divided into 2 sections.

Left: IAWA Menus section, and Right: the Browse & Search section.

On the left side “IAWA Feature Numbers and Codes Menus” you have the choice to open different menus, and that is usually the starting point of any determination. All you need to know is whether you are dealing with hardwood, softwood or fossil wood. For this you only need to click on the various names. Also available are the PDFs of Hardwood identification and Softwood identification. This is a must for everyone, but especially for any beginner who wants to learn more about the fascinating realms of wood anatomy. In principle the website is self-explanatory, but there are many useful features that are sometimes overlooked.



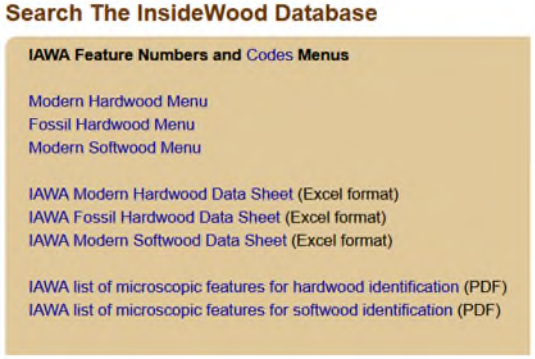



At the bottom is also a box where properties can be filled in. If this is used, the properties must be filled in as described directly above. Below are the buttons to search for the entered features. But more about this later.

In general we look for modern hardwood or modern softwood. Therefore we open the menu provided for this. Now let's assume that we have hardwood of which we do not know what kind it is, so we open the “Modern Hardwood menu”.

**Modern Hardwood menu**

After opening the menu a selection page appears. It consists of 3 columns, the first gives the feature number. The second gives the description of the feature and the third column contains the examples and the input fields. If you hover the mouse over the info button, usually an image with an explanation appears. So far there are 221 features, but probably a few more will be added in the future. Take a look at the information button in the list and try to find some of the features.

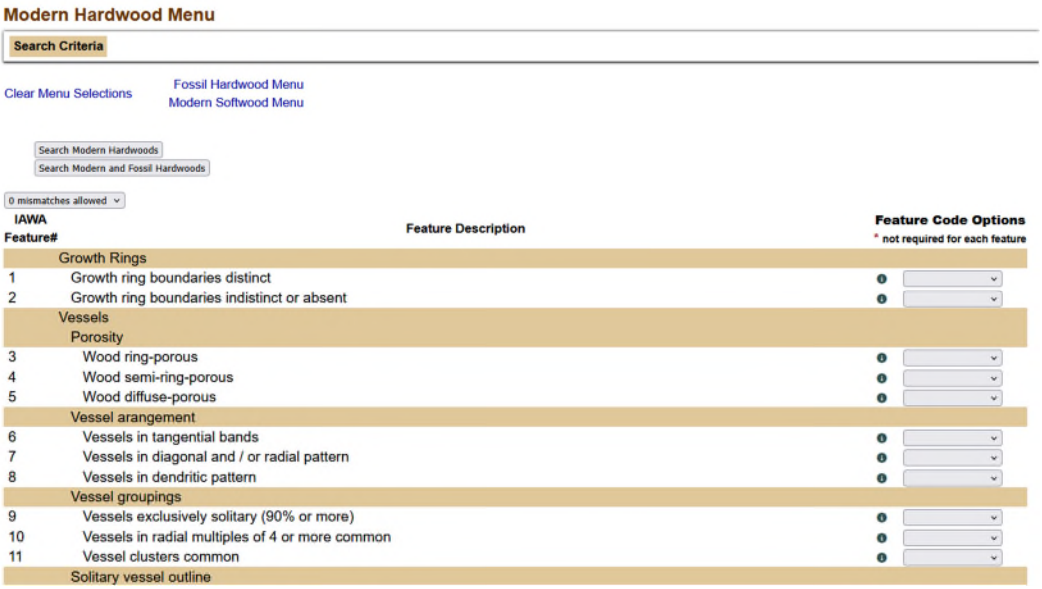



At the top of the list there are 3 buttons, 1 for "search modern hardwoods", 1 for "search for modern and fossil hardwoods" and 1 for "search modern softwoods". Below are the menus to download it in Excel format. Handy to place them next to your microscope.

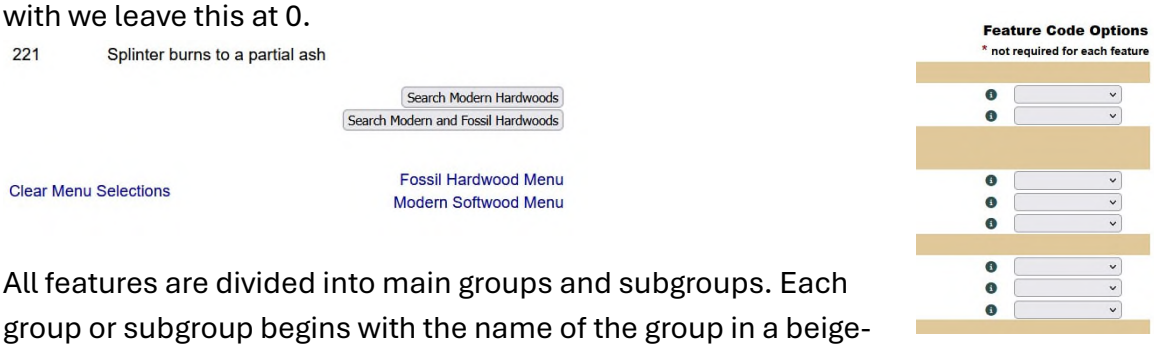
Much more information can be found in the PDF “IAWA list of microscopic features for hardwood identification” and “IAWA list of microscopic features for softwood identification” on the home page. Note that many features also have comments on how to interpret the feature, how to use the feature and what to look out for. Everything is accompanied by relevant images.

**Lets start**

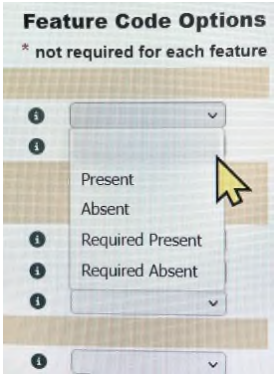
Start filling in the characteristics with features that we know for sure. If you are unsure whether you can interpret the characteristic correctly, read the info-button or read the books of Hard - en Softwood identification downloaded in the PDF.



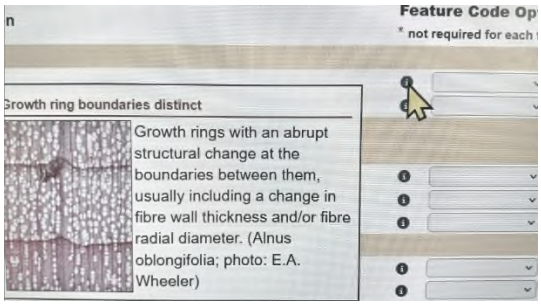

At the top is a line with "Search Criteria" and the rest of the line is empty. As soon as one selects a feature it will be shown in this line. Below are the buttons for "search modern hardwoods" and for "search for modern and fossil hardwoods". Below that is the button "0 mismatches allowed" Here we can fill in how many errors we want to allow the menu to calculate. At the bottom of the page you will also find the same menu option. To start with we leave this at 0.




All features are divided into main groups and subgroups. Each group or subgroup begins with the name of the group in a beige-brown row.




Click on the first button at the bottom at "Feature Code Options" just at feature 1. Now a list of choices appears with a ‘field without text’, "Present", "Absent", "Required Present" and "Required Absent". The designations are self-explanatory, but the difference between searching with and without 'Required' is that, when searching with mismatches 'Present' every entry is considered a possible error. If you mark certain entries with 'Required' they will be skipped during the calculation and the number of possibilities will be reduced.




If you still want to know what is meant by the feature, look at the info button and compare it with the info of the next or previous feature in the same group (here Growth rings), or read the relevant feature in the PDF and compare the images there and especially read definitions, procedures, comments and caution.

We select "present" for feature 1 and click on the button "Search modern hardwood". A new page appears with "Search Results" and under "select all description results" it now reads how many species are described in InsideWood with this feature. "Showing 1 to 50 of 3455" (You can try this with each feature.)


In the middle above it reads "Search Criteria: 1p with 0 allowable mismatches"


At the top right it now says "Refine Menu Selections". If we click on this text we return to the selection menu, without the already selected features being cleared and we can add a next feature. We also select present for feature 2 and let the search start again. Now the "Search Results" appears as “Showing 1 to 50 of 1571”, which means that there are 1570 species of wood that contain both features. Because these features are always indicated for features 3, 4 and 5, I usually skip features 1 and 2 and do not use them because they have little influence on the selection criteria.

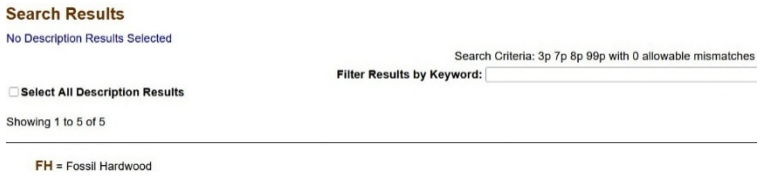

**Hand lens features**

Let us first look at some hand lens features to see if an identification is possible.

Click on Refine Menu Selections and empty feature 1 and 2. This can be done by clicking on the empty top area in the selection box to clear just one field, or click on "Clear Menu Selections" at the top left to clear all fields, or directly on "search" and open a new menu. The last 2 possibilities are useful in case of a new investigation, to make sure all checkboxes are cleared.


Now we choose feature 3 and let search again. The result is surprising, because there is "Showing 1 to 50 of 360" which means that there are only 360 wood species with this feature described in InsideWood.
This feature is a very selective feature and excludes 95% of all other species of wood that InsideWood describes. Searching for these types of characteristics is the best possible solution to quickly come to a result. That is why I advise to note down these types of features to come to a result with as few features as possible.
Refine the menu and add the feature 7 and let it search. The result is "Showing 1 to 50 of 116", and shows in the middle above "Search Criteria: 3p 7p with 0 allowable mismatches". Note that the entered criteria's always appear in this row. This way you can check whether you have made the right choice.

Repeat this procedure and add feature 8. You get the info; "Search Criteria: 3p 7p 8p with 0 allowable mismatches" and "Showing 1 to 50 of 58", Now add feature 99 and see the result. "Search Criteria: 3p 7p 8p 99p with 0 allowable mismatches" and "Showing 1 to 5 of 5". A great result with 4 features that everyone can master in a few days.




Now we want to look for even more species of wood that we want to determine exclusively with a 10x, 15x or 20x magnifying hand lens! With the help of a very sharp knife and a smooth surface all features are clearly visible, both on the cross-, radial- and tangential section.

**Determination in Modern Hardwood menu**

Now we want to determine a European Birch. For this we only use features that can be observed with a hand lens. We know for sure that the wood is diffuse porous (feature 5), with scalariform perforation plates with 10 to 20 bars (feature 16), vessels up to 100 µm (feature 41), between 40 and 100 vessels per 1mm$^2$ (feature 49), diffuse parenchyma (feature 76), and parenchyma diffuse-in-aggregates (feature 77), Rays between 4 and 10 cells wide (feature 98), rays consisting of exclusively procumbent cells (feature 104) and between 4 and 10 per tangential mm (feature 115), but fill in each feature separately and then search! Start with an empty Modern Hardwood menu.

View the outcome after each result.
Search Criteria: 5p with 0 allowable mismatches and Showing 1 to 50 of 7288
Search Criteria: 5p 16p with 0 allowable mismatches and Showing 1 to 50 of 682
Search Criteria: 5p 16p 41p with 0 allowable mismatches and Showing 1 to 50 of 449
Search Criteria: 5p 16p 41p 49p with 0 allowable mismatches and Showing 1 to 50 of 233
Search Criteria: 5p 16p 41p 49p 76p with 0 allowable mismatches and Showing 1 to 50 of 155
Search Criteria: 5p 16p 41p 49p 76p 77p with 0 allowable mismatches ern Showing 1 to 50 or 91
Search Criteria: 5p 16p 41p 49p 76p 77p 98p with 0 allowable mismatches and Showing 1 to 44 of 44
Search Criteria: 5p 16p 41p 49p 76p 77p 98p 104p with 0 allowable mismatches and Showing 1 to 4 of 4
Search Criteria: 5p 16p 41p 49p 76p 77p 98p 104p 115p with 0 allowable mismatches and Showing 1 to 3 of 3

This is the maximum result that can be achieved with a hand lens. However, if you look at the result more closely, you can also exclude 2 species because feature 89 in our wood has not been described. InsideWood also often provides important information at the bottom of the result list, which can lead to the exclusion of other species.

**Mismatches**

In this way you can determine approximately many species of wood! However, if we use 1 or 2 mismatches for the same feature, the result is completely different. Refine the selection and fill in 2 for mismatches and the result is clear.
Search Criteria: 5p 16p 41p 49p 76p 77p 98p 104p 115p with 2 allowable mismatches and Showing 1 to 50 of 271.
You see, you allowed 2 mistakes and get 271 species as a result! That is 90x the result of 0 mismatches.


If you change the 2 mismatches to 1, you still have 58 species left.

Here you can see that working with mismatches results in a much larger range of results. However, it is important that the features are 100% certain in order to be recognized. If you doubt one feature, first look for others that are clear before you start filling in

mismatches. Moreover, it is useful to select features as required that are certain to reduce the mismatches.

**Identify with 0 mismatches**

Try out the features indicated here, all features are clearly recognizable with a hand lens. [3p 6p 56p 89p 98p 102p 104p], [ 7p 10p 77p 96p 101p], [9p 79p 97p 127p], [41p 79p 85p 97p 133p], [10p 43p 56p 96p 130p], [8p 10p 48p 101p 116p], [9p 97p 131p], [43p 48p 127p], [15p 50p 118p], [7p 50p 96p 101], [4p 9p 77p 78p 89p 97p], [5p 80p 102p 103p 131p]

You see that with the simple hand lens many wood species can be identified. With less than 10 properties recognizable with the hand lens you can certainly make a match of more than 100 species of wood. The condition for this is that you must be able to see and name the features with certainty.

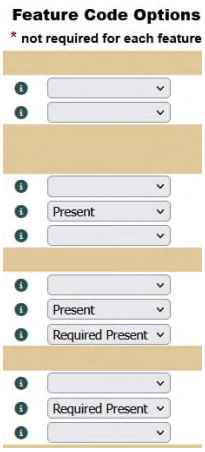
For every determination with a microscope, many more detailed features can be indicated, which cannot be recognized with the hand lens. The limit here is your knowledge of wood anatomy and/or the limited described number of wood species in InsideWood.

My advice for identifying wood species is: always follow the same procedure, this will prevent many mistakes. Start with hand lens features and then move on to the microscope for more details. Change some features to make them more recognizable instead of adding too many. Only use features that you clearly see, recognize and can identify on the wood or in your slide and do not enter too many features into InsideWood at once. Follow the results and check whether everything is filled in correctly. Filling in an incorrect box always gives a different result.

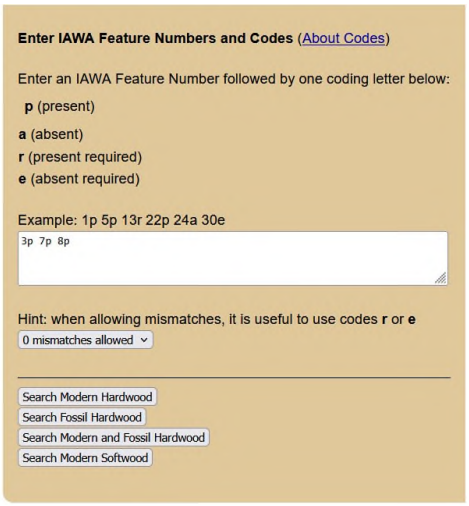
Keep in mind that many features have a high selection value and can therefore exclude a large number of species. See also the list in the list
https://insidewood.lib.ncsu.edu/files/Wheeler.Gasson.Baas.2020.IW.pdf

**Work with mismatches**

If you want to work with mismatches, it is much more convenient to mark a number of features as ‘required’ to limit the selection to features that you are not 100% convinced are present. It is not convenient to mark features as absent, because it is always possible that it is not present here, but maybe is present in another place in the same sample or in another piece. Wood is a living product in which much variation is possible. Even within one growth ring variations can occur. Try the hand lens features indicated above with 1 or 2 mismatches and view the results.



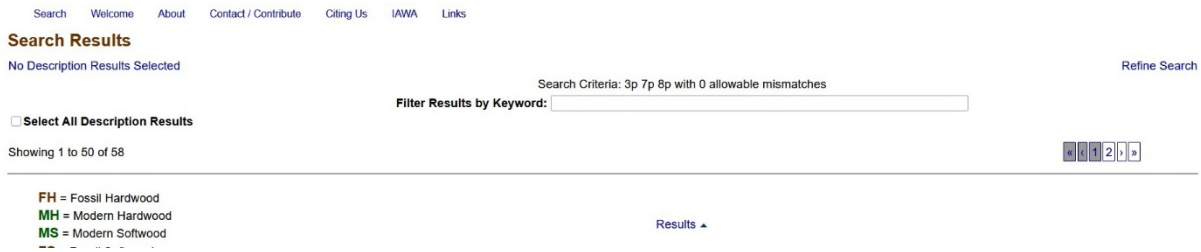
## Work with Enter IAWA Feature Numbers and Code



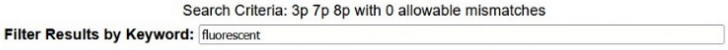

When entering features in the field "Enter IAWA Feature Numbers and Code" it is important to separate all features with a single space, otherwise you will get error messages. Do not use periods or commas. It is useful to copy the features into the box. When entering long series, where you also want to use mismatches, it is useful to mark those that are 100% certain as required here as well. Note! Only a (absent), p (present), e (required absent), r (required present) are allowed here otherwise you will get the message on top "'featuresAndCodes' is not a valid value of type FeaturesAndCodes". Also read the link 'About Codes' above next to "Enter IAWA Feature Numbers and Codes'. In this box you cannot specify variables with v or ? characters, this will result in an error message. So be careful when copying features from the result list.

## Work with Filter Results by Keyword

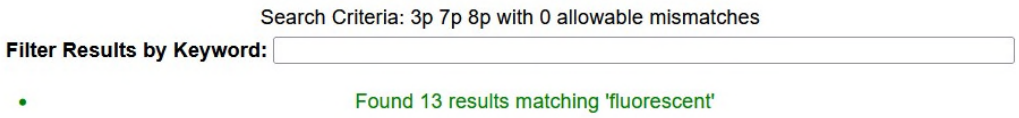
Copy one of the above listed feature series into the input box, and view the result. Note: when you return to the Search page the box is empty again. If you previously copied results from the result list the result is the same. In long result lists it is sometimes useful to use "Filter Results by Keyword".




This allows you to filter on all possible keywords. The condition is that names, words, abbreviations or numbers that you want to enter also appear in the result list. Look at and study the "Keyword Search Hints" link on the search page, next to "Search InsideWood by Keyword". Start with the features [3p 7p 8p] to try out some possibilities. Fill in and search, the result is; Search Criteria: 3p 7p 8p with 0 allowable mismatches. Fill in now at "Filter Results by Keyword" e.g. 'fluorescent', and enter.



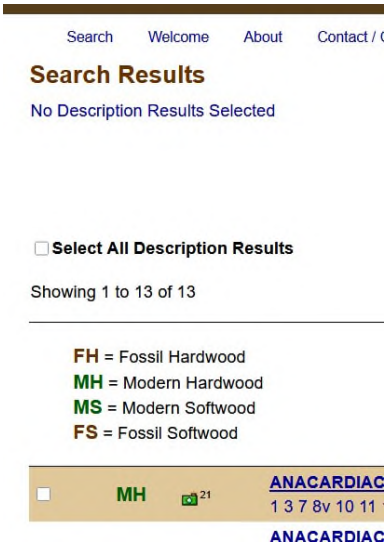
The message Found 13 results matching 'fluorescent' now appears. Try this with [rays up to 6-seriate], [Yellow], [<=40], [rural Nepal], [pist*ia] or [cyprus or sumac] and always




view the results. Any word that appears anywhere in the description will be filtered and the result will be shown.

**Comparing results**

In the result list, you will see a square checkbox that you can check for each row that also shows the descriptions.
Comparing two or a few results can be done by eliminating the similar features and trying to find the remaining features in your sample or slide. It is important to also know the features that make the difference. For long result lists it is easier to import everything than to compare on the page.



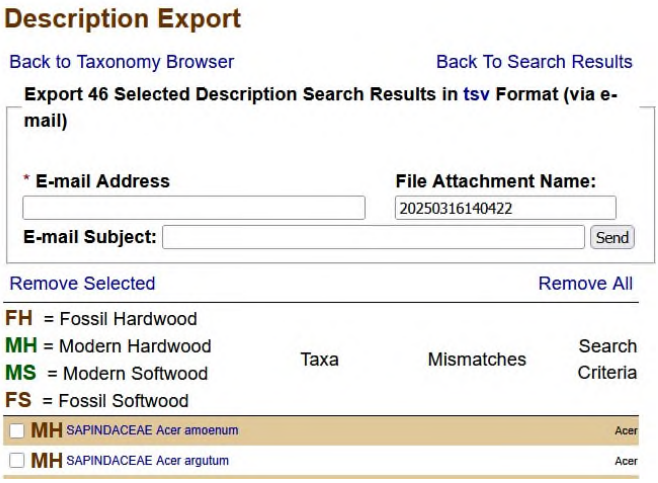

Go to the home page and select “Browse by Taxonomy” and select “Genus” from modern hardwood. Select “Acer”, now Showing 1 to 50 of 53.

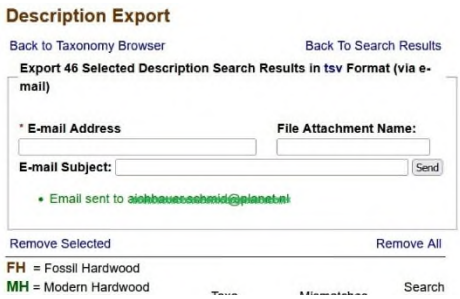

Here you can compare all species of a family or genus. You can also compare your own results list with all species from your list. At the top of the list is a box that says "Select All Description Results" if you want to compare all the results click here. If you only want to compare a few, you only need to check those boxes.
Here you can select all species of the genus Acer to compare the results. When you click on the selection box at the top you can select everything at once. If you only want to select a few you have to click box by box. When you click twice the selection will be deselected.
You see that rows that only have photos have no checkbox. When you select all, all these rows disappear immediately because they have no data to compare. We click on Select All Description Results at the top. We select “Select All Description Results” and

see that above it says “View / Export 46 Selected Results”, all results without a description have been filtered out.


Now at the bottom of the pages it says "View / Export 4 Selected Results" instead of "No Description Results Selected".

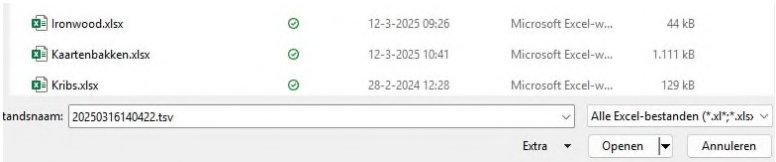
If you now click on View / Export 46 Selected Results a new page will appear called "Description Export". Here you have to enter the email address where the report should be sent to. In most cases that is your own E-mail address.

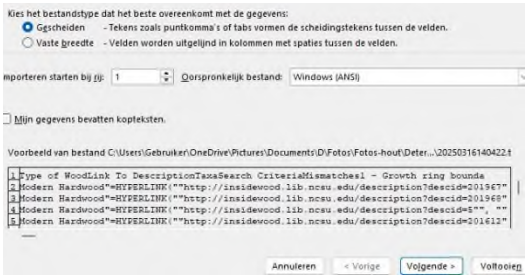



You will see a box with a number next to the email address, that is the name of the document you receive in a .tsv file. You can also add an email subject but a is not necessary. Click send and you will receive the list as an attachment in your email.


Now you can insert the .tsv file into your Datasheet. Normally you need to save the file first and open it in your spreadsheet. Then put it in a designated directory. Note that if you use Excel, it is possible that Excel will not pick up the filename. My experience is that it is better to copy and paste the file name with extension in de open box. When you open the file, you



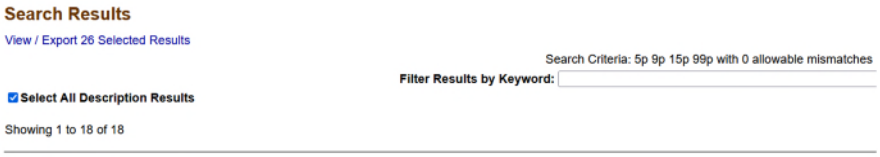




get a window where you can still choose the layout, but you don't have to and just click next until the datasheet opens. All species are now in one row and the same features are on top of each other. This way you can filter all the features to see which differences occur.

**Merging result lists**

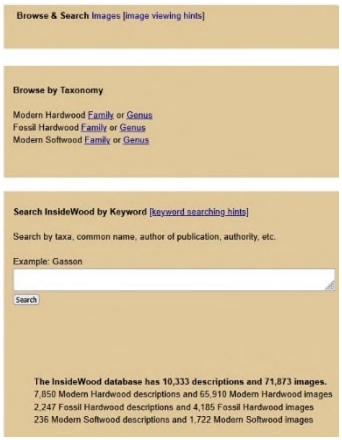
It is possible to merge multiple results from two or more search criteria and export them at once, in order to compare them with each other. For this you need to make sure that the first one is selected to start the export and then start the next search criteria. To do this, select 3p 7p 8p 9p and start the search. Click on Select All Description Results and then on Refine Menu Selections.


Clear Menu Selections and select 5p 9p 15p 99p and start the search again, then click Select All Description Results again, the result of this search attempt will be added to the first.




Note that the number has been added to the already selected range and it says "View / Export 26 Selected Results".


You can repeat this if you want to merge multiple results of your search criteria. If everything is to your satisfaction, start the export and continue as described above. If you want to make a new selection and you already have one selected you must first click "View / Export xxx Selected Results" and then "Remove All" to cancel the selections. Then go back one step and start a new choice or determination. In this case after one step back it says "No Description Results Selected", underneath it still says "Showing 1 to 18 of 18". To start with a completely new selection or with a new search it is necessary to refine search and clear menu selection or go back to the search menu to start over again.

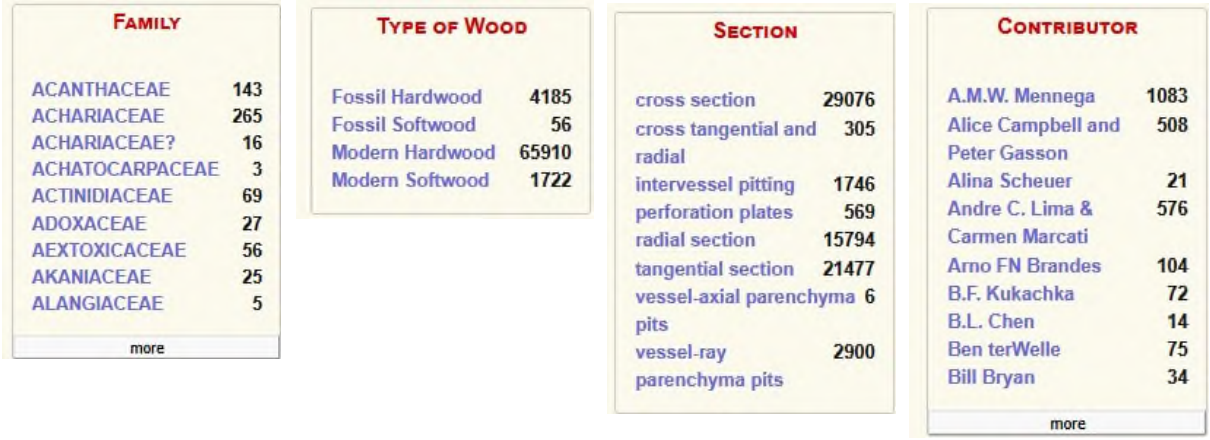



**Browse & Search, Browse by Taxonomy and Search InsideWood by Keyword**
**Inside Wood Images**
If you click on "Browse & Search Images" above, the page with "Inside Wood Images" appears.


At the top is a search field with search and start over.


Below that, previous and next, which can also be found at the bottom of the page.

On the left are a few boxes with Family, type of wood, section and contributor that you can choose from directly, but there is more, you can also search for wood names, countries, and any other keyword described in Work with Filter Results by Keyword.

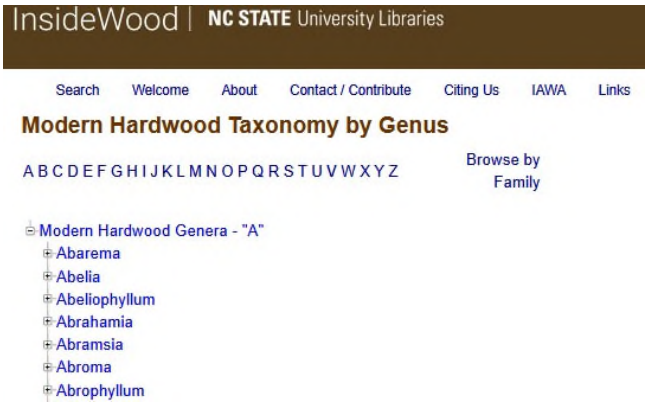



In "full text search for images" you can enter anything such as: family name, species name, common wood names, entire or parts of the distributors of the images, Institutes, etc. To restart the search criteria, clear the search window by selecting the selection, delete and enter, then a new criterion can be entered.

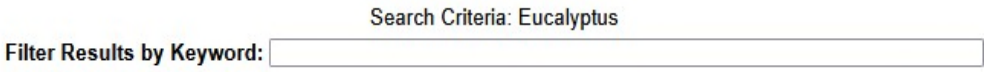

**Browse by Taxonomy**

Modern Hardwood Family or Genus
Fossil Hardwood Family or Genus
Modern Softwood Family or Genus
Here are listed all wood species described in InsideWood. At family or genus level all species are listed.

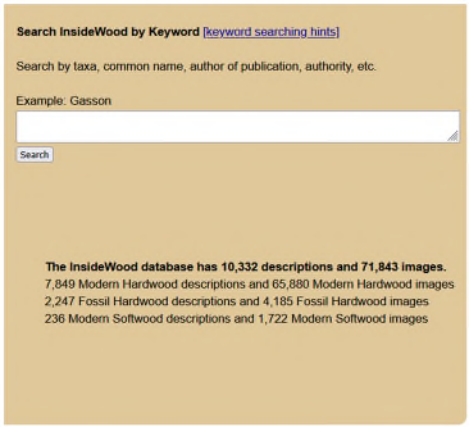
Taxonomy by Genus or Family all work the same. You can select a name or the little button in front of it. If you click on the name, a list of all species published in InsideWood from this genus appears. If you click on the plus sign in front of it, the list of all species published in InsideWood opens below each other, from which you can directly click on another one.




All species are shown with their features and also all species of which only images are present. Because the lists are very long, they are sorted alphabetically and can be called up individually. Some lists like most families or just genera like Eucalyptus are long, but all are sorted alphabetically and when you open them, you will see under search criteria, depending on what you have opened, the family or the genus.

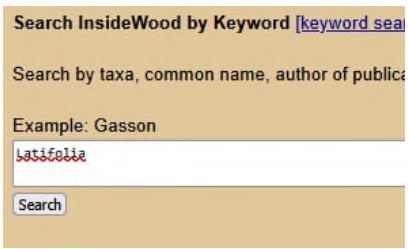



Here too you can filter as described above under: Work with Filter Results by Keyword.




**Search InsideWood by Keyword**

First look at the hints and click on the text on the link.
Here everything is possible that can be found in the descriptions, regardless of whether it is listed as a characteristic in the result list or somewhere in the text. Also parts of names of authors are possible, try Raimund and you will get all pages where images of mine are published. If you enter Cerre as a search term only those images of Jean-Claude Cerre will appear.



Betuloides produces all wood species that have this species name, latifolia all species with this species name. The name entered as a search term is always at the top and below that Found x results matching 'xxx'. Here too you can work with all the options described in Keyword Search Hints and the results are the same as with Work with Filter Results by Keyword.


For both "Browse by Taxonomy" and "Search InsideWood by Keyword" you can filter in the same way as above described in Work with Filter Results by Keyword, Comparing results and Merging result lists.

**Hardwood**

Hardwood is with ±4000 species, the most common wood in the trade. Commercial wood can often be determined with magnifying glass characteristics down to the species. Be careful with the origin of species. Because nowadays much wood is also planted outside their natural distribution area. Many exotic trees and shrubs can be found as garden plants and in the public urban landscape, as well as commercial planting in forests and plantations.

**Softwood**

Identifying softwood in InsideWood is not possible without a microscope and knowledge of microscopic features. Study the “IAWA List of Microscopic features for softwood identification”. You can download this book as a PDF on the homepage.
Softwood cannot be identified with a hand lens, because many features important for identification can only be identified with a microscope. Features such as: streaking, colour, odour, resin ducts and other features that can be identified with a hand lens are not sufficiently conclusive to achieve clear identification.

**Monocotyledonous wood**

There is little to be found about monocot wood and this is not or rather not yet described in InsideWood. A number of publications can be found in the various - IAWA journals -. Martin H. Zimmermann, P. B. Tomlinson, many publications in - Journal of the Arnold Arboretum - of Harvard University, Sherwin Carlquist, articles in many - Annals of the Missouri Botanical Garden - , and the - Botanical Review – are published.

**Fossil and subfossil wood**

Identifying fossil wood is mainly for professionals. Although fossil wood has many characteristics that are also present in normal wood, fossil wood is completely petrified and for this reason only can be partially compared to modern hardwood. Many more specific characteristics are needed. Because many characteristics can only vaguely be recognized in fossil wood, special grinding slides are needed, which can only be made with very specialized equipment. Knowledge about the paleontological layers of the sites is also important. Special books and publications about Paleobotany are available for this purpose.

Subfossil wood can generally be identified with the modern hardwood database, because it is not petrified wood. Here most finds are from gravel pits, sedimentary layers (gravel banks) in river plains and strata of peat. Subfossil wood is generally not petrified and only little changed in structure, but different in appearance, usually dark brown or black. Subfossil wood often consists exclusively of heartwood. Some types of wood are less solid after drying of the wood and sometimes it crumbles easily.