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# SCIENTIFIC RESTORATION OF NATIONAL SHRINES AND LANDMARKS IN THE PHILIPPINES BY THE FOREST PRODUCTS RESEARCH AND DEVELOPMENT INSTITUTE WOOD IDENTIFICATION TECHNIQUE

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***Abstract***

*This is the output of 5 contract projects collaborated by the Forest Products Research and Development Institute(FPRDI), Department of Science and Technology (DOST) and the National Historical Commission of the Philippines (NHCP) in the last 5 years. Within the period covered, 5 project sites classified as shrines and landmarks in the country were visited and 1,911 items of movable, immovable, furniture and other woodcrafts were identified in the field and the laboratory. DOST-FPRDI developed a practical wood identification in the scientific identification of the samples from the field to the final identification in the Herbarium and Xylarium ($CLP^{I}$, $CLP_{W}$) using the authentic samples. Published available literature were also consulted to confirm identification. Simple tools were used in the field i.e., 20x Coddington hand lens, NT cutter, lighter, flashlights, hand gloves and face masks to gather preliminary identification of the woodcrafts. Macro-photographs were also taken for each species of sample examined for the final identification in the laboratory using a Leica stereoscope. Field notes were also gathered from the field i.e., accession number, personal conversation with the curators and the age of specimens. All the woodcrafts were identified with an acceptable level of accuracy (80%) comparable to the newly introduced computer-based xylotron by the United States Department of Agriculture (USDA) aimed to remove bias in the identification of wood.*

***Keywords****: Practical wood identification; Herbarium and xylarium; Restoration of shrines and landmarks.*

## Introduction

The Forest Products Research and Development Institute (FRRDI) of the Department of Science and Technology (DOST) based in College, Los Baños, Laguna, Philippines is one of the leading agencies in the country recognized for its capability to identify and issue certification of wood for the private, government, academe and other forest-based institutions [1-2]. This is made possible by the FPRDI Herbarium and Xylarium, an extensive collection of authentic Philippine and foreign wood and herbarium voucher specimens where unknown wood samples submitted for identification are systematically compared. The only one of its kind in

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the country, the facility is internationally recognized [3] and is known by the acronym CLP[2] (Fig. 1).

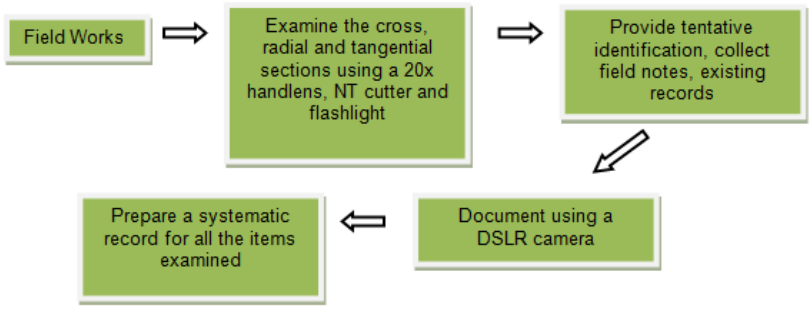


**Fig. 1.** Flowchart of field work showing how the preliminary dentification is carried out

In the last three decades or more, the Institution had been serving the forest based industries in the identification of herbarium and wood specimens for various purposes. *J.M. Conda et al* [4] described and enumerated the number of authentic voucher collections, history, functions, services offered and the clients served by the facility. In addition, it is instrumental in the production of legal evidence by way of identifying confiscated materials (lumber, timber or processed wood products) for the Department of Environmental and Natural Resources (DENR) specifically its forest laws and policies implementing arm, the Forest Management Bureau (FMB) to build a legal case against offenders in their efforts to curb illegal logging in the country. This is especially true at present because government has recognized the need to preserve the remaining natural and secondary forests to limit further environmental degradation thus issued Executive Order 23 s. 2011 [5], declaring the whole country under an indefinite logging moratorium.

**Wood Structure and Identification**

Wood structure and identification is the science of identifying wood using its macro-micro anatomical features, including its physico-mechanical properties. To acquire the skills of identifying an unknown wood needs dedication, time and effort. To learn the craft is a lifetime activity for foresters, botanists and wood anatomists. Moreover, familiarity on the recent related available literature will help in the identification process [6-17].

Wood specimens submitted to FPRDI-DOST for identification come in various forms, shapes, and sizes and in conditions beyond identity as when specimens are in a state of decomposition or originated from archeological artifacts projects. In addition, with the advances made on photography some specimens submitted occur in image forms. Again, such specimens require long experience in wood identification for a botanist or a forester to identify since diagnostic characters had been lost in the decomposition process. A great number of these wood specimens bear striking resemblances in general appearance and structure so that it is difficult to pinpoint their specific identification, based on gross characteristics or minute features. Wood identification, briefly speaking, is a useful tool in the determination of the usefulness of a piece of timber. As mentioned elsewhere, it will take a lot of dedication, patience and passion for anybody to be able to be competent in identifying a wood in a scientifically-based manner.

[2] International abbreviation of the FPRDI Wood Collection at College, Laguna 4031 as recognized in the *Index Herbariorum* by Holmgren and Holmgren (1990) and *Index Xylariorum* by Stern (1988).

## Materials and Methods

Wood identification of all furniture and woodcrafts of five national shrines and landmarks has two phases, namely: i) pre-identification phase and ii) wood identification and data gathering phase.

The pre-identification phase (field works) were done to familiarize the team on how to do the details and devise techniques on how to identify the furniture and woodcrafts (Fig. 1). The cross, radial and tangential sections of the wood was examined using 20× hand lens, NT cutter and flashlight. Field notes, existing records and macro-photographs were collected for tentative identification. The photo-documentation of each item examined and identified was made using a Nikon D7000 camera with a 55mm micro-Nikon lens and an ordinary flashlight for lighting. Oftentimes, images produced tend to be not very clear, so several shots should be made and select the clearest photo. The photo-documentation proved to be laborious since the pores and other features of the wood examined were so minute and needed careful preparation before a good photo-macro-shot was made.

Final identification and data gathering were done in the laboratory (Figs. 2 and 3).

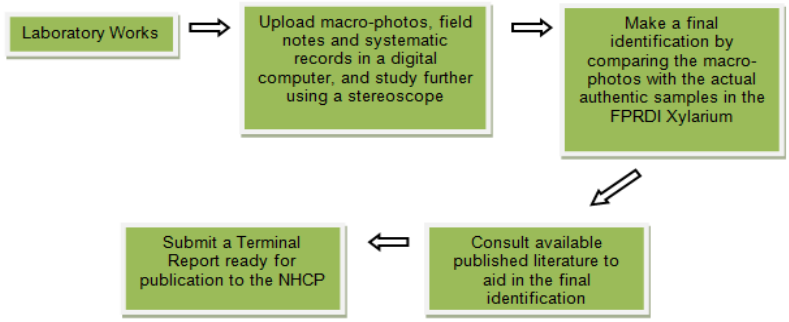


**Fig. 2**. Flowchart of laboratory work

**Fig. 3**.Final identification of wood specimen in the AFBS-MSD Laboratory

**Fig. 4**. Leica digital stereoscope used to review and come up with a final identification of wood items examined from all the shrines/landmarks visited

Using the macro-photographs gathered in the field, images were uploaded in a computer (Fig. 4) then compared to authentic wood samples deposited in FPRDI xylarium. Characters observed and compared were: growth rings, vessels/pores, parenchyma, rays, resin canals (resin ducts) and other secretory structures, splinter (ash) test and other field notes/record available in the shrine/landmark.

Several features useful for accurate identification were lost making identification more difficult compared to the normal process. In addition, wood structure and identification has inherent limitations. Several taxa are not possible to identify specifically, thus, the use of "groups" referring to generic identification are used. Difficulties in wood identification include:

- Age of the furniture and woodcrafts altered the general appearance of wood.
- Finishing applied repeatedly on the items altered the natural color.
- Items needed handling with utmost care.
- The cross section which is the most important source of technical information to identify the items was usually difficult to locate (usually the legs of the heavy items i.e., tables, chairs, and other similar items should be lifted).
- The radial and longitudinal sections were difficult to locate to extract information.
- The splinter test (ash test) was not possible to do since this required burning splinters and observing the ash produced to determine specific identification, especially in closely related species.
- The team found it difficult to position themselves and take observations; oftentimes they found themselves in awkward positions (even observing on the floor) to gather needed wood identification data.

## Results and Discussions

Tables 1 and 2 present the summary of the results of the identification made for all the five shrines and landmarks. Appendix 1 presents the photo-macrographs o species/taxa/groups with the most items used in all the project sites taken from the sites compared with the macro-photographs from available literature [9-10] for reference and future use of interested readers.

The items identified for the five project sites are presented in Table 1 with an aggregated total of 1,911. The number of items identified Cebu, Bohol, Iloilo and Batañgas and Laguna Provinces is yielded the highest number in descending order. Table 2 on the other hand revealed that molave (*Vitex parviflora* A. Juss.) yielded the most important species used in all the sites visited.

At present, however, the cutting and use of all species in the secondary forest of the country is prohibited owing to the implementation of EO 23, declaring a moratorium of cutting trees not declared as plantation forest owing to over-exploitation.

## Wood Structure and Identification

The following key diagnostic features were observed to arrive at a reliable, scientific and accurate identification of the wood used in the manufacture of furniture and woodcrafts in the 5 national shrines/landmarks visited.

***Growth Rings.*** These are increments of growth which result from the discontinuous action of the vascular cambium. When present, they may be distinct or indistinct, and may be used as an aid in identification. This feature is not so distinct in tropical timbers as intemperate species, but there are some Philippine woods with distinct growth rings. Common occurrence in foreign woods in the northern hemisphere, found distinct and diagnostic in alder (*Alnus* sp.), beech (*Fagus* sp.) and walnut (*Juglans* sp.).

***Vessels/Pores.*** Pores appear on the cross section as round, oblong or angular holes in the wood, depending on the species. They may be large or distinct to the naked eye or readily visible to the naked eye; or they may be small as to make them barely visible to the naked eye or visible only with a hand lens. They may be filled with foam-like structures (tyloses) or with deposits of yellow, black, chalky, white, and other colors.

**Table 1.** Distribution of all species used in wooden structures, ecclesiastical museum collection and other immovable crafts in five project sites visited

| | Official Common Name/ Group/ Trade Name | Scientific name | Family | Batañgas and Laguna | Bohol | Nagcarlan Laguna | Cebu | Iloilo | Total | Percent species/ group/ distribution |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Molave | *Vitex parviflora* A. Juss | Verbenaceae | 15 | 186 | 5 | 274 | 36 | 516 | 27.00 |
| 2 | Batikuling group | *Litsea* sp. | Lauraceae | 5 | 151 | 9 | 148 | 3 | 316 | 16.54 |
| 3 | Tindalo | *Afzelia rhomboidea* (Blanco)S. Vidal | Caesalpiniaceae (Leguminosae) | 10 | 26 | | 161 | 17 | 214 | 11.20 |
| 4 | Kamagong group | *Diospyros* sp. | Ebenaceae | 8 | 13 | 1 | 9 | | 31 | 1.62 |
| 5 | Lauan group | *Shorea* sp. | Dipterocarpaceae | | 44 | | | | 44 | 2.30 |
| 6 | Ipil | *Intsia bijuga* (Colebr.) O. Kuntze | Caesalpiniaceae (Leguminosae) | 3 | 44 | | | 4 | 51 | 2.67 |
| 7 | Ipil ipil | *Leucaena leucocephala* (Lam) de Wit | Minosaceae | | 4 | | | | 4 | 0.21 |
| 8 | Yakal group | *Shorea sp.* | Dipterocarpaceae | 8 | 10 | 4 | 46 | 9 | 77 | 4.03 |
| 9 | Santol | *Sandoricum koetjape* (Burm.f.)Merr. | Meliaceae | 2 | 7 | | | | 9 | 0.47 |
| 10 | Narra | *Pterocarpus indicus* Willd. | Papilionaceae (Leguminosae) | 124 | 20 | 3 | 44 | 8 | 199 | 11.00 |
| 11 | Nato group | *Palaquim* sp. | Sapotaceae | | 2 | 1 | 22 | 1 | 26 | 1.50 |
| 12 | Bagalunga | *Melia azedarach* L. | Meliaceae | | 2 | | | | 2 | 0.10 |
| 13 | Apitong group | *Dipterocarpus* sp. | Dipterocarpaceae | 4 | 8 | 2 | 59 | 9 | 82 | 4.29 |
| 14 | Malugai | *Pometia pinnata* J.R.Forst. & G.Forst. | Sapindaceae | | 1 | | | | 1 | 0.05 |
| 15 | Kamatog | *Sympetalandra densiflora* (Elmer) Steenis | Leguminosae | | 1 | | 6 | | 7 | 0.37 |
| 16 | Makaasim group | *Syzygium* sp. | Mrtaceae | | | | 22 | | 22 | 1.15 |
| 17 | Malasaging group | *Aglaia sp.* | Meliaceae | | 2 | | | | 2 | 0.10 |
| 18 | Dungao/ sambulauan group | *Astronia* sp. | Melastomataceae | | 1 | | | | 1 | 0.05 |
| 19 | Almon | *Shorea almon* Foxw. | Dipterocarpaceae | 1 | 1 | | | | 2 | 0.10 |
| 20 | Mayapis | *Shorea palosapis* Merr. | Dipterocarpaceae | | 2 | | | | 2 | 0.10 |
| 21 | Philippine Mahogany group | *Shorea* sp. | Dipterocarpaceae | 8 | | 17 | 151 | 25 | 201 | 10.52 |
| 22 | Pine(foreign | *Pinus* sp.* | Pinaceae | | 4 | | 5 | 8 | 17 | 0.89 |
| 23 | Antipolo | *Artocarpus blancoi* (Elmer) Merr. | Moraceae | | 1 | | | | 1 | 0.05 |
| 24 | Balete group | *Ficus* sp. | Moraceae | | | 5 | | | 5 | 0.26 |
| 25 | Sangilo | *Pistacia chinensis* Bunge | Anacardiaceae | | | | | 7 | 7 | 0.37 |
| 26 | Mahogany | *Swietenia macrophylla* King | Meliaceae | | 3 | | 1 | | 4 | 0.21 |
| 27 | Kalantas | *Toona calantas* Merr. & Rolfe | Meliaceae | 20 | | | 1 | | 21 | 1.10 |
| 28 | Katong-matsin groip | *Chosocheton* sp. | Meliaceae | | | 3 | | | 3 | 0.16 |
| 29 | Kalingag | *Cinnamomum mercadoi* Vid. | Lauraceae | 1 | | | | | 1 | 0.05 |
| 30 | Kalingag group | *Cinnamomum* sp. | Lauraceae | | | | 1 | | 1 | 0.05 |
| 31 | Toog | *Petersianthus quadrialatus* (Merr.)Merr. | Lecythidaceae | | | | 4 | | 4 | 0.21 |
| 32 | Duguan | *Myrystica* sp. | Myristicaceae | | | 1 | | 1 | 2 | 0.10 |
| 33 | Alupag | *Dimocarpus* sp. | Sapindaceae | | | | | 1 | 1 | 0.05 |
| 34 | Malapinggan group | *Trichadenia* sp. | Flacourtiaceae | 1 | | | | | 1 | 0.05 |
| 35 | Salinay group | *Helicia sp.** | Proteaceae | 1 | | | | | 1 | 0.05 |
| 36 | Lanete | *Wrightia* sp. | Apocynaceae | 1 | | | | | 1 | 0.05 |
| 37 | Almon | *Shorea almon* ***Foxw.*** | Dipterocarpaceae | 1 | | | | | 1 | 0.05 |
| 38 | Erect palm | *Corypha* or *Livistona* | Palmae | 1 | | | | | 1 | 0.05 |
| 39 | Tugbak group | *Stemonurus* sp. | Icaceanaceae | 1 | | | | | 1 | 0.05 |
| 40 | Tambulian | *Eusideroxylon zwageri* Teijm.&Binn. | Lauraceae | 1 | | | | | 1 | 0.05 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 41 | Raintree/Acacia | *Samanea saman (Jacq.)Merr.* | Mimosaceae (Leguminosae) | 3 | | | | | 3 | 0.16 |
| 42 | Dao | *Dracontomelon dao (Blanco)Merr. &Rolfe* | Anacardiaceae | 1 | | | | | 1 | 0.05 |
| 43 | Salinggogon group | *Cratoxylum* sp. | Guttiferae | 1 | | | | | 1 | 0.05 |
| 44 | Walnut (Foreign) | *Juglans* sp.* | Juglandaceae | 1 | | | | | 1 | 0.05 |
| 45 | Alder (Foreign) | *Alnus* sp.* | Betulaceae | 1 | | | | | 1 | 0.05 |
| 46 | Poplar (Foreign) | *Populus* sp.* | Salicaceae | 4 | | | | | 4 | 0.21 |
| 47 | Beech (Foreign) | *Fagus* sp.* | Fagaceae | 9 | | | | | 9 | 0.47 |
| 48 | Narig group | *Vatica* sp. | Dipterocarpaceae | 1 | | | | | 1 | 0.05 |
| 49 | Tree fern | *Cyathea* sp. | Cyatheaceae | 1 | | | | | 1 | 0.05 |
| 50 | Makaasim group | *Syzygium* sp. | Myrtaceae | | 5 | | | 1 | 6 | 0.31 |
| | **Total** | | | **238** | **538** | **51** | **954** | **130** | **1911** | **100.00** |

**Table 2.** Summary and importance value of all the items identified in the five sites.

| Official Common Name | Scientific Name | Family | Number of items identified | Percent |
|---|---|---|---|---|
| Molave | *Vitex parviflora* A. Juss | Verbenaceae | 516 | 27.00 |
| Batikuling group | *Litsea* sp. | Lauraceae | 316 | 16.54 |
| Tindalo | *Afzelia rhomboidea* (Blanco)S. Vidal | Caesalpiniaceae(Leguminosae) | 214 | 11.20 |
| Narra | *Pterocarpus indicus* Willd. | Papilionaceae (Leguminosae) | 199 | 11.00 |
| Philippine Mahogany group | *Shorea* sp. | Dipterocarpaceae | 201 | 10.52 |
| Apitong group | *Dipterocarpus* sp. | Dipterocarpaceae | 82 | 4.29 |
| Yakal group | *Shorea sp.* | Dipterocarpaceae | 77 | 4.03 |
| Ipil | *Intsia bijuga* (Colebr.) O. Kuntze | Caesalpiniaceae(Leguminosae) | 51 | 2.67 |
| Lauan group | *Shorea* sp. | Dipterocarpaceae | 44 | 2.30 |
| Kamagong group | *Diospyros* sp. | Ebenaceae | 31 | 1.62 |
| Nato group | *Palaquim* sp. | Sapotaceae | 26 | 1.50 |
| Makaasim group | *Syzygium* sp. | Myrtaceae | 22 | 1.15 |
| Santol | *Sandoricum koetjape* (Burm.f.)Merr. | Meliaceae | 9 | 0.47 |
| Ipil ipil | *Leucaena leucocephala* (Lam) de Wit | Mimosaceae(Leguminosae) | 4 | 0.21 |
| Kamatog | *Sympetalandra densiflora* (Elmer) Steenis | Caesalpiniaceae(Leguminosae) | 7 | 0.37 |
| Bagalunga | *Melia azedarach* L. | Meliaceae | 2 | 0.10 |
| Malugai | *Pometia pinnata* J.R.Forst. & G.Forst. | Sapindaceae | 1 | 0.05 |
| Malasaging group | *Aglaia* sp. | Meliaceae | 2 | 0.10 |
| Dungao/ sambulauan group | *Astronia* sp. | Melastomataceae | 1 | 0.05 |
| Almon | *Shorea almon* Foxw. | Dipterocarpaceae | 2 | 0.10 |
| Mayapis | *Shorea palosapis* Merr. | Dipterocarpaceae | 2 | 0.10 |
| Antipolo | *Artocarpus blancoi (Elmer) Merr.* | Moraceae | 1 | 0.05 |
| Pine (Foreign) | *Pinus sp.** | Pinaceae | 17 | 0.89 |
| Balete group | *Ficus sp.* | Moraceae | 5 | 0.26 |
| Sangilo | *Pistacia chinensis Bunge* | Anacardiaceae | 7 | 0.37 |
| Mahogany | *Swietenia macrophylla King* | Meliaceae | 4 | 0.21 |
| Kalantas | *Toona calantas Merr. & Rolfe* | Meliaceae | 21 | 1.10 |
| Katong-matsin group | *Chisocheton sp.* | Meliaceae | 3 | 0.16 |
| Kalingag | *Cinnamomum mercadoi Vid.* | Lauraceae | 1 | 0.05 |
| Kalingag group | *Cinnamomum sp.* | Lauraceae | 1 | 0.05 |
| Toog | *Petersianthus quadrialatus (Merr.)Merr.* | Lecythidaceae | 4 | 0.21 |
| Duguan | *Myrystica sp.* | Myristicaceae | 2 | 0.10 |
| Alupag | *Dimocarpus sp.* | Sapindaceae | 1 | 0.05 |
| Malapinggan group | *Trichadenia sp.* | Flacourtiaceae | 1 | 0.05 |
| Salinay group | *Helicia sp.** | Proteaceae | 1 | 0.05 |
| Lanete | *Wrightia sp.* | Apocynaceae | 1 | 0.05 |
| Almon | *Shorea almon Foxw.* | Dipterocarpaceae | 1 | 0.05 |
| Erect palm | *Corypha or Livistona* | Palmae | 1 | 0.05 |
| Tugbak group | *Stemonurus sp.* | Icacinaceae | 1 | 0.05 |
| Tambulian | *Eusideroxylon zwageri Teijm.&Binn.* | Lauraceae | 1 | 0.05 |
| Raintree/Acacia | *Samanea saman (Jacq.)Merr.* | Mimosaceae (Leguminosae) | 3 | 0.16 |
| Dao | *Dracontomelon dao (Blanco)Merr. &Rolfe* | Anacardiaceae | 1 | 0.05 |
| Salinggogon group | *Cratoxylum sp.* | Guttiferae | 1 | 0.05 |
| Walnut (Foreign) | *Juglans sp.** | Juglandaceae | 1 | 0.05 |
| Alder (Foreign) | *Alnus sp.** | Betulaceae | 1 | 0.05 |
| Poplar (Foreign) | *Populus sp.** | Salicaceae | 4 | 0.21 |
| Beech (Foreign) | *Fagus sp.** | Fagaceae | 9 | 0.47 |
| Narig group | *Vatica sp.* | Dipterocarpaceae | 1 | 0.05 |
| Tree fern | *Cyathea sp.* | Cyatheaceae | 1 | 0.05 |
| Makaasim group | *Syzygium sp.* | Myrtaceae | 6 | 0.31 |
| | | | 1,911 | 100 |

Pores may be grouped in such a manner that they are much larger or more numerous at the beginning of the growth ring than those farther out the ring. Woods which exhibit this kind of arrangement are referred to as *ring-porous* as in narra (*Pterocarpus indicus*) and sangilo (*Pistacia chinensis* Burge). When the pores are fairly uniform in size and distribution, they are known as *diffuse-porous* as in the majority of Philippine timbers. Some woods have almost solitary pores, e.g. apitong (*Dipterocarpus* spp.) and other exhibit a combination of solitary and radial pore multiples of two, three or more subdivisions, and in clusters or in chain. In this case, it is necessary to determine whether the solitary pores predominate or they are comparatively more or less than the radial multiples or vice versa, for this helps in identification. Also, it is essential to observe the presence of oblique arrangement of the pores or whether they are characteristically arranged in a more or les radial pattern as in members of the family Sapotaceae.

The presence of scalariform perforation plates is characteristic of certain species of some families of the family Myristicaceae. This feature is usually observed in longitudinal surfaces visible with the aid of a hand lens, appearing in vessel line as thin, elongated, and parallel bars which was a limitation in this case. In cross section, it can also be seen across the pores. Reference to the appearance of vessel lines on longitudinal surfaces is also useful.

***Parenchyma***. This is commonly referred to as soft tissue, consisting of two main types: (i) *apotracheal* – one which is typically independent of the vessels, and (ii) *paratracheal* – that type which is associated with the vessels. Both types may be present in some timbers. Apotracheal parenchyma may be *diffuse*, *marginal* (terminal or initial), *apotracheal banded*, or *diffuse-in-aggregates*. When the parenchyma is scattered singly, appearing sometimes as light-colored dots among the fibers or through the wood, it is said to be *diffuse* in many taxa. That kind of parenchyma which is formed in a more or less continuous layer or line of variable width at the close of a growth period is known as *terminal* in some Leguminous and Sapindaceous species. If it is formed at the beginning of a growth period, it is referred to as *initial* parenchyma. If the soft tissues are in concentric bands or lines typically independent of the vessels, they are known as *apotracheal bands* (Plate II C), e.g. species of Sapotaceae and Meliaceae. They may be spaced uniformly or irregularly and often wavy. If the parenchyma tends to be grouped in short tangential lines from ray to ray, it is referred to as *diffuse-in-aggregates*).

Paratracheal parenchyma may be *vasicentric*, *aliform*, *confluent* or *paratracheal banded*. *Vasicentric* parenchyma forms a complete sheath, narrow or broad, around a pore and circular or slightly oval in shape, usually observed in leguminous woods. If the soft tissue consists of wing-like lateral extensions, it is referred to as *aliform*, e.g., tindalo (*Afzelia rhomboidea*). It is confluent when a series of aliform shapes are connected together, forming irregular tangential or diagonal lines or bands, also seen in tindalo, other members of the Leguminosae and Meliaceae. When it forms concentric lines or bands (more or less in a straight line) associated with pores, it is referred to as *paratracheal banded*. The arrangement of parenchyma in various woods is not clear cut, being intermediate between two or more kinds and, moreover, more than one kind of parenchyma may be present in the same wood.

***Rays.*** The rays appear on the cross section, by the naked eye or hand lens, as lines varying appreciably in width in different timbers. They either run straight or tend to curve, touching one or both sides of the pores; broad in some timbers, as in *Helicia* sp. and in others, they consist of two distinct sizes broad and narrow as in the oak family (Fagaceae) or they are either fine and narrow in most timbers. It is important to compare the ray width the size (tangential diameter) of the pores for it helps in identification. In this report, found diagnostic in alder (*Alnus* sp.) and beech (*Fagus* sp.).

In some timbers, the rays as seen on a tangential surface are in horizontal rows and quite uniform in height. Such arrangement is called storied and appears, as “ripple marks” when

viewed with a hand lens or naked eye. The wood of narra exhibits this characteristic feature. Others are continuous or discontinuous line (interrupted) as viewed in the cross section

***Resin Canals (Resin Ducts) and other Secretory Structures.*** Intercellular canals or usually known, as resin canals or gum/resin ducts, are very useful in identification. These are cavities, not cells, surrounded by special parenchyma cells known as epithelium that secretes resin, gum, oil, etc. into the canal. They are in disposition either axial or vertical, radial or horizontal, and are normal or natural, pathologic or traumatic.

Normal axial resin canals are characteristic features of the Philippine Dipterocarpaceae. On cross section, they are arranged in concentric formation or in tangential series as in the "Philippine mahogany," or diffuse and in short tangential series of two, three or more in apitong. They are either visible to the naked eye or only visible with the aid of a hand lens and often filled with dark contents when fresh (apitong), usually white (Philippine mahogany) and some are empty. Among the members of the Philippine mahogany, mayapis (*Shorea palosapis*) is readily distinguished by its empty resin canals; almon (*Shorea almon*) is partially filled; and the rest, completely filled.

Normal radial canals are found in certain species of the families Anacardiaceae and Burseraceae. In tangential surface, they are usually so small or minute that they can only be observed under a microscope, but some can be seen with the aid of a hand lens because of their dark color due to their contents or they form smudges on the wood.

***Splinter (Ash) Test.*** This test involves the burning in still air of a splinter of match-stick size from the heartwood and observing the appearance and color of the residue. To a certain extent, this test has been found successful in recognizing some timbers that are closely-related in structure as in the "Philippine mahogany" and "Manggachapui" groups. For example, in the Philippine mahogany, tangile (*Shorea polysperma*) can be differentiated from red lauan (*Shorea negrosensis*), the former yields complete ash usually whitish or brownish; the latter burns to a charcoal or leaves fine threads of blackish to black ash in small quantities. In the case of the manggachapui group, test splinter samples of dalingdingan (*Hopea foxworthyi*) burn to brownish (in dark-brown specimens) to white (in lighter-colored samples) compared with manggachapui (*Hopea acuminata*) and gisok-gisok (*H. philipinensis*) which yield white and whitish to grayish ash. Results of the ash test, however, are only indicated when such closely-related species could be separated or a given species yields a characteristic residue that helps to identify it. However, this feature was not used in this project due to limitations encountered in this project

The residue may consist of the following:

- *Complete or Full Ash.* The specimen burns to an ash, which remains in the specimen and more or less retains the shape of the original wood (splinter).
- *Partial Ash*. The residue drifts during the process of burning or the splinter leaves fine amounts of ash.
- *Charcoal*. The splinter burns to a charcoal sometimes with fine threads of black ash.

## Taxonomy

The Cronquist system of plant classification is based on all taxonomic evidences which includes all available information on taxa and relates all evidences to build a truly phylogenetic system reflecting evolutionary relationships of taxa, the ultimate goal of plant taxonomy [18]. Similarly, the APG system of classification is based on a multidisciplinary approach but largely focused on the DNA. Thus, it does not follow the traditional taxonomic hierarchy but uses clades instead. In addition, the PBG system disregards traditional plant morphology so that the clades are not necessarily homogenous morphologically.

To reconcile this, the *Angiosperm Phylogeny Group* (APG) I [19] used the APG clades and the Cronquist-affected families and genera in the order level of the taxonomic hierarchy.

For practical purposes, the Cronquist system is still useful in plant revisions and monographs of taxonomically poorly known taxa, but the APG system truly reflects the phylogenetic relationships of plants [20-22].

**Vernacular names, official common names, trade names**

In the experience of the team, vernacular names aid in determining identity of species in question so that they are included as an important source of information especially to the beginners and those not well trained in wood identification. For this purpose however, vernacular names are not used but the official common names for there is only one valid and accepted name for every species of tree in the country [22]. The use of vernacular names creates confusion for there are many vernacular names referring to the same species [23].

Trade names are used for the sole purpose of convenience as far as marketing of wood is concerned. Species under a trade usually belong to the same family and genera and have similar physico-mechanical properties, thus, the same end-uses. The Philippine Mahogany is a trade name used to refer to seven species under the family Dipterocarpaceae i.e., almon (*Shorea almon*), bagtikan (*Parashorea malaanonan*), mayapis (*Shorea palosapis*), red lauan (*Shorea negrosensis*), tangile (*Shorea polysperma*), tiaong (*Shorea ovata*) and white lauan (*Shorea contorta*). They are so closely related and difficult to identify given the limitations encountered in the identification of the woods. However, they are easily identified when all the surfaces are seen, pores clearly seen given a wider scope of observation, and the use of splinter test. The same is true with other trade names/group names reflected in the report, for instance, malapinggan group (*Trichadenia* sp.), apitong group (*Dipterocarpus* sp.), lanete group (*Wrightia* sp. and *Kibatalia* sp.) , yakal group (*Shorea* sp.), narig group (*Vatica* sp.), tugbak group (*Stemonurus* sp.), salinggogon group (*Cratoxylum* sp.) and kamagong group (*Diospyros* sp.).

**Uses of Species Identified (Local woods and foreign woods)**

Four foreign woods namely, poplar (*Populus* sp.), alder (*Alnus* sp., beech (*Populus* sp.) and walnut (*Juglans* sp.) were identified suggesting that at those times importing woods timber from the northern hemisphere prevailed especially among “illustrados” or relatively rich Filipinos. These woods were identified as component of piano, bent as components of chairs and tables and similar uses. Walnut was used as a component of an imported wall clock. These species are abundant up to the present and used in the manufacture of veneer and plywood.

Local wood used is predominated by narra (*Pterocarpus indicus*) suggesting that the species abounds at that times and available for a variety of uses principally for high quality furniture and woodcrafts. Species with high strength, durability and attractive and decorative grain (usually observed on the radial and tangential sections) include tindalo (*Afzelia rhomboidea*), malapinggan (*Trichadenia* sp.), ipil (*Intsia bijuga*), molave (*Vitex parviflora*), yakal (*Shorea* sp.), narig (*Vatica* sp.), tambulian (*Eusideroxylon zwageri*), raintree/acacia (*Samanea saman*) and kamagong (*Diospyros* sp.). Tambulian is identified for a pestle because it is inherently tough and durable having a relative density of 1 or more. Batikuling (*Litsea* sp.) is ideal for wood carving and other similar end-uses for the wood is relatively light and soft and with natural oil glands ideal for the purpose. The wood of tree fern (*Cyathea* sp.) and erect palms (*Corypha* sp.and *Livistona* sp.) are typical materials for decorative purposes in combination with other furniture. Kalingag (*Cinnamomum mercadoi*) is species with sweet long-lasting scent preferred for cabinets, small items like cigar box, jewelry box, and similar woodcrafts. The fine grained and smooth to the touch lanete (*Wrightia* sp. and *Kibatalia* sp.) is used for small items like chess pieces.

On the other hand, the use of Philippine mahogany is presumably a recent introduction as part of renovations made throughout the years in the shrines and landmarks visited although we assumed they are. These species are ideal for general construction and furniture manufacture at present and originally abundant and composed the bulk of the natural forests.

Dao (*Dracontomelon dao*) and kamagong (*Diospyros* sp.) are ideal for decorative furniture purposes due to their black streaks as seen on the longitudinal sections. Santol (*Sandoricum koetjape*) is preferred for chopping board for the inherent high compression strength.

## Conclusions

Based on the results, field data and other relevant information gathered and presented in this report the following conclusions and recommendations are made. The pieces of furniture and woodcrafts in the 5 national shrines and landmarks visited by the FPRDI wood identification team were identified with a relatively high degree of accuracy using the practical wood structure and identification technique. The result of this study is useful in the restoration and renovation of the historical landmarks and shrines in the Philippines. The replacement of the broken structures and woodcrafts with similar wood will bring the restoration closer it's original and unique form.

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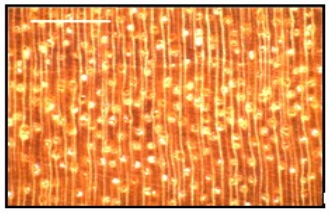
## Appendix 1.

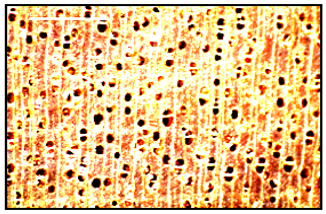
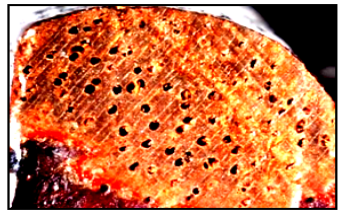
Cross-section macro-photographs of important woods used in the renovation of furniture movable and immovable woodcrafts identified in 5 project sites

1. Official Common Name : Molave
   Scientific Name : *Vitex parviflora* Juss.
   Family Name : VERBENACEAE
   Trade Names : Molave, traded in South-East Asia as "vitex"



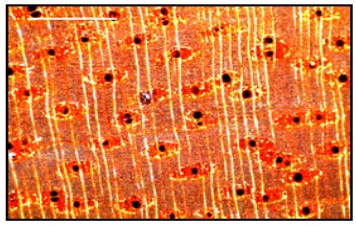

MOLAVE (20X) NHCP IMAGE

2. Official Common Name : "Batikuling group"
   Scientific Names : *Litsea philippinensis Merr.*
   Family Name : LAURACEAE
   Trade Names : Batikuling, Litsea, traded in South-East Asia as "medang"

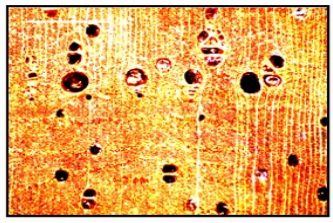
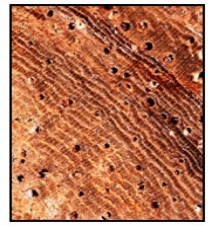
BATIKULING GROUP (20X) NHCP IMAGE

3. Official Common Name : Tindalo
   Scientific Name : *Afzelia rhomboidea* (Blanco) Vidal
   Family Name : CAESALPINIACEAE (APG: LEGUMINOSAE)
   Trade Names : Tindalo, afzelia



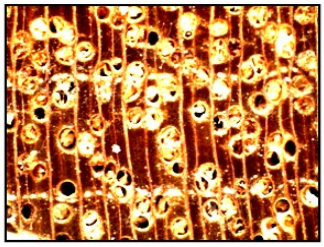

TINDALO (20X) NHCP IMAGE

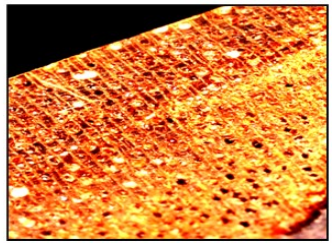
4. Official Common Name : Narra
   Scientific Name : *Pterocarpus indicus* Willd.
   Family Name : PAPILIONACEAE (FABACEAE); (APG: LEGUMINOSAE)
   Trade Names : Narra, pterocarpus, traded in South-East Asia as "narra"

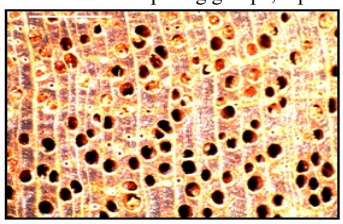
Narra (20x) NHCP Image

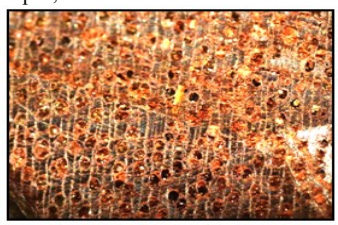
5. Official Common Name : "Philippine mahogany group"
Scientific Names : *Shorea sp.* and *Parashorea*
Family : DIPTEROCARPACEAE
Trade Names : "Philippine Mahogany Group" (*Shorea* and *Parashorea*), S*horea* is traded in South-East Asia as "meranti" while *Parashorea* as "seraya"


PHILIPPINE MAHOGANY GROUP (20X)

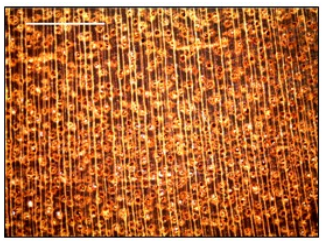

NHCP IMAGE

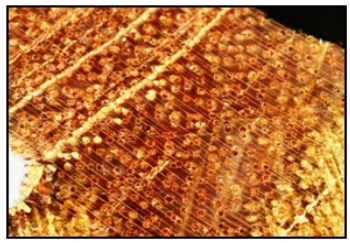
6. Official Common Name : "Apitong group"
Scientific Name : *Dipterocarpus* sp.
Family Name : Dipterocarpaceae
Trade Names : "Apitong group", dipterocarpus, ttraded in South- East Asia as "keruing"


APITONG GROUP (20X)

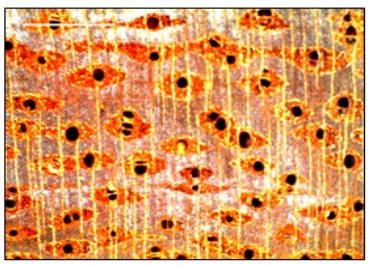

NHCP IMAGE

7. Official Common Name : Yakal Group
Scientific Name : *Shorea* sp.
Family Name : DIPTEROCARPACEAE


YAKAL GROUP

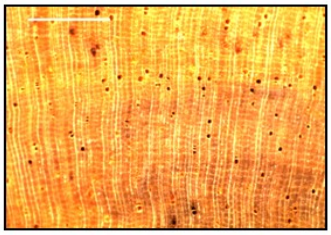

NHCP IMAGE

8. Official Common Name : Ipil
Scientific Name : *Intsia bijuga* (Colebr.) O. Kuntze
Family Name : CAESALPINIACEAE
Trade Names : Ipil, Intsia, traded in South-East Asia as "merbau"


IPIL (20X)

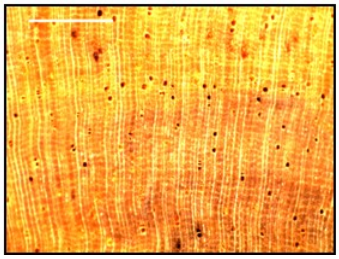

NHCP IMAGE

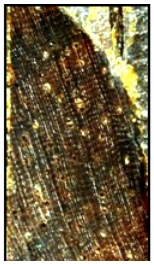
9. Official Common Name : "Kamagong group"
Scientific Names : *Diospyros sp.*
Family Name : EBENACEAE
Trade Names : Kamagong, Anang, Ata-Ata, diospyros, traded in South- East Asia as "streaked ebony"


KAMAGONG GROUP" (20X)

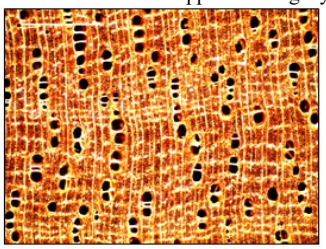

NHCP IMAGE

10. Official Common Name : "Kamagong group"
Scientific Names : *Diospyros sp.*
Family : EBENACEAE
Trade Names : Kamagong, Anang, Ata-Ata, diospyros, traded in SouthEast Asia as "streaked ebony"


KAMAGONG GROUP (20X)

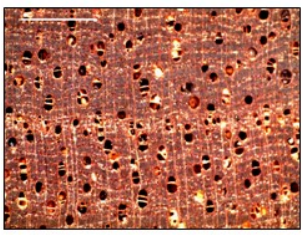

NHCP IMAGE

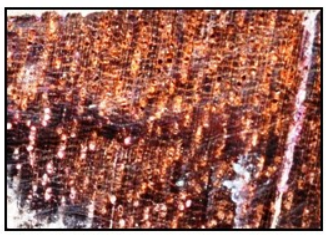
11. Official Common Name : Nato
Scientific Name : *Palaquim* sp.
Family Name : SAPOTACEAE
Trade Names : Nato, Palaquim, traded in South-East Asia as "nyatoh" (sometimes mixed with dark red Philippine Mahogany}


Nato (20x)


NHCP Image

12. Official Common Name : Makaasim group
Scientific Names : *Syzygium* sp.
Family : Myrtaceae
Trade Names : Makaasim, *Syzygium* traded in Southeast Asia as "kelat"


Makaasim group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