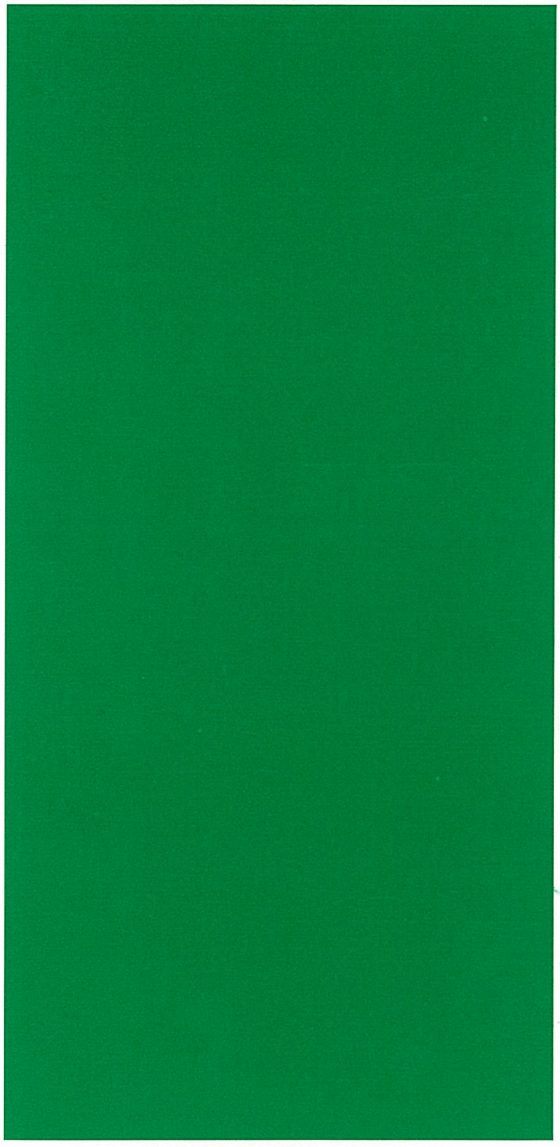
NOUVELLES ESSENCES COMMERCIALISABLES D'AFRIQUE



NEW MARKETABLE SPECIES IN AFRICA

NUEVAS ESPECIES COMERCIABLES DE AFRICA

NEW MARKETABLE SPECIES IN AFRICA

Andoung

DENOMINATIONS

BOTANICAL NAMES

- *Monopetalanthus coriaceus* Morel (Cesalpiniaceae family)
- *Monopetalanthus durandii* F. Halle and Normand
- *Monopetalanthus hedinii* Pellegr.
- *Monopetalanthus heitzii* Pellegr.
- *Monopetalanthus letestui* Pellegr.
- *Monopetalanthus pellegrini* A. Chev.
- *Monopetalanthus longeracemosus* A. Chev.

Note: the name "Andoung" is often applied to numerous trees belonging to the Cesalpiniaceae family. This confusion is due to the fact that the family includes genera possessing very similar botanical characteristics, and this makes their identification in the forest somewhat difficult.
The name Andoung should be applied only to species of soft wood of the genus Monopetalanthus.

COMMERCIAL NAMES

International name ..... ANDOUNG

- Cameroon ..... : Ekop (Ekop Mayo, Ekop Zoele, etc.)
- Congo ..... : Kikayi
- Equatorial Guinea : Andjung, Ekop
- Gabon : Andoung, N'Douma

Andoung

ORIGIN AND SUPPLY

Geographical distribution
Andoungs of the genus *Monopetalanthus* occur throughout West Africa, from Guinea to Zaire; they are encountered more particularly in countries south of the Gulf of Guinea (Gabon, Cameroon and Congo).

Frequency in the forest
Stands of Andoung may consist of a single species or of a mixture of several species.
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 9.3 m^3/ha.
The commonest species in the forest is the Le Testu Andoung.
Andoungs are frequently confused in the forest with Ekaba *(Tetraberlinia bifoliolata),* and this confusion can also occur in industry.

Supply
These woods are commonly exploited and marketed locally, but they are exported only in small quantities and in the form of logs, notably from the Cameroon and Gabon.
If demand increases in the future, they could be marketed to a much greater extent and exported regularly and in considerable quantities, in view of their abundance in certain regions (Cameroon, Congo and Gabon).

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
Andoungs may attain a height of 30 to 40 m.
The bole is generally cylindrical, quite high except in the case of Heitz Andoung; some trees may present a marked curvature.
There are substantial buttresses at the base of the bole. The bark, which is reddish in Heitz Andoung, is light grey to dark grey in other species.
It is smooth, and 10 to 15 mm thick. When green, it may peel off in large strips.

Conformation of the logs
Andoung logs are quite well shaped.
They are usually straight and cylindrical; their diameter varies from 0.70 m to 1 m.
The sapwood is not clearly demarcated from the heartwood when green.

Preservation of logs
Andoung logs are liable to attack by insects and fungi. It is advisable to remove them rapidly from the felling zone and apply fungicidal and insecticidal treatment if they have to remain for any length of time in the forest.

Ability to float
With the exception of *Monopetalanthus durandii,* which is sometimes not floatable (unless it is made up into rafts with lighter woods), Andoung logs may be floated away from the working site, as their density is less than 1 when green.

DESCRIPTION OF THE WOOD

The heartwood is slightly darker than the sapwood, which is pinkish brown, occasionally with a touch of bronze.
The wood darkens on exposure to light more or less rapidly, depending on the species, and becomes a light reddish brown colour when it ages.
There is generally a slight regular interlocking of the grain, which sometimes gives a decorative striped appearance to quartercuts. But the interlocking is sometimes very marked.
Monopetalanthus durandii is the species which usually has the straightest grain.
Species belonging to the Andoung group possess generally similar characteristics; however, from one species to another the interlocking of the grain may be more or less marked, and variations in colour may also be observed.
Magnification (x 15) reveals:
- less than 10 pores per mm^2, of average diameter between 125 and 200 µ;
- parenchyma of two sorts, narrow vasicentric and sporadically in fine marginal lines;
- a relatively large number of rays (8 to 14 mm), monoseriate or biseriate, of homogeneous to subhomogeneous structure; they may or may not be placed at intervals.

TECHNICAL PROPERTIES

Andoungs are light to moderately heavy and soft to moderately hard. Their linear shrinkage is slight to average. Their volumetric shrinkage is average.
Their mechanical strength is between weak and average.

Principal physical and mechanical properties
N.B. : the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density
- **Air dry*:** 530 to 650 kg/m^3.
- **Green:** 750 to 900 kg/m^3.
- **Basic density:** 0.45 to 0.53.

Hardness (Chalais-Meudon scale)*: 2.3 to 3.2 (soft to moderately hard)
Saturation point: 24 % to 35 %
Total volumetric shrinkage: 10.2 % to 11.8
Total tangential shrinkage: 6.5 % to 8.3 %
Total radial shrinkage: 3.8 % to 4.4 %
Sensibility to variations in air humidity: not very important
Movement in use: stable
Volumetric shrinkage for 1 % variation in moisture content: 0.36 % to 0.52 %
Splitting strength*: 12.7 x 10^3 N/m (12.9 kg/cm) to 19.8 x 10^3 N/m (20.2 kg/cm)
Compression strength*: 42 MPa (429 kg/cm^2) to 50 MPa (510 kg/cm^2)
Bending strength*: 87 MPa (888 kg/cm^2) to 112 MPa (1,143 kg/cm^2)
Modulus of elasticity in bending*: 9,800 MPa (100,000 kg/cm^2) to 12,700 MPa (129,600 kg/cm^2)
Shock resistance*: 0.48 kg/cm^2 to 0.64 kg/cm^2 (moderate)

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
Andoung heartwood has a weak natural resistance to fungi causing rot, and requires preservative treatment for all uses in which the wood is liable to be rehumidified. It should not be used in permanent contact with a source of damp.

Natural resistance to Lyctus
There is often no clear demarcation, or none at all, between the sapwood and the heartwood. The entire mass of the wood should be considered as being liable to attack by these insects.

Natural resistance to termites
Andoungs have no resistance to termites *(Reticulitermes santonensis).*

Impregnability
Andoungs are moderately to slightly impregnable.

PROCESSING

Sawing
Andoungs are fairly easy to saw. The silica content of the wood may be considered as negligible, and it consequently has no blunting effect. The interlocked grain tends to make the sawn surfaces fibrous. Yields are generally satisfactory. There are no substantial internal tensions during sawing.

Slicing and peeling
Andoungs slice and peel fairly easily.
Cold peeling is possible in the case of freshly cut logs. In case of steaming, the operation should be performed at 80 °C for 30 hours on logs of diameter 0.60 m.
Peeling usually causes a syrupy resin to be exuded.
The interlocking grain of the wood may give rise to a "chattering" phenomenon when peeling very thick veneers.
The adjustment of the peeler is identical to that recommended for Okoumé wood.
The veneers must be dried carefully in view of possible risks of distorsions and splitting. The veneers are slightly brittle, but may be rolled without causing any marked damage.
The veneers may be glued satisfactorily with glues of the urea-formol or phenol-formol type.
The recommended gluing pressure for making plywood is between 1.3 and 1.4 MPa, depending on the density of the wood.
Andoung plywood conforms to French high quality technical specifications for the manufacture of panels for outdoor use, or for making formwork.

Conclusion
Andoungs are considered easy to peel by manufacturers who use this species. The veneers are slow to dry, but of attractive appearance.

Drying

Air drying
Andoungs must be air dried slowly. Because of the nature of the wood and the presence of possible considerable interlocking, it is advisable to stack the wood under cover, and so far as possible to load the stacks in order to reduce the risk of distorsion.

Kiln drying
The kiln drying of Andoungs is fairly slow. It should therefore be performed carefully and slowly, especially if the grain is interlocked.
The following drying table may be used for wood up to 41 mm thick.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green	45	43	90
60	45	42	85
40	45	41	80
30	50	44	70
25	55	46	60
20	60	50	55
15	65	52	50

Note: pieces with a marked interlocking of the grain may become distorted during drying. In this case it is preferable to subject them to air drying (under load) or to preserve them for uses which do not require perfect straightness or perfect stability over a period of time.

Le Testu Andoung has a linear shrinkage slightly greater than that of other species and its drying must therefore be particularly controlled.
Furthermore, since the industrial identification of the different species of *Monopetalanthus* is not always easy, Andoungs in general should always be dried with particular care.

Fastening

Nails and screws can be inserted easily, and are held satisfactorily.

Gluing

Andoungs may be glued with glues in common industrial use without any special difficulty. Reconstituted solid wood panels and glued laminated beams can be made satisfactorily.

Machining

Andoungs can be machined easily. In the case of interlocking grain, well sharpened tools should be used and the cutting angle should be about 15°.

Finishing

Andoungs are easily sanded. Varnishes and paints can be applied without difficulty.

CONCLUSIONS AND USES

The characteristics of Andoungs may be summed up as follows:

- they are of variable quality and colour (more of less marked interlocking of the grain),
- they possess average mechanical properties,
- they are not very durable and not easily impregnated,
- they require some precautions during drying, but are easy to prepare for use.

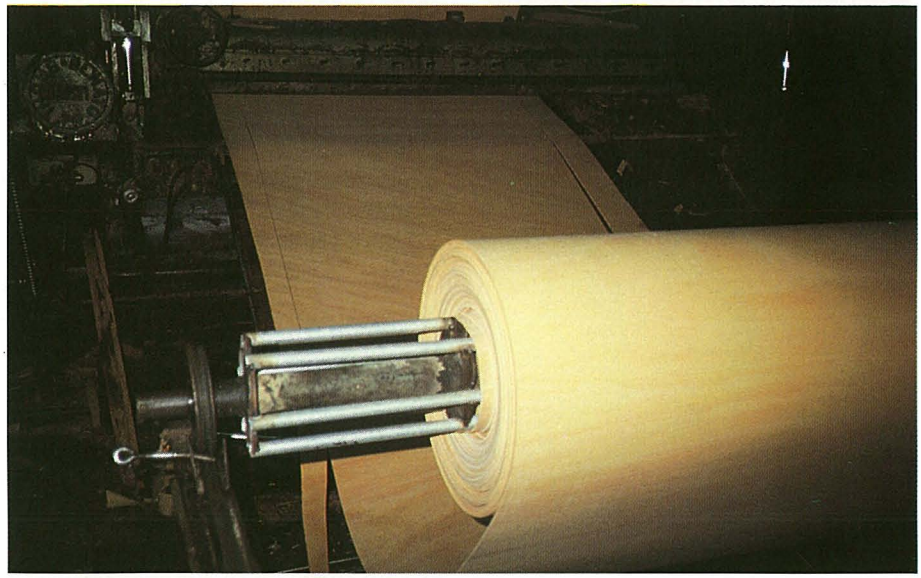
By reason of these properties, Andoungs can be successfully employed locally in several sectors of industry, or they can be exported either in the form of logs of first and second quality (preferably for peeling), or in the form of dry sawnwood, graded so as to eliminate pieces with a markedly interlocked grain.

Primarily, they can profitably be used by the plywood industry for making ordinary plywood panels. The veneers can be combined with other species and used either for the outer surfaces or for the internal layers.

In addition, the physical and mechanical properties of Andoungs, together with their ease of preparation for use, make them a satisfactory wood for interior joinery such as doors, cupboards and staircases.

They can be used for exterior joinery, subject to a correct application of an effective preservative treatment so as to give them sufficient durability.

Furthermore, Andoungs may be used for making furniture components, industrial flooring, truck floors and items or structures not requiring top quality wood.



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NEW MARKETABLE SPECIES IN AFRICA

Bilinga

DENOMINATIONS

BOTANICAL NAMES

- *Nauclea diderrichii* Merril (Rubiaceae family)
- *Nauclea gilletii* Merril
- *Nauclea xanthoxylon* Aubrév.

COMMERCIAL NAMES

International name ..... BILINGA

- Angola ..... : Engolo
- Cameroon ..... : Akondoc
- Central African Republic ..... : Kilu
- Congo ..... : Mokessé, Linzi, N'gulu-maza
- Côte-d'Ivoire ..... : Badi
- Gabon, Equatorial Guinea.... : Aloma, Bilinga
- Ghana ..... : Kusia
- Nigeria, U.K. ..... : Opepe, Opepi
- Sierra Leone ..... : Bundui
- Uganda ..... : Kilingi
- Zaire ..... : N'gulu-maza, Bonkangu

Bilinga

ORIGIN AND SUPPLY

Geographical distribution
Bilinga occurs from Sierra Leone to Angola in the South and to Uganda in the East. It is encountered in the dense forest, and grows preferably on moist or even marshy ground. It is a light species which is also found in the secondary forest, sometimes in conversion plantations.

Frequency in the forest
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 9 m^3/ha.

Supply
Bilinga is known and appreciated locally; it is used for structural framework in the building industry, and generally speaking in all cases where good durability is needed.
Already available in the form of logs or sawnwood from the principal African producing countries (Cameroon, Côte-d'Ivoire, Congo, Gabon, Equatorial Guinea, Ghana, Nigeria, Liberia, and Zaire), Bilinga could enjoy a larger share of the market in the future.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
Bilinga can attain a height of 40 to 50 m. Its trunk, 20 to 30 m, is cylindrical, straight, slender and has no buttress. The bark is rough, very thick and fibrous, and without cracks.

Conformation of logs
Bilinga logs are well-shaped; their diameter varies from 60 to 90 cm, averaging 80 cm.
The sapwood is not very thick (3 to 5 cm) and is generally distinct from the heartwood.

Preservation of the logs
Bilinga sapwood can be attacked by insects and fungi. In general, the heartwood does not deteriorate unless the logs are left a long time in the forest, in which case fungicidal and insecticidal treatment is advisable.

Ability to float
Because the density of the green wood is greater than 1, Bilinga logs cannot be floated away from the working site unless they are made up into rafts in combination with floatable woods.

DESCRIPTION OF THE WOOD

The sapwood is greyish yellow or pinkish yellow in colour.
The heartwood is bright lemon yellow, and darkens slightly on exposure to light, becoming orange or old gold with a faint « moiré » appearance. The grain is often wavy and/or interlocked.
The texture is fairly coarse. The wood has no particular odour.
Magnification ($\times$ 15) reveals:
- Rather unequally distributed pores, often isolated, and few in number (3 to 6 per mm^2). They may be of two different sizes, the larger ones from 200 to 250 μ in diameter and the smaller ones from 100 to 150 μ).
- Small rays, sometimes articulated, 2 to 3 cells wide and of very heterogeneous structure, 10 to 15 per mm.
- Scanty parenchyma, consisting of isolated cells or short tangential lines, is perceptible only under higher magnification.

TECHNICAL PROPERTIES

Bilinga is a moderately hard to hard wood, and moderately heavy to heavy, with average linear shrinkage. Its volumetric shrinkage is average to high.
Its mechanical strength is average.

Principal physical and mechanical properties

N.B. : the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density
- **Air dry*:** 730 to 890 kg/m^3 (average 760 kg/m^3)
- **Green:** 1,000 to 1,100 kg/m^3
- **Basic density:** 0.65

Hardness (Chalais-Meudon scale)*: 5.3 (fairly hard to hard)
Saturation point: 25 %
Total volumetric shrinkage: 12.3 %
Total tangential shrinkage: 7.5 %
Total radial shrinkage: 4.7 %
Sensibility to variations in air humidity: moderately important
Movement in use: fairly stable
Volumetric shrinkage for 1 % variation in moisture content: 0.55 %
Splitting strength*: 17.6 $\times$ 10^3 N/m (17.9 kg/cm)
Compression strength*: 63 MPa (638 kg/cm^2)
Bending strength*: 104 MPa (1,060 kg/cm^2)
Modulus of elasticity in bending*: 11,800 MPa (120,000 kg/cm^2)
Shock resistance*: 0.29 kg/cm^2 (poor)

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
Bilinga's resistance to different types of white rot (*Coriolus versicolor, Pycnoporus sanguineus, Lentinus squarrosulus)* and brown rot (*Antrodia sp.*) is good to very good. It can therefore be used without preservative treatment for most of its applications.
If it is not in direct and permanent contact with the ground, its natural durability can be improved by treatment under vacuum and pressure with appropriate compounds (e.g. creosote for railway sleepers).

Natural resistance to Lyctus
The heartwood is immune to Lyctus.

Natural resistance to termites
Bilinga has a good resistance to termites *(Reticulitermes santonensis).*

Impregnability
The impregnability of Bilinga in a

pressure impregnation plant is usually satisfactory, allowing absorptions of around 200 l/m³ and a good penetration of the compounds in the wood (up to several centimetres).

Natural resistance to marine borers

Among tropical woods, Bilinga is one of the most resistant species to these destructive organisms in the temperate waters of the Atlantic and the Mediterranean.

CHEMICAL PROPERTIES

Bilinga is characterized by:

- a high content of alcohol-benzene extracts (5.8 %) and lignin (33.9 %),
- a low ash content (0.3 %),
- little silica (0.01 %).

The other constituents correspond to the average for tropical woods:

- water extracts: 2.3 %
- hemicelluloses: 13.8 %
- cellulose: 42.1 %

ENERGY PROPERTIES

Carbonization

The charcoal obtained in a laboratory kiln with a yield of 36 % has the following properties:

- Density: 0.36
- Ash: 1.5 %
- Volatile matter: 12 %
- Rehumidification: slight
- Friability: slight

PROCESSING

Sawing

Bilinga can be sawn normally provided that powerful equipment is used. The silica content of the wood may be considered as negligible ($c < 0.05$ %).

Slicing and peeling

Bilinga is difficult to peel. By contrast, it slices easily and gives decorative veneers of good quality provided that it is properly steamed.

Drying

Air drying

Experiments carried out in Gabon made it possible to reduce the moisture content of 34 mm and 41 mm green plants to 19 % in 12 to 15 weeks. Bilinga distorts very slightly in drying. It is very liable to checking and must always be dried slowly and carefully under cover.

Kiln drying

As a general indication, in a conventional kiln, the moisture content of wood 42 mm thick is reduced in 20 days from green to 15 %, in accordance with the following table:

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green	48	45	85
60	50	46	80
40	51	46	75
30	54	48	70
25	60	51	60
20	68	54	50
15	68	54	50

On completion of drying, shallow and frequent checks are observed, but this is a slight defect and usually disappears after planing.

Conclusion: Bilinga must be dried slowly and carefully, whether in air or in a kiln, in order to limit the occurence of checking at the end of the drying cycle.

Note: quarter-cut pieces dry normally without any substantial risk of checks. By contrast, flat-cut pieces dry less easily (more or less serious end splits and checks may occur).

Fastening

Nails and screws can be inserted without difficulty, subject to preboring.

Gluing

Trials carried out with glues of the resorcinal type show that:

- the shear strength is satisfactory in the planes of gluing,
- adhesion is very satisfactory,
- gluability is satisfactory (delamination test).

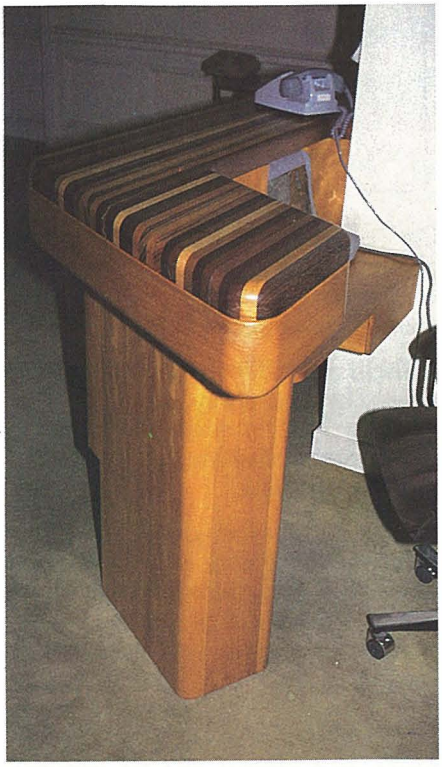
In general, Bilinga glues well with all types of glue in common industrial use. It may even be used for laminated beams under certain conditions.

Finishing

Bilinga sands well. Varnishes and paints can be applied without difficulty. However, if a first class finish is required a filling is recommended.

CONCLUSIONS AND USES

Although comparatively little Bilinga is produced at present because demand for it is slight, this species is fairly commonly used in the areas of production. At the present time, Bilinga is exported in small quantities but regularly.



In view of its satisfactory mechanical strength, good durability and impregnability in a pressure impregnation plant, Bilinga is suitable for numerous outdoor uses: e.g. railway sleepers and harbour and river installations.

More refined uses of this wood can be envisaged, but it should be well dried and protected by a varnish, paint or wax finish in order to reduce exchanges of humidity between the wood and the ambient air, thereby reducing the risk of checking.

In view of the foregoing, Bilinga is suitable for the production of:

- laminated panels
- interior joinery
- exterior joinery
- furniture
- indoor fittings
- parquet floors
- house framing
- truck and wagon trays
- boat building.

It can also provide decorative sliced veneers.

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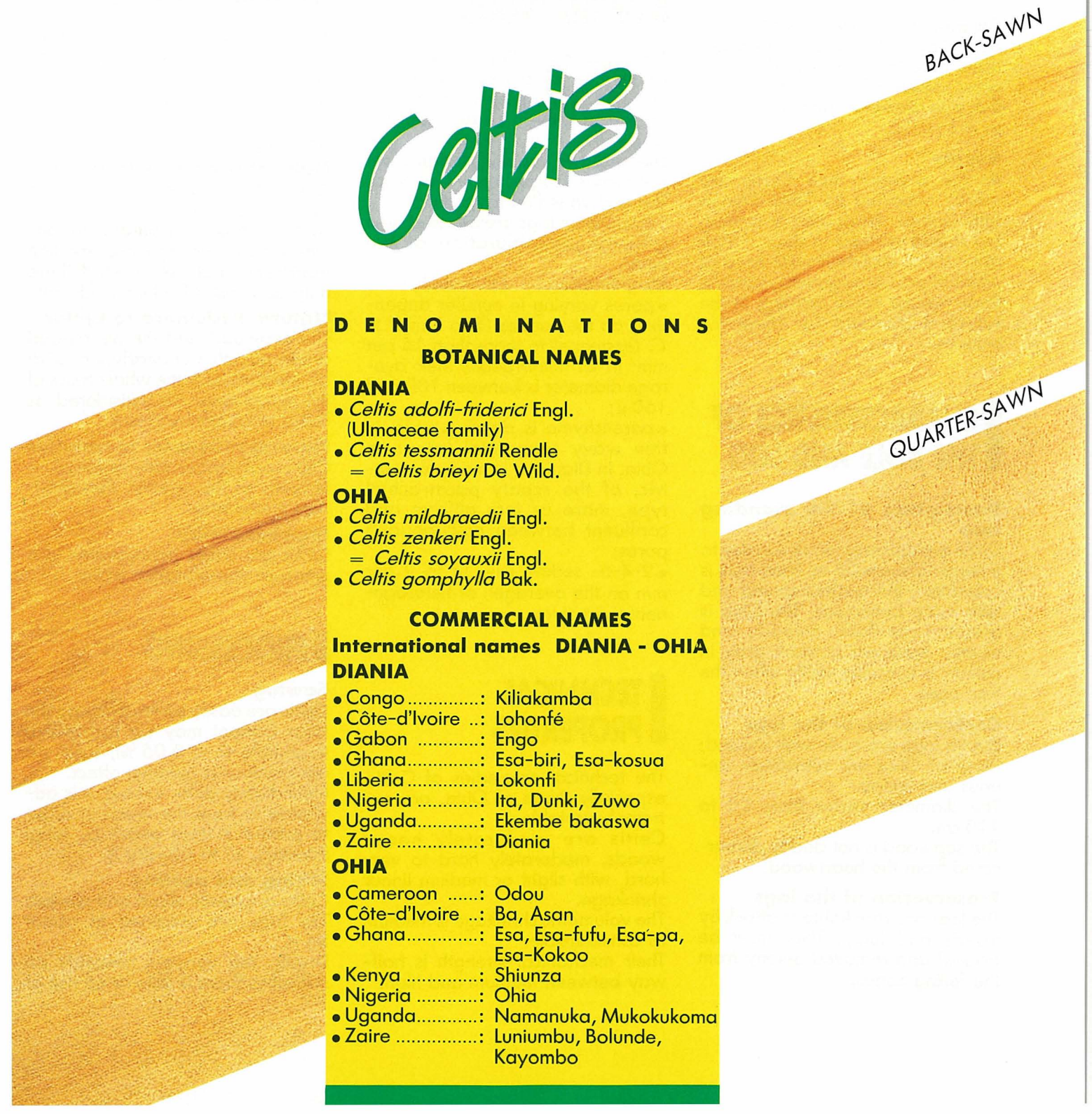

Celtis

DENOMINATIONS

BOTANICAL NAMES

DIANIA

- *Celtis adolfi-friderici* Engl. (Ulmaceae family)
- *Celtis tessmannii* Rendle = *Celtis brieyi* De Wild.

OHIA

- *Celtis mildbraedii* Engl.
- *Celtis zenkeri* Engl. = *Celtis soyauxii* Engl.
- *Celtis gomphylla* Bak.

COMMERCIAL NAMES

International names DIANIA - OHIA

DIANIA

- Congo .....: Kiliakamba
- Côte-d'Ivoire ..: Lohonfé
- Gabon .....: Engo
- Ghana.....: Esa-biri, Esa-kosua
- Liberia .....: Lokonfi
- Nigeria .....: Ita, Dunki, Zuwo
- Uganda.....: Ekembe bakaswa
- Zaire .....: Diania

OHIA

- Cameroon .....: Odou
- Côte-d'Ivoire ..: Ba, Asan
- Ghana.....: Esa, Esa-fufu, Esa-pa, Esa-Kokoo
- Kenya .....: Shiunza
- Nigeria .....: Ohia
- Uganda.....: Namanuka, Mukokukoma
- Zaire .....: Luniumbu, Bolunde, Kayombo

Celtis

ORIGIN AND SUPPLY

Geographical distribution
Celtis occur over very extensive areas; they are encountered in the semi-deciduous moist dense forests and transition forests from Côte-d'Ivoire in the West to Tanzania in the South-East.

Frequency in the forest
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 4.5 m^3/ha.

Supply
At the present time Celtis are mainly exported by Côte-d'Ivoire and Ghana. Production is limited, but should increase in view of their abundance and their wide area of distribution. Consequently, trade in these woods could develop in the future if demand for them increases.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
Celtis are tall trees which can rise to a height of more 35 m. Their bole is cylindrical, but is often curved and with alate buttresses. The bark is about 1 cm thick, smooth, and usually brownish to dark grey in colour; it becomes scaly when the tree ages.

Conformation of the logs
Diania logs are quite well shaped; those of Ohia are sometimes sinuous and lumpy.
The diameter varies from 80 to 110 cm.
The sapwood is not clearly demarcated from the heartwood.

Preservation of the logs
The logs are very liable to attack by insects and fungi. They must be treated and removed quickly from the felling zones.

Ability to float
The logs may be floated away from the working site, since their density when green is less than 1. However, this form of transport is not recommended by reason of their lack of natural durability.

DESCRIPTION OF THE WOOD

The sapwood of Celtis is yellowish white. The heartwood is yellowish white to light beige when green, turning to greyish beige when the wood dries.
The grain is usually straight, but sometimes irregular or interlocked.
The texture is fine to medium.
Some Diania logs are affected by a greenish discolouration at the heart.
Magnification (× 15) reveals :
- pores varying in number depending on the species (5 to 7 mm^2 in *C. tessmannii* to more than 15 per mm^2 in *C. mildbraedii);* their average diameter is between 100 and 150 µ;
- parenchyma is clearly visible, in thin wavy tangential layers in Ohia. In Diania, it is more vasicentric, of the scanty paratrachial type, more or less aliform and confluent between neighbouring pores;
- 2-4-6- seriate rays (6 to 9 per mm on the average), of heterogeneous structure.

TECHNICAL PROPERTIES

The technical properties of Celtis, especially those of Ohia, are extremely variable.
Celtis are moderately heavy woods, moderately hard to very hard, with slight or medium linear shrinkage.
The volumetric shrinkage is medium to considerable.
Their mechanical strength is halfway between medium and high.

Principal physical and mechanical properties
N.B.: the opposite values preceded by an asterisk correspond to a moisture content of 12 % (French standard NF B 51-002).

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
African Celtis have little resistance to rotting fungi. They must be considered as non-durable woods which must undergo preservation treatment for all uses in which there may be a risk of rehumidification.

Natural resistance to Lyctus
The sapwood and the heartwood are frequently not clearly, or not at all, demarcated; the whole mass of the wood must be considered as liable to attack by Lyctus.

Natural resistance to termites
Celtis are moderately resistant to termites of the species *Reticulitermes santonensis.*

Impregnability
Celtis are easily impregnable in a pressure impregnation plant.

PROCESSING

Sawing
Celtis are easily sawn. Because the silica content may be considered negligible ($c < 0.05$ %), they do not produce a blunting effect.
Immediately after sawing, it is advisable to treat the wood in order to protect it from attack by fungi (blueing), or to kiln-dry it.

Slicing and peeling
Celtis are easily sliced and peeled. The logs are steamed at about 85 °C.
Drying the veneers presents no difficulty; there is little or no risk of

	Diania	Ohia
Density:		
• **Dry air**	620 to 830 kg/m³ (average: 720 kg/m³)	580 to 900 kg/m³ (average: 760 kg/m³)
• **Green**	850 to 1,000 kg/m³	850 to 1,000 kg/m³
• **Basic density**	0.63	0.63
Hardness (Chalais-Meudon scale*)	5 (fairly hard to hard)	7 (fairly hard)
Saturation point	26 %	26 %
Total volumetric shrinkage	11.8 %	12.9 %
Total tangential shrinkage	7.4 %	8.3 %
Total radial shrinkage	4.0 %	4.8 %
Sensitivity to variations in air humidity	slight to moderate	
Movement in use	fairly stable wood	
Volumetric shrinkage for 1 % variation in moisture content	0.55 %	0.55 %
Splitting strength (*)	17.3 x 10³ N/m (17.7 kg/cm)	18.5 x 10³ N/m (18.9 kg/cm)
Compression strength (*)	59 MPa (600 kg/cm²)	
Bending strength (*)	126 MPa (1,290 kg/cm²)	
Modulus of elasticity in bending (*)	13,330 MPa (136,000 kg/cm²)	
Shock resistance (*)	0.46 kg/cm² (moderate)	

splitting, and tangential shrinkage is moderate.

They may be satisfactorily glued with glues of the urea-formol or phenol-formol type. The recommended gluing pressure for making plywood is between 1.4 and 1.5 MPa, depending on the density of the wood.

It should be noted that sanding Ohia panels may create dust which is sometimes irritating.

As a general indication, industrial trials of peeling and plywood production in the case of Celtis have been carried out under the following conditions:

- steaming temperature: 65-70 °C;
- adjustment of peeler:
  - sharpened blade at 19.5°,
  - sharpened pressure bar at 55°;
- veneer thicknesses: 11/10, 23/10, 30/10;
- continuous drying of veneer:
  - 160 °C for a feed rate of 15 m/mm (veneer 30/10 mm),
  - 180 °C for a feed rate of 30 m/mm (veneer 11/10 mm);
- urea-formol gluing on both sides (330 g/m²).

The results of these trials were as follows:

- no undesirable consequences of steaming (no end splitting of the logs);
- veneers of good appearance, but with knots;
- yield: veneer 81 %, plywood 54 %;
- after drying, satisfactory appearance of the veneers apart from some slight buckling.

Drying

The wood must be dried slowly and carefully. There may be a risk of distortion in the case of markedly interlocked pieces. End splits may also occur during drying, especially in Ohia.

Air drying

To avoid the risk of attack by fungi, fungicidal treatment should be applied immediately after sawing. In addition, the sawnwood should preferably be stacked under cover. It is also recommended:

☐ To load the wood in order to prevent possible distortions of the pieces at the top of the stacks (a customary precaution).

☐ To coat the ends of the planks with paint or anti-splitting compounds.

Kiln drying

Kiln drying calls for precautions similar to those recommended for air drying. As a general indication, for wood 42 mm thick, 15 days are required in a conventional kiln dryer in order to lower the moisture content of the wood from 38 % to 16 %, in accordance with the table of the following page.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green	40	37	85
50	48	44	80
40	52	47	75
30	52	45	68
25	56	47	60
20	56	44	50
15	60	44	40

At the end of this drying process, fissures and end cracks are observed in most of the flat-cut pieces. To limit this risk, the relative humidity of the air should be maintained at higher levels than those indicated above, or the temperature should be reduced.

Conclusion : if Celtis are dried too rapidly, checks and splits may occur, and possibly also distortions in the case of interlocked pieces.
As for all woods of this type, drying should be performed slowly and carefully. In the case of air drying, fungicidal treatment should be applied in order to avoid any risk of blue stain.

Fastening

For dense and heavy woods, preboring is necessary prior to nailing or screwing.

Gluing

Celtis may be glued with all glues in common industrial use.
On glued laminated beams composed of a single species or different species (Diania, Ohia), trials with glues of the resorcin type have shown that:

- the shear strength in the planes of gluing is satisfactory;
- adhesion is satisfactory.

Machining

Celtis are easily machined, unless there is substantial interlocking in the sawnwood; in which case the tools should be well-sharpened and the cutting angle should be about 15°.
The machining of Ohia creates dust which may sometimes be irritating; each machine should therefore be fitted with a dust extractor.

Finishing

Celtis are easily sanded. Paints and varnishes can be applied without any special difficulty.

CONCLUSIONS AND USES

Considering their abundance and extensive area of occurence, Celtis are still inadequately exploited.
They are suitable for numerous uses, provided that some precautions are taken after felling (treatment of logs) such as careful drying in order to prevent the risk of splitting and distortion.

By reason of their satisfactory mechanical properties and their amenability to impregnation, Celtis may be used for:

- interior joinery
- floors (notably for sports premises)
- furniture
- stairs
- mouldings and baseboards
- structural frames under cover
- exterior joinery (treated)
- sports gear.

For all indoor uses, prior treatment to protect the wood against Lyctus is recommended.

Second grade pieces can also be used for formwork and crates.
In the producing countries, Celtis are used in the form of veneer for making plywood (notably for packaging) and are sometimes used for decorative purposes.

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NEW MARKETABLE SPECIES IN AFRICA

Dabéma

DENOMINATIONS

BOTANICAL NAME

- *Piptadeniastrum africanum* Brenan (Mimosaceae family)
  = *Piptadenia africana* Hook.

COMMERCIAL NAMES

International name ..... DABÉMA

- Angola, Congo ..... : N'Singa
- Cameroon : Atui
- Central African Republic : Koungou
- Côte-d'Ivoire ..... : Dabéma
- Equatorial Guinea..... : Tom
- Gabon ..... : Toum
- Ghana (and U.K.) ..... : Dahoma, Elae, Odan
- Liberia ..... : Mbeli
- Nigeria (and U.K.)..... : Agboin, Ekhimi
- Sierra Leone ..... : Mbele, Guli
- Uganda ..... : Mpewere
- Zaire..... : Bokungu, Likundu
- Netherlands..... : Bukundu

Dabéma

ORIGIN AND SUPPLY

Geographical distribution

Dabéma occurs from the Casamance in Senegal to Angola in the South and Uganda in the East.

It is one of the most abundant of trees growing in dense forests. It is also encountered in transition forests in climates where there is a very marked dry season. It also frequently occurs in semi-deciduous forests on river banks.

Frequency in the forest

According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.15 to 6 m^3/ha.

Supply

This species is currently exported in small quantities by most countries on the West coast of Africa, especially Côte-d'Ivoire, Liberia, Ghana, Nigeria, Cameroon, Gabon, Congo and Zaire. Inventories made in various African countries reveal a considerable volume of exploitable and marketable standing timber.

Though Dabéma is less abundant in other countries and regions, the potential supply is nevertheless very considerable. Consequently this species could be supplied regularly and in abundance if systematically exploited.

It is at present supplied mainly in the form of logs. However, its supply in the form of sawnwood presents no technical difficulty and should develop in the future. This should make it possible to export only wood of the first and second grades (with little or no interlocking).

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree

Dabéma is a tall tree whose trunk may rise to a height of 25 to 30 m below the branches. The trunk is straight, cylindrical, and has slight but well-developed buttresses at its base; they separate and snake out for a considerable distance from the foot of the tree.

The bark, which does not adhere very firmly, is thin, smooth or slightly scaly; sometimes it is horizontally grooved.

Conformation of the logs

Dabéma logs are usually well-shaped; their diameter varies from 70 to 115 cm, but may occasionally attain 180 cm.

The sapwood, 5 to 15 cm thick, is clearly demarcated from the heartwood.

Preservation of logs

Dabéma sapwood is liable to attack by insects and fungi. In general, the heartwood does not deteriorate unless the logs are left for a long time in the forest, in which case fungicidal and insecticidal treatment is advisable.

Ability to float

By reason of the high density of the wood when green, the logs cannot be floated away from the working site unless they are made up into rafts in combination with floatable wood.

DESCRIPTION OF THE WOOD

The sapwood of Dabéma is greyish white. The heartwood varies in colour; it may be pale golden brown, greenish yellow, or yellowish grey.

The grain is sometimes irregular and often interlocked. Sometimes it is regular, giving certain sawn wood a striped appearance.

The texture tends to be coarse.

When fresh, the wood has a characteristic foetid odour, slightly ammoniacal, which disappears after drying.

Dabéma occasionally has wind shakes.

Magnification (x 15) reveals:

- pores, which are sparse (2 or 3 per mm^2) and large (200 to 250 µ);
- parenchyma of two kinds, either vasicentric, becoming aliform and confluent at the end of growth, or in the form of isolated and dispersed cells among the fibres or along the rays;
- small rays, 3- to 5- seriate, 5 or 6 per mm, of homogeneous structure.

TECHNICAL PROPERTIES

Dabéma is a moderately heavy, moderately hard wood whose linear shrinkage is slight to medium. Its volumetric shrinkage is medium to considerable. Its mechanical strength is average.

Principal physical and mechanical properties

N.B. : the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density

- **Air dry*:** 590 to 800 kg/m^3 (average 700 kg/m^3)
- **Green:** 900 to 1,100 kg/m^3
- **Basic density:** 0.59

Hardness (Chalais-Meudon scale)*: 4.4 (fairly hard)

Saturation point: 27 %

Total volumetric shrinkage: 12.4 %

Total tangential shrinkage: 8.5 %

Total radial shrinkage: 3.8 %

Sensibility to variations in air humidity: not very important

Movement in use: moderately stable, if the wood is straight-grained and properly dried. Unstable if the wood is interlocked

Volumetric shrinkage for 1 % variation in moisture content: 0.55 %

Splitting strength*: 23.8 × 10^3 N/m (24.3 kg/cm)

Compression strength*: 57 MPa (584 kg/cm^2)

Bending strength*: 136 MPa (1,390 kg/cm^2)

Modulus of elasticity in bending*: 12,260 MPa (125,000 kg/cm^2)

Shock resistance*: 0.48 kg/cm^2 (moderate)

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
The natural resistance of Dabéma to fungi causing rot varies considerably, from good to mediocre. The resistance decreases from the external heartwood towards the core of the tree; the core is no more resistant than the sapwood.

Natural resistance to Lyctus
The heartwood is immune to Lyctus.

Natural resistance to termites
The heartwood has a satisfactory resistance to termites *(Reticulitermes santonensis).*

Impregnability
Dabéma heartwood is resistant to impregnation, even under pressure.

PROCESSING

Sawing
Like most hard and dense woods on the market, Dabéma saws well provided powerful equipment is used. Stellited blades may be used, but are not essential. The silica content of the wood may be considered as negligible ($c < 0.01$ %).

Slicing and peeling
Only the possible presence of large knots may make Dabéma difficult to peel.
It is advisable to steam the wood at about 85 °C.
The veneers dry slowly and irregularly (presence of pockets of water).
The risk of splitting is slight, but the veneers may present considerable corrugations.
The veneers may be glued satisfactorily with glues of the urea-formol and phenol-formol type.
The recommended gluing pressure for making plywood is between 1.5 and 1.8 MPa, depending on the density of the wood.
The plywood obtained from Dabéma veneers has excellent mechanical characteristics and satisfactory natural durability (the core is not processed because of its poor durability).
This plywood conforms to high-quality French technical specifications for the manufacture of panels for outdoor uses, or for making formwork.
Dabéma slices well, but slicing is mainly to be envisaged when the logs have a regular interlocked grain which can give striped veneers. Dabéma's heterogeneous colour then gives the veneers an appearance which certain users highly appreciate.

Drying
Dabéma is sometimes difficult to dry.
The risk of distortion of pieces with an irregular interlocked grain, and of case-hardening, is not negligible.
The best results, from the point of view of both quality and economy (cost of drying) are obtained by air drying prior to kiln drying.
It is advisable to stabilize the wood at the end of the cycle.

Air drying
The sawnwood should preferably be stacked under cover. It is also advisable to:
- load the wood in order to prevent possible distortion of the pieces at the top of the pile;
- coat the ends of the planks with paint or anti-splitting compounds.

Kiln drying
Kiln drying requires the same precautions as air drying.
To avoid any risk of case-hardening, the following drying table may be used for drying wood up to 54 mm thick. A preliminary stage of preheating is recommended (at 50 °C and 90 % relative humidity of the air). This is maintained for about an hour for each centimetre of thickness. It is advisable to begin drying at a lower temperature (in the region of 35 °C) and to keep the air at a high level of relative humidity.
Note: when the pieces are air dried before being kiln dried, they should be reheated to 45 °C and at 90 % air humidity, after which they should be dried under the conditions corresponding to the moisture content of the wood, nevertheless increasing the relative humidity of the air by about 15 % during the first stage.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
(1) green	50	48	90
(2) green	35	33	85
100	35	32	80
80	36	33	80
60	38	33	70
50	40	33	60
40	45	36	55
30	48	37	50
25	54	39	40
20	60	42	35
15	60	42	35
(3)	50	44	70

(1) Preheating.
(2) Cooling to 35 °C, maintaining the relative humidity of the air at 85 %.
(3) Regularization (for about 16 to 24 hours for pieces up to 55 mm thick).

Fastening

Nails and screws can be inserted easily but there may be some risk of splitting at the extremities of the pieces.
Nails and screws are held well.

Gluing

Trials carried out with glues of the resorcin type reveal that:
- the shear strength in the planes of gluing is satisfactory;
- adhesion is slightly below the average for other woods of the same density;
- the glue holds satisfactorily over a period of time (delamination test).

With other industrial glues, Dabéma presents no special difficulty.

Machining

Dabéma is easily machined. But like all woods with a very interlocked grain, the tools should be well sharpened, and the cutting angle should be about 15°. Machining may create dust which is sometimes irritating; it is therefore advisable for each machine to be fitted with an efficient dust extractor.

Finishing

Dabéma can be sanded, painted and varnished without difficulty. However, in view of its coarse texture, sanding must be performed carefully, and a sealing coat is essential before the application of paint or varnish.

CONCLUSIONS AND USES

The unpleasant odour of the wood when fresh, its variable durability, the precautions to be taken during drying and preparation for use, and its mediocre stability in use, are all factors which at present restrict the marketing of this wood. However, considering its satisfactory mechanical characteristics and its abundance, Dabéma remains insufficiently marketed and could be systematically extended to other uses provided that:
- It is marketed in the form of sawnwood.
- The wood is selected so that only straight-grained or regularly interlocked-grained pieces are machined (first and second grade wood).
- Its use in the form of glued laminated wood is developed.

By reason of its appearance, Dabéma can in some cases compete with species such as oak for traditional structural frames, parquet floors, flat decks, staircases, railway truck floors.
It may also be used for interior or exterior frames and joinery which are intended to be painted, as well as for railway sleepers and harbour works.
Its appearance makes it suitable for the manufacture of "rustic" furniture.
In the form of reconstituted panels, it is suitable for numerous uses:
- prefabricated parquet floors;
- partitions;
- panels for cupboards, shelving, etc.

It can also provide high-performance plywood panels of good durability, suitable for special uses.
Dabéma will never compete with tropical species of the very highest quality, but by reason of its abundance it will become increasingly appreciated in the future.

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NEW MARKETABLE SPECIES IN AFRICA

Gombé

DENOMINATIONS

BOTANICAL NAMES

- *Didelotia africana* Baill. (Cesalpiniaceae family)
- *Didelotia idae* Oldeman, de Witt, J. Léonard
- *Didelotia letouzeyi* Pellegr.

COMMERCIAL NAMES

International name..... GOMBÉ

- Cameroon..... : Ekop-gombé
- Côte-d'Ivoire..... : Broutou
- Gabon..... : Angok
- Liberia ..... : Bondu
- Sierra Leone ..... : Timba

Gombé

ORIGIN AND SUPPLY

Geographical distribution
Gombé occurs in all the wet forests of West Africa from Liberia and Sierra Leone in the West to Congo and Central African Republic in the East.
But it is more frequently encountered in Cameroon, Congo and Gabon, and locally in the Central African Republic.

Frequency in the forest
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 0.5 m^3/ha.

Supply
At the present time, a certain amount of Gombé is exported, mainly in the form of logs, from the producing countries, notably Cameroon and Côte-d'Ivoire.
Appreciably greater quantities of this wood could be exploited and exported if demand increases.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
Gombé is a tall tree which can rise to a height of more than 50 m.
Its trunk, 20 to 25 m high, is practically cylindrical as far as the buttresses, which are thick and usually short.
The bark is smooth, grey and mottled with whitish, greenish or pinkish spots which form superposed bands. On old trees, the bark peels off in places in discs 2 to 5 cm in diameter.

Conformation of logs
The logs are generally well shaped; their diameter can reach 1 m to 1.20 m.
The sapwood, sometimes more than 10 cm thick, is clearly demarcated from the heartwood.

Preservation of logs
Gombé logs are liable to attack by insects and fungi, and must be quickly removed from the felling zone. Fungicidal and insecticidal treatment of the logs is advisable if they have to remain for a long time in the forest or in storage yards.

Ability to float
Because their density when green is less than 1, Gombé logs can be floated away from the working site.

DESCRIPTION OF THE WOOD

The sapwood is whitish to yellowish.
The heartwood is salmon pink, sometimes with a few greenish-brown veins.
The grain is usually straight, occasionally interlocked. This interlocking is however inconsiderable.
The texture is coarse.
When green, the wood has a strong odour (slightly pungent) which is difficult to define.
Magnification (× 15) reveals :
- few pores (2 to 5 per mm^2), fairly large (170 to 250 µ), sometimes isolated and with an oval contour, sometimes radially joined in twos or threes;
- moderately abundant vasicentric parenchyma in lozenge form, and sporadically in final marginal lines;
- monoseriate or biseriate rays, very small, averaging 9 per mm, and of very slightly heterocellular structure.

TECHNICAL PROPERTIES

Gombé is a light and soft wood, with average linear shrinkage. Its volumetric shrinkage is also average.
Its mechanical strength is halfway between weak and average.

Principal physical and mechanical properties
N.B.: the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density
- **Air dry*:** 570 to 690 kg/m^3 (average: 640 kg/m^3)
- **Green:** 700 to 900 kg/m^3
- **Basic density:** 0.50

Hardness (Chalais-Meudon scale)*: 2.2 (soft)

Saturation point: 32 %

Total volumetric shrinkage: 13 %

Total tangential shrinkage: 8.6 %

Total radial shrinkage: 4.8 %

Sensibility to variations in air humidity: not very important

Movement in use: stable

Volumetric shrinkage for 1 % variation in moisture content: 0.55 %

Splitting strength*: 14.4 x 10^3 N/m (14.7 kg/cm)

Compression strength*: 54 MPa (551 kg/cm^2)

Bending strength*: 101 MPa (1,035 kg/cm^2)

Modulus of elasticity in bending*: 11,560 MPa (118,000 kg/cm^2)

Shock resistance*: 0.49 kg/cm^2 (moderate).

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
The natural resistance of Gombé to fungi causing white rot *(Lentinus squarrosulus, Coriolus versicolor)* is weak to average. Its resistance to agents causing brown rot *(Antrodia sp.)* is weak.
In practice, the wood needs to be treated for uses in which it is exposed to risks, such as exterior joinery. Gombé is not recommended for uses in which the wood is in contact with the soil or with frequent sources of damp, even if it is treated.

Natural resistance to Lyctus
The heartwood is immune to Lyctus.

Natural resistance to termites
Gombé has a weak resistance to termites *(Reticulitermes santonensis).*

Impregnability
Gombé is difficult to impregnate. For outdoor uses under shelter, a double-vacuum pressure impregnation plant treatment is necessary in order to ensure durability.

CHEMICAL PROPERTIES

Chemical composition of the wood
Gombé is characterised by:

- a low extract content (alcohol-benzene extracts: 1.7 %; water extracts: 1.6 %);
- a low ash content: 0.6 %;
- a high content of hemicelluloses (18.1 %) and lignin (33 %).

The cellulose content (41 %) is average for tropical woods in general.

PROCESSING

Sawing
Gombé is easily sawn. The silica content can be considered negligible ($c < 0.05$ %).
The sawing yield is generally satisfactory, though certain logs may contain a considerable amount of sapwood.

Slicing and peeling
Gombé can usually be peeled without difficulty. The logs must be steamed at about 80 °C.
There may be some difficulties in drying the veneers (risk of splitting).
The veneers can be satisfactorily glued using glues of the urea-formol or phenol-formol type. The recommended gluing pressure for the production of plywood is between 1.4 and 1.6 MPa.
Gombé plywood has a satisfactory mechanical strength.
Gombé slices without any special difficulty, and gives veneers a particular aspect highly appreciated by certain users.

Drying
Air drying
Gombé can be air-dried without any substantial risk. But because the tangential shrinkage of this wood is greater than average for tropical woods in general, it is more advisable to take certain precautions (drying under cover) in order to prevent excessively rapid drying.

Kiln drying
The kiln drying of Gombé poses no particular problem.

As a general indication, for wood 27 mm thick, 20 days are needed to lower the moisture content of the green wood to 15 % in accordance with the following table.

Wood free of defects can be obtained with it.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green	48	45	84
40	51	46	78
30	54	48	73
25	60	51	63
20	66	53	50
15	72	54	40

Conclusion: Gombé generally dries well, and no substantial defects occur. However, drying should not be performed too quickly because of the possible risk of splitting and case-hardening where very thick pieces are concerned.

Fastening
Nails, screws and staples can be inserted without difficulty, and are held satisfactorily.

Gluing
Gombé can be satisfactorily glued with all glues in common industrial use, notably vinyl glues.

Gombé can be used to make laminated beams.

Machining
Gombé can be machined without any special difficulty. Some pieces may have an interlocked grain, and it is therefore advisable for the tools to be well sharpened in order to ensure a satisfactory surface quality after machining.

Finishing
Gombé is easily sanded.
Paints and varnishes can be applied without difficulty.

CONCLUSIONS AND USES

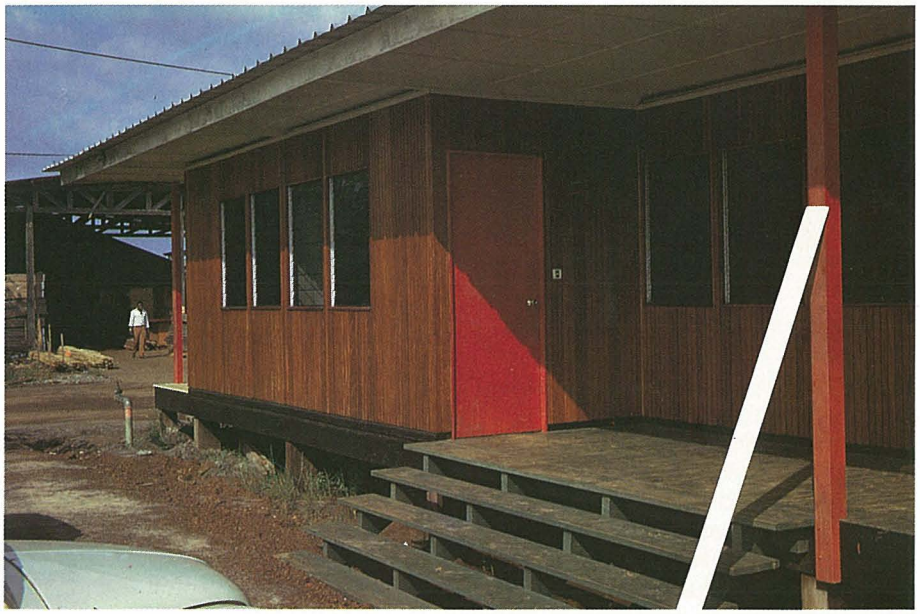
Though not a great deal of Gombé is produced at present because of the low demand, greater quantities of this wood could be exported in the future, having regard to:

- its availability, which is by no means negligible in certain regions and which is comparable to that of other species frequently exploited and marketed;
- its satisfactory and useful technical properties;
- its decorative appearance.

Furthermore, by reason of its physical and mechanical properties and its easy workability, Gombé is suitable for numerous uses, including:

- interior joinery
- exterior joinery (in temperate zones and subject to treatment)
- furniture and seats
- structural frames
- construction of timber-frame houses
- decoration
- industrial flooring and wagon floors.

In some producing countries, Gombé is at present commonly peeled for making plywood intended for outdoor uses (formwork, the building industry). It is also peeled and can provide veneers for the furniture industry.



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NEW MARKETABLE SPECIES IN AFRICA

iatandza

DENOMINATIONS

BOTANICAL NAME

- *Albizia ferruginea* Benth.
  (Mimosaceae family)
  = *Albizia angolensis* Welw.

COMMERCIAL NAMES

International name..... IATANDZA

- Angola..... : Zanzangue
- Cameroon..... : Evouvous
- Congo ..... : Sifou-sifou
- Côte-d'Ivoire.. : Yatandza
- Ghana ..... : Awiemfo-samina, Okuro, Kulo, Awiafu-samina
- Nigeria ..... : Ayinre-ogo
- Togo ..... : Murase
- Uganda..... : Muchole
- Zaire ..... : Elongwamba, Okuru

iatandza

ORIGIN AND SUPPLY

Geographical distribution
The area in which Iatandza grows extends from the Casamance in the East to Angola and Zaire in the South-West. It is encountered in all the dense, wet, semi-deciduous forests in this area.

Frequency in the forest
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 0.5 m^3/ha.

Supply
Though Iatandza could be worked and marketed to a greater extent than it is, little of it is exported. However, it is regularly exported from Côte-d'Ivoire, Ghana, Congo and Zaire to certain European countries where it is appreciated.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
The Iatandza is a very tall tree which can rise to a height of more than 40 m.
Its bole, 9 to 12 m, is straight, cylindrical and without a buttress.
The bark is reddish brown to dark grey, fairly thick, cracked and scaly.

Conformation of the logs
Iatandza logs are generally straight, cylindrical and well formed. Their diameter varies from 60 to 90 cm.
The sapwood, about 5 cm thick, is clearly demarcated from the heartwood.

Conservation of the logs
Iatandza sapwood is liable to attack by insects and fungi. The heartwood does not generally deteriorate unless the logs remain for a long time in the forest, in which case fungicidal and insecticidal treatment is advisable.

Ability to float
Because of their high density when green, the logs cannot be floated away from the working site unless they are made up into rafts in combination with floatable woods.

DESCRIPTION OF THE WOOD

The sapwood is whitish to pale brown.
The heartwood is brown to dark brown, with touches of gold.
The grain is not often straight and frequently interlocked (slightly or considerably, regularly or irregularly).
The texture is coarse.
Magnification (x 15) reveals:
- Pores, frequently isolated, few in number (1 to 3 per mm^2), and relatively large (200 to 300 µ in diameter);
- parenchyma of two sorts: vasicentric, lozenged, more or less frequently confluent, or in the form of isolated and diffused cells (often cristalliferous);
- 2-to 5-seriate rays, narrow (15 to 40 µ), and of homogeneous structure.

TECHNICAL PROPERTIES

Iatandza is a light wood, soft to moderately hard, with slight linear shrinkage. Its volumetric shrinkage is average.
Its mechanical strength is halfway between weak and average.

Principal physical and mechanical properties
N.B. : the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density
- **Air dry*:** 500 to 640 kg/m^3 (average 600 kg/m^3)
- **Green:** 850 to 1,050 kg/m^3
- **Basic density:** 0.51

Hardness (Chalais-Meudon scale)*: 3.4 (soft to fairly hard)
Saturation point: 24 %
Total volumetric shrinkage: 9.2 %
Total tangential shrinkage: 4.9 %
Total radial shrinkage: 2.9 %
Sensitivity to variations in air humidity: not very important
Movement in use: stable
Volumetric shrinkage for 1 % variation in moisture content: 0.43 %
Splitting strength*: 16.10^3 N/m (16.3 kg/cm)
Compression strength*: 50 MPa (515 kg/cm^2)
Bending strength*: 89 MPa (913 kg/cm^2)
Modulus of elasticity in bending*: 10,500 MPa (107,000 kg/cm^2)
Shock resistance*: 0.22 kg/cm^2 (poor).

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
Iatandza has a satisfactory resistance to fungi causing rot, and therefore may be used without treatment except under extremely unfavourable conditions of exposure (in contact with the soil or with a permanent source of rehumidification).

Natural resistance to Lyctus
The heartwood is immune to Lyctus.

Natural resistance to termites
The heartwood is satisfactorily resistant to termites of the species *Reticulitermes santonensis.*

Impregnability
Iatandza heartwood is not easily amenable to impregnation, even under pressure. The sapwood is permeable.

CHEMICAL PROPERTIES

Chemical composition of the wood

This species is characterized by:

- a high content of alcohol-benzene extracts: 8.0 %;
- a low cellulose content: 40.8 %.

It has a low ash content (0.7 %), and contains very little silica (0.04 %).

Its other constituents are average for tropical woods in general: water extracts (2.4 %), hemicelluloses (16.4 %), lignin (30.4 %).

PROCESSING

Sawing

Iatandza is easily sawn and requires no particular precautions. Its silica content may be considered as negligible ($t < 0{,}05$ %), and consequently it does not produce a blunting effect.

Slicing and peeling

Iatandza can be sliced and peeled very easily. The logs are steamed at about 85 °C.

The drying of the veneers presents no difficulty (little risk of splitting, slight tangential shrinkage). They can be glued satisfactorily with glues of the urea-formol or phenol-formol type. The recommended gluing pressure for making plywood is between 1.4 and 1.6 MPa.

Sanding of the veneers may produce irritating dust.

Drying

Air drying

Iatandza dries rather slowly, but generally without difficulty. When there is a considerable and irregular interlocking of the grain, the same precautions should be taken as for all woods with interlocked grain:

- preferably stack the wood under cover,
- load the stacks,
- apply an anti-splitting paint to the ends of the planks.

Kiln drying

Like air drying, kiln drying is rather slow but presents no difficulty.

Since the radial and tangential shrinkage of this wood is particularly low in relation to its density, the risk of splitting and checking is only occasional.

The following drying schedule may be used for thicknesses between 27 and 54 mm.

Conclusion: though it dries easily, Iatandza should be dried slowly because of the nature of this wood; distortions may occur if the wood has a considerable interlocked grain.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green	57	54	85
50	57	53	80
40	60	53	70
30	65	55	60
20	76	59	45

Fastening

Nails, screws and staples may be inserted without any special difficulty.

Gluing

Iatandza glues satisfactorily with all glues in common industrial use. It can be used for making glued laminated beams or for other interior or exterior purposes.

Machining

Iatandza is easily machined. If the wood has a considerable interlocking of the grain, the tools should be well sharpened and applied at a cutting angle of about 15°.

Machining may generate dust, which may occasionally be irritating; each machine should therefore be fitted with an effective dust extractor.

Finishing

By reason of its rather coarse grain, Iatandza must be sanded carefully. To obtain a first class finish, a sealing coat is essential before varnishing or painting.

iatandza

CONCLUSIONS AND USES

At the present time, Iatandza is not used to any great extent, though its satisfactory mechanical properties, durability and low shrinkage make it suitable for a wide range of uses. Only its rather coarse texture and its frequent interlocking grain limit its application where a first class finish is required.
It is suitable for:

- exterior joinery (without treatment)
- interior joinery
- parquet flooring
- urban furniture
- furniture
- structural frames.

Being amenable to slicing and peeling, it can also be used for making plywood and peeled veneers.
Iatandza of slightly inferior quality can be used for making formwork and crates.

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NEW MARKETABLE SPECIES IN AFRICA

izombé

DENOMINATIONS

BOTANICAL NAME

- *Testulea gabonensis* Pellegr. (Ochnaceae family)

COMMERCIAL NAMES

International name ..... IZOMBÉ

- Cameroon..... : Rone
- Congo ..... : N'Gwaki
- Gabon ..... : Zombé, Mogongou, Ake, N'komi, Akewe, Ossakogha

izombé

ORIGIN AND SUPPLY

Geographical distribution
Izombé occurs in Gabon (notably in the Lambaréné-Tchibanga-Lastoursville triangle, in the vicinity of Lake Onangué in the region of the estuary), in Congo (in particular in the Sibiti-Zanaga zone), and in Cameroon (particularly in the Campo region).

Frequency in the forest
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 1 m^3/ha.

Supply
Comparatively little Izombé is produced at the present time, there being no great demand for it on the international market.
It is currently exported mainly in the form of logs, particularly from Cameroon and Gabon. The supply of dried sawnwood could develop in the future and favour the marketing of this wood.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
Izombé is a tall tree 30 to 40 m high, whose buttresses can reach several metres high.
Its bole, 15 to 18 m, is high, straight and cylindrical. Its bark has a thin film of cork in the form of brittle flakes of unequal thickness which when they come off reveal yellow ochre depressions on a lenticellate background.

Conformation of the logs
Izombé logs are usually very well shaped, straight and cylindrical. Their diameter varies from 0.70 m to 0.90 m, but may attain 1.20 m. The sapwood is not very thick (3 to 5 cm) and not clearly distinct from the green heartwood.

Preservation of the logs
Izombé sapwood can be attacked by insects and fungi. In general, the heartwood does not deteriorate unless the logs are left for a long time in the forest, in which case fungicidal and insecticidal treatment is advisable.

Ability to float
Because of the high density of the greenwood, Izombé logs cannot be floated away from the working site unless they are made up into rafts in combination with floatable woods.

DESCRIPTION OF THE WOOD

When dry, Izombé heartwood is of a uniform yellow ochre colour, sometimes tinted with a slightly more sustained reddish brown shade.
The sapwood is not clearly distinct from the green heartwood. When drying, it separates and takes on a light greyish colour, often edged with a purplish brown vein.
Flat sawn surfaces have a slight figuring; quartered surfaces are more regularly shaded.
The texture is fine and often very fine. The grain is often wavy and interlocked, so that the wood is frequently "moiré".
The flecking is very fine and barely visible.
The wood contains no resin to create any problems in its use. It has no special odour.
Magnification (× 15) reveals :
- pores which are almost always isolated, fine (70-90 µ) and numerous (25 to 40 per mm^2); they are often obstructed by reddish resinoid deposits;
- scanty paratracheal or diffuse parenchyma, not very abundant and not easily perceptible;
- 2-3- seriate rays, 8 to 10 mm, of heterogeneous structure.

TECHNICAL PROPERTIES

Izombé is a moderately heavy, moderately hard wood with average linear and volumetric shrinkage.
Its mechanical strength is average.

Principal physical and mechanical properties
N.B.: the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density
- **Air dry*:** 640 to 790 kg/m^3 (average: 720 kg/m^3)
- **Green:** approximately 1,000 kg/m^3
- **Basic density:** 0.60

Hardness (Chalais-Meudon scale)*: 5.2 (fairly hard)
Saturation point: 25 %
Total volumetric shrinkage: 10.2 %
Total tangential shrinkage: 7.0 %
Total radial shrinkage: 4.0 %
Sensitivity to variations in air humidity: not very important
Movement in use: stable
Volumetric shrinkage for 1 % variation in moisture content: 0.48 %
Splitting strength*: 16.6 x 10^3 N/m (16.9 kg/cm)
Compression strength*: 61 MPa (620 kg/cm^2)
Bending strength*: 111 MPa (1,135 kg/cm^2)
Modulus of elasticity in bending* : 10,500 MPa (108,000 kg/cm^2)
Shock resistance*: 0.25 kg/cm^2 (poor).

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
Izombé has a very good resistance to *Coriolus versicolor, Pycnoporus sanguineus* and *Antrodia sp.* Its resistance to *Lentinus squarrosulus* is somewhat less.
Izombé can therefore be considered as a durable or very durable wood. Under unfavourable conditions of exposure, it requires no preservation treatment.

Natural resistance to Lyctus
The heartwood is immune to Lyctus.

Natural resistance to termites
The wood has a satisfactory resistance to termites *(Reticulitermes santonensis).*

Impregnability
Izombé heartwood is not easily impregnated, even under pressure.

CHEMICAL PROPERTIES

Chemical composition of the wood
Izombé is characterized by:

- A high lignin content (38.7 %) and a high content of alcohol-benzene extracts (6.7 %).
- A low cellulose content (35.2 %).
- A low ash content (0.4 %).

It contains practically no silica.
The other chemical constituents of Izombé correspond to those of tropical woods in general:

- water extracts: 1.9 %
- hemicelluloses: 14.2 %.

PROCESSING

Sawing
Izombé is easily sawn, but requires powerful equipment because of its hardness and the large diameter of the logs. The silica content of the wood is negligible ($c < 0.05$ %).

Slicing and peeling
Izombé slices easily and gives decorative veneers. It can be peeled, but because of its density it is of limited value for the production of plywood.

Drying

Air drying
Quarter sawn pieces dry quickly and well, whereas flat sawn pieces are very liable to checking.
Air drying before artificial drying must be performed in barely ventilated but protected sheds in order to slow down the drying process and thereby reduce the risk of checking.

Kiln drying
Drying Izombé in a conventional kiln is a tricky operation and calls for many precautions. The best results have been obtained by maintaining a moderate temperature and high level of humidity so as to slow down the drying process.
At the beginning of the cycle, it is advisable to maintain a humidity of 100 % in the cell for 24 hours, and to stabilize when drying is completed (100 % relative humidity for 4 to 5 hours).
In the light of the above, the following table may be adopted.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green (100)	45	45	100
40	40	38	90
30	40	38	90
20	40	37	85
15	40	37	85

As an indication, for wood 41 mm thick, 20 days are required in a drying kiln to lower the moisture content from 40 % to 16 % in accordance with the following table. This table shows that Izombé dries very rapidly despite the maintenance of a high moisture content during the whole drying cycle; and it confirms that in order to reduce the risk of checking and splitting, drying must be performed slowly.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
40	25	25	100
28	32	32	100
22	35	35	100
18	35	33	90
16	35	32	80

Conclusion: Izombé must be dried with care, especially at the end of the cycle, in order to avoid checking (moderate temperature, and high air humidity slightly decreasing in the course of drying). It is also advisable to dry the wood to a moisture content below that appropriate for its conditions of use.

Fastening
Nails and screws can be inserted easily, and are held, but preboring is recommended in the case of industrial uses, particularly for pieces of small cross-section.

Gluing
Trials carried out with glues of the vinyl type have proved satisfactory. In general, Izombé can be glued firmly with all glues in common industrial use, provided that the wood is very dry and that the presses are heated to the lowest possible temperature.

Finishing
Izombé is easily sanded, giving a very smooth finish.
Paints and varnishes can be applied without difficulty.

CONCLUSIONS AND USES

In view of its abundance in certain regions and its worthwhile mechanical characteristics, the marketing of Izombé should develop in the future. Provided certain precautions are taken during drying, Izombé is primarily an excellent wood for solid or veneered cabinet-making work, as well as for decorative elements and fittings, and for some of these uses it could compete with cherrywood.

Its characteristics in respect of machining and finishing, together with its excellent durability, also make it suitable for:

- exterior joinery (without preservation treatment)
- interior joinery
- ships' masts and ribs (as a substitute for teak)
- parquet flooring
- staircases
- mouldings
- sports equipment (skis).

It is also suitable for the production of sliced veneers.

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NEW MARKETABLE SPECIES IN AFRICA

Lati

DENOMINATIONS

BOTANICAL NAMES

- *Amphimas ferrugineus* Pierre (Cesalpiniaceae family)
- *Amphimas pterocarpoïdes* Harms

COMMERCIAL NAMES

International name .....LATI

- Cameroon : Edjin-Edzil
- Congo : Muizi
- Côte-d'Ivoire : Lati
- Gabon : Edzui
- Ghana : Yaya, Asanfran
- Liberia : White oak, Bliaglü, Va-tue
- Zaire : Bokanga

Lati

ORIGIN AND SUPPLY

Geographical distribution

Lati occurs in the dense forests, transition forests and secondary forests on the shores of the Gulf of Guinea.

Amphimas pterocarpoïdes is the commonest species; it is encountered from Equatorial Guinea to Zaire.

Amphimas ferrugineus is more particularly encountered in Cameroon, Gabon and north-western Angola.

Frequency in the forest

According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 1.5 m^3/ha.

Supply

At the present time, small quantities of Lati are exported from the producing countries, but exports could be stepped up appreciably in the future if demand increases.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree

Lati is a tall tree which can attain a height of 40 to 50 m.

Its bole is high (20 to 25 m), straight and cylindrical; but in trees growing in secondary forests it may be irregular.

The base has thick and fairly regular buttresses.

The bark is about 5 mm thick, scaly, and dark grey to blackish in colour.

Conformation of the logs

The logs are generally well shaped. Their diameter varies from 0.80 m to 1 m, sometimes more.

The sapwood is clearly demarcated from the heartwood in *Amphimas pterocarpoïdes,* but less so in *Amphimas ferrugineus.*

Preservation of the logs

Lati logs are very liable to attack by insects and fungi. They must be removed from the working site as soon as possible after felling. Fungicidal and insecticidal treatment is recommended.

Ability to float

Lati logs may be floated away from the working site, since their density when green is less than 1. However, floating is not advisable by reason of their lack of natural durability.

DESCRIPTION OF THE WOOD

The sapwood is yellowish-white; the heartwood is yellowish-white to brownish.

The presence of regularly spaced and clearly visible bands of parenchyma give the wood a characteristic appearance reminiscent of Eyong.

The grain is straight; when it is interlocked, the defect is not a serious drawback.

The texture is coarse.

Magnification (× 15) reveals :

- few pores, of variable diameter (150 to 350 µ);
- parenchyma (visible to the naked eye) in thick and slightly wavy tangential bands, enclosing the pores;
- 3-4- seriate rays, 6 or 7 per mm, of homogeneous structure, in staggered configuration;
- a tiered structure, clearly visible on tangential sections.

TECHNICAL PROPERTIES

Lati is a moderately heavy, moderately hard to hard wood with average radial shrinkage and high tangential shrinkage. Its volumetric shrinkage is considerable.

Its mechanical strength is average.

Principal physical and mechanical properties

N.B.: the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density :

- **Air dry*:** 700 to 880 kg/m^3 (average: 800 kg/m^3)
- **Green:** 900 to 1,000 kg/m^3
- **Basic density:** 0.62

Hardness (Chalais-Meudon scale)*: 5.3 (moderately hard to hard)

Saturation point: 32 %

Total volumetric shrinkage: 16.5 %

Total tangential shrinkage: 10.7 %

Total radial shrinkage: 6.4 %

Sensitivity to variations in air humidity: not very important

Movement in use: fairly stable wood

Volumetric shrinkage for 1 % variation in moisture content: 0.66 %

Splitting strength*: 21.2 x 10^3 N/m (21.6 kg/cm)

Compression strength*: 68 MPa (694 kg/cm^2)

Bending strength*: 126 MPa (1,285 kg/cm^2)

Modulus of elasticity in bending* : 13,230 MPa (135,000 kg/cm^2)

Shock resistance*: 0.59 kg/cm^2 (moderate).

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi

Lati has only a mediocre resistance to rotting fungi and preservative treatment is recommended for all uses in which the wood is liable to be temporarily rehumidified.

Natural resistance to Lyctus

The sapwood and the heartwood are not clearly demarcated, and it is therefore wise to consider the whole mass of the wood as being liable to attack by Lyctus.

Natural resistance to termites

Lati has an average to mediocre resistance to termites of the species *Reticulitermes santonensis.*

Impregnability

Lati has a satisfactory impregnability.

CHEMICAL PROPERTIES

Chemical composition of the wood

The following chemical composition relates only to *Amphimas pterocarpoïdes,* which is the most common species.

This species has a particularly low content of extractable matter (alcohol-benzene extracts: 1.9 %; water extracts: 0.9 %).

The ash content is low (0.7 %) and the silica content is negligible.

The other constituents are average for tropical woods in general:

- hemicellulose: 15.9 %
- cellulose : 41.9 %
- lignin: 32.1 %.

PROCESSING

Sawing

Because of the hardness of the wood (moderately hard to hard) and the sometimes considerable diameter of the logs, powerful equipment is needed.

Slicing and peeling

By reason of its nature and appearance, Lati is not in great demand for peeling at the present time, though when sliced it can give worthwhile decorative veneers.

Drying

Difficulties may arise in drying Lati; the risk of distorsion and checking, especially in flat cuts, is not negligible. Air drying is advisable prior to kiln drying, and the wood should be stabilized at the end of the cycle.

Air drying

Air drying must be performed under cover and under moderate ventilation, in order to reduce the risk of checking. It is also advisable to load the stacks of wood so as to limit the risk of distorsion.

Kiln drying

Drying Lati in a conventional kiln is a tricky operation, and certain precautions must be taken. A preliminary stage of preheating is recommended (at 50 °C and 100 % relative humidity) in order to prevent case-hardening.

The following drying schedule is recommended for pieces up to 54 mm thick.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green	50	50	100
Green	40	38	90
40	40	38	90
30	45	42	85
25	50	44	70
20	55	49	70
15	60	54	70

Conclusion: to avoid the risk of checking, air drying and kiln drying must both be performed slowly, maintaining the relative humidity of the air at a high level.

Fastening

Nails and screws can be inserted easily, subject to pre-boring.

Gluing

Lati can be glued satisfactorily with all common industrial glues, notably vinyl glues.

Machining

Lati can be machined without difficulty. However, because of the structure of this wood, the tools must be well sharpened in order to prevent stripping of the fibres.

Finishing

Lati is easily sanded.

Varnishes and paints can be applied without difficulty.

CONCLUSIONS AND USES

Production of Lati is on a small scale at present, but could develop in the years to come in view of its relative abundance in certain regions and its fairly extensive area of distribution.
Lati can be used for a wide range of purposes, subject to:

- careful drying (preliminary air drying, and kiln drying with the relative humidity of the air maintained at a high level);
- insecticidal and fungicidal treatment when the wood is liable to attack by fungi or insects.

In the light of its satisfactory mechanical properties, its satisfactory impregnability, and its attractive appearance, Lati is suitable for:

- interior joinery
- wainscoting
- mouldings
- modern furniture
- decorative panels and structures
- general purpose furniture
- heavy structural frames
- flooring.

It may also be used for indoor furnishings and fittings and decorative plywood.

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NEW MARKETABLE SPECIES IN AFRICA

Limbali

DENOMINATIONS

BOTANICAL NAMES

- *Gilbertiodendron dewevrei* J. Léonard (Cesalpiniaceae family)
  = *Macrolobium dewevrei* De Wild.
- *Gilbertiodendron preussii* J. Léonard

Note: certain other species are also marketed under the name of Limbali, among them:

- *Gilbertiodendron taïense* Aubrév.
- *Gilbertiodendron brachystegioïdes* J. Léonard
- *Gilbertiodendron klainei* J. Léonard

COMMERCIAL NAMES

International name ..... LIMBALI

- Cameroon ..... : Ekobem
- Central African Republic ..... : Molapa
- Congo..... : Epal, Bemba
- Côte-d'Ivoire .... : Vaa
- Gabon ..... : Abeum with large leaves, Bembe
- Liberia..... : Sehmeh
- Nigeria ..... : Ekpagoi eze
- Sierra Leone..... : Mbombi
- Zaire ..... : Limbali, Ditshipi, Ligudu

Limbali

ORIGIN AND SUPPLY

Geographical distribution
Limbali occurs from Sierra Leone to Zaire. *Gilbertiodendron dewevrei* is mainly encountered in Zaire, while *Gilbertiodendron preussii* is confined to Côte-d'Ivoire and adjacent countries.
Among the twenty or so species of *Gilbertiodendron, Gilbertiodendron dewevrei* and *Gilbertiodendron preussii* produce the finest trees. They are usually encountered in dense wet forests on firm (and especially sandy) ground, but also in marshy forests or on river banks.
Gilbertiodendron dewevrei can occur in extensive pure stands.

Frequency in the forest
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 14 m^3/ha.
Densities may be much higher locally in pure stands.

Supply
At present, Limbali is mainly exported by Côte-d'Ivoire, Nigeria, Cameroon, Congo and Zaire.
However, it is exploited irregularly and in small quantities. In view of its abundance in certain regions, a regular and substantial supply in the form of logs or sawnwood could be foreseen if demand is forthcoming.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
Gilbertiodendron dewevrei can attain a height of 30 to 45 m.
Gilbertiodendron preussii is usually shorter.
The base of the bole of Limbali has no buttress or flare; sometimes there is a slight thickening at the base of the trunk.
The bole is straight and cylindrical.
The bark is yellowish brown, about 1 cm thick, and peels off in large patches.

Conformation of the logs
Limbali logs are usually well shaped. Their diameter varies from 70 to 90 cm and may exceed 115 cm.
The sapwood, 5 to 10 cm thick, is clearly demarcated from the heartwood.

Preservation of the logs
The sapwood of Limbali may be attacked by insects and fungi. In general, the heartwood does not deteriorate unless the logs are left for a long time in the forest, in which case fungicidal and insecticidal treatment is advisable in order to protect the sapwood.

Ability to float
Because the density of the green wood is greater than 1, Limbali logs cannot be floated away from the working site unless they are made up into rafts in combination with floatable woods.

DESCRIPTION OF THE WOOD

The sapwood is yellowish white to light pinkish brown.
The heartwood is reddish brown with greenish or coppery hues.
The grain is usually straight, or sometimes slightly interlocked.
The texture is coarse.
Magnification (× 15) reveals:
- Few pores (2 to 5 per mm^2); they are large (200-250 μ).
- Vasicentric lozenged parenchyma, and sporadically in fine marginal lines.

Numerous fine rays (8 to 12 per mm), monoseriate or partially biseriate, of somewhat heterogeneous structure.

TECHNICAL PROPERTIES

Limbali is moderately heavy to heavy, moderately hard to hard, with average linear shrinkage.
Its volumetric shrinkage is considerable.
Its mechanical strength is halfway between average and high.

Principal physical and mechanical properties
N.B.: the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density :
- **Air dry*:** 730 to 880 kg/m^3 (average: 815 kg/m^3)
- **Green:** 1,000 to 1,200 kg/m^3
- **Basic density:** 0.66

Hardness (Chalais-Meudon scale)*: 5.5 (fairly hard to hard)
Saturation point: 26 %
Total volumetric shrinkage: 13.9 %
Total tangential shrinkage: 9.0 %
Total radial shrinkage: 4.7 %
Sensitivity to variations in air humidity: not very important
Movement in use: fairly stable
Volumetric shrinkage for 1 % variation in moisture content: 0.62 %
Splitting strength*: 17.1 x 10^3 N/m (17.4 kg/cm)
Compression strength*: 72 MPa (732 kg/cm^2)
Bending strength*: 152 MPa (1,555 kg/cm^2)
Modulus of elasticity in bending* : 14,500 MPa (148,000 kg/cm^2)
Shock resistance*: 0.59 kg/cm^2 (moderate).

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
Though Limbali generally has a good resistance to fungi causing white rot *(Coriolus versicolor, Pycnoporus sanguineus, Lentinus squarrosulus),* its resistance to agents causing brown rot *(Antrodia sp.)* is no more than average.
In practice, it is suitably durable without treatment for uses carrying only a moderate risk (exterior joinery in the building industry). Because of the poor impregnability of the wood, its durability in exposed uses (in contact with the soil or with frequent sources of humidity) is poor, even if a preservative treat-

ment is applied.

Natural resistance to Lyctus
The heartwood is immune to Lyctus.

Natural resistance to termites
Limbali is moderately resistant to *Reticulitermes santonensis.*

Impregnability
Limbali is difficult to impregnate.

CHEMICAL PROPERTIES

Chemical composition of the wood
Limbali is characterized by:

- A low extract content: alcohol-benzene extract: 0.9 %; water extracts: 1.2 %.
- A high lignin content (35.5 %).
- Little silica (0.03 %).

The other chemical constituents are average for tropical woods in general:

- ash: 0.9 %
- hemicelluloses: 15.2 %
- cellulose: 41.7 %.

PROCESSING

Sawing
By reason of the fairly large diameter of the logs and the hardness of the wood, powerful equipment is needed to saw Limbali. Even though the silica content is low ($c < 0.05$ %), this wood has a slightly blunting effect. Some logs may crack because of internal tensions. Consequently sawing in the round is recommended promptly after felling.

Slicing and peeling
Limbali can be sliced and peeled.

Drying
Air drying
Limbali dries slowly in air. Distorsions, checks and splits may occur during drying. To guard against these defects, it is advisable to place the wood under cover.

Kiln drying
As a general indication, for wood 27 mm thick, 23 days are required in a conventional kiln dryer to lower the moisture content of the green wood to 15 %, in accordance with the following table.

Moisture content of wood (%)	**Temperature dry bulb** (°C)	**Temperature wet bulb** (°C)	**Relative humidity of air** (%)
Green	50	46	80
30	54	49	75
25	58	50	65
20	62	51	55
15	66	50	43

Note: this drying schedule is prudent for wood 27 mm thick, and has given pieces free of defects. It should also give good results for thicknesses ranging between 27 and 54 mm.

Conclusion: Limbali dries rather slowly, and drying must be performed carefully in order to avoid splitting and checking which may occur by reason of the physical properties of this wood (considerable anisotropic shrinkage).

Fastening
Nails and screws can be inserted in Limbali, but pre-boring is often necessary and is recommended to reduce the risk of splitting.

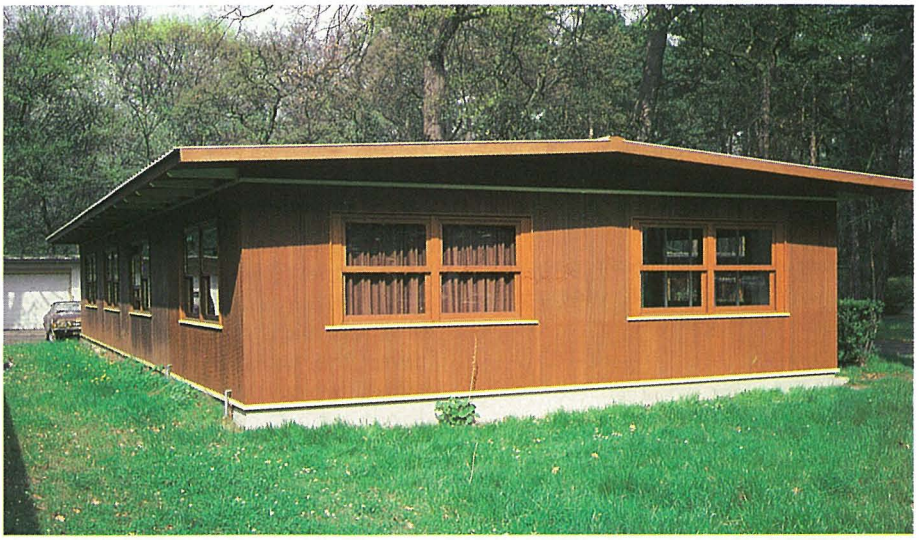
Gluing
Limbali glues easily with all glues in common industrial use, notably vinyl glues. But its use for laminated wood exposed to bad weather conditions is to be avoided (because of its marked shrinkage).

Finishing
Limbali is easily sanded, and acquires an attractive polish.
Paints and varnishes can be applied without difficulty, but must be laid on abundantly because the wood is highly absorbant. For uses where special care is needed, the application of these finishes is advisable in order to guard against rehumidification which may cause distortion.

CONCLUSIONS AND USES

In view of its exceptional abundance in some regions, Limbali offers future possibilities of regular supplies, and could be exported in substantial quantities.
Though slow, its drying presents no special difficulty.
Its good mechanical strength and satisfactory natural durability make Limbali suitable for a wide range of uses, among them:

- exterior joinery (without treatment)
- wainscoting
- interior joinery
- construction of wooden houses
- heavy structural frames
- parquet flooring
- vehicle floor panelling
- bridge decking
- garden furniture
- boat building (decking).



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NEW MARKETABLE SPECIES IN AFRICA

Tola

DENOMINATIONS

BOTANICAL NAME

- *Gossweilerodendron balsamiferum* Harms (Cesalpiniaceae family)

COMMERCIAL NAMES

International name ..... TOLA

- Angola (and Germany) .... : Tola branca
- Cameroon : Sinedon
- Congo ..... : Tola, Tola blanc
- Gabon ..... : Emolo
- Nigeria (and U.K.) : Agba, Otabo
- Zaire ..... : Ntola

Tola

ORIGIN AND SUPPLY

Geographical distribution
Tola is a tall tree characteristic of the overstorey canopy of closed evergreen forests.
It occurs from Southern Nigeria to Angola and in Zaire, and is quite abundant in Gabon.

Frequency in the forest
According to the regions and available results of inventories, the gross volume of trees of more than 0.6 m in diameter ranges from 0.1 to 2 m^3/ha.

Supply
Nigeria, Cameroon, Gabon, Congo, Zaire and Angola are the principal Tola producing countries.
At present, Tola is supplied mainly in the form of logs, because it is principally used for making plywood.
Its supply in the form of sawnwood should develop in the future and create a steady demand for producing countries such as Cameroon, Congo and Zaire.

CHARACTERISTICS OF THE BOLE AND LOG

Description of the standing tree
Tola can reach a height of 45 m. Its trunk, 20 to 25 m, is straight, cylindrical and tall; it has no buttress or irregularities at the base.
The bark is in the form of elongated scales.

Conformation of the logs
Tola logs are well shaped; their diameter varies between 0.70 and 1.10 m, sometimes attaining 1.50 m.
The sapwood, 5 to 10 cm thick, is clearly demarcated when green. When the bark and the ends of the logs are cut away after felling, the sapwood exudes a greenish fluid resin.

Preservation of the logs
Tola sapwood can be attacked by insects and fungi. In general, the heartwood does not deteriorate unless the logs are left for a long time in the forest, in which case fungicidal and insecticidal treatment is advisable in order to protect the sapwood.

Ability to float
Tola logs can easily be floated away from the working site, as their density is lower than 1.

DESCRIPTION OF THE WOOD

The sapwood is whitish. The heartwood is light yellowish beige and becomes more or less dark pinkish brown after exposure to light and air. The boundary between the sapwood and the heartwood is not always distinct. It is recommended to consider the 2 to 3 cm of the intermediate zone as sapwood.
The grain is straight, slightly undulating, and sometimes slightly interlocked.
The texture is fine.
Tola has a slightly pungent odour when freshly felled.
The cut timber and veneer may have scattered small knots and small resin stains.
Magnification ($\times$ 15) reveals:
- disseminated pores (4 to 8 per mm^2) of medium size (150 μ to 200 μ), isolated or grouped radially in twos or threes;
- parenchyma of two sorts, either vasicentric, or confluent between the pores and the adjacent canals, or independent in continuous terminal lines;
- rays in series of 1 - to 4 -, 5 - to 8 - per mm;
- numerous canals (diameter 60 to 85 μ) secreting oleoresin, generally dispersed among the pores.

TECHNICAL PROPERTIES

Tola is a soft wood, lightweight to very lightweight, with slight linear shrinkage. Its volumetric shrinkage is slight to moderate.
Its mechanical strength is weak.

Principal physical and mechanical properties
N.B. : the values below preceded by an asterisk correspond to a moisture content of 12 % (French Standard NF B 51-002).

Density
- **Air dry*:** 470 to 580 kg/m^3 (average 520 kg/m^3)
- **Green:** 750 to 850 kg/m^3
- **Basic density:** 0.44

Hardness (Chalais-Meudon scale)*: 2.3 (soft)
Saturation point: 27 %
Total volumetric shrinkage: 7.7 %
Total tangential shrinkage: 5.5 %
Total radial shrinkage: 2.4 %
Sensibility to variations in air humidity: moderately important
Movement in use: stable
Volumetric shrinkage for 1 % variation in moisture content: 0.33 %
Splitting strength*: 12.6 $\times$ 10^3 N/m (12.9 kg/cm)
Compression strength*: 37 MPa (378 kg/cm^2)
Bending strength*: 73 MPa (748 kg/cm^2)
Modulus of elasticity in bending*: 8,800 MPa (90,000 kg/cm^2)
Shock resistance*: 0.26 kg/cm^2 (poor)

DURABILITY AND IMPREGNABILITY

Note: the following characteristics are those of the heartwood. The sapwood must always be considered as less durable than the heartwood with regard to insects and fungi.

Natural resistance to fungi
Tola is moderately resistant to fungi causing rot. Treatment is necessary only for uses in which it may be in contact with an occasional source of damp.

Natural resistance to Lyctus
The heartwood is immune to Lyctus.

Natural resistance to termites
Tola has a weak resistance to termites *(Reticulitermes santonensis).*

Impregnability
Tola heartwood is moderately impregnable in autoclave; the sapwood is permeable.

CHEMICAL PROPERTIES

Chemical composition of the wood

Tola has a high content (10 %) of alcohol-benzene extracts and a very low content of water extracts (1.7 %).

Its ash content is low (0.3 %) and its silica content is negligible.

The cellulose content is low (39.7 %), while the hemicellulose content is 17.9 %. Lignin accounts for 28.3 % of the dry matter.

PROCESSING

Sawing

Tola is easily sawn. Its silica content may be considered as negligible ($c < 0.05$ %).

Slicing and peeling

Tola slices and peels easily. Peeling may be performed without preheating if the wood is freshly cut, or after mild steaming (55° to 60 °C). The veneers dry without appreciable difficulty; they may present some corrugations, but the risk of splitting is slight.

The veneers can be satisfactorily glued with glues of the urea-formol or phenol-formol type.

The recommended gluing pressure for the manufacture of plywood is between 1 and 1.3 MPa, depending on the density of the wood.

In sanding, the presence of resin may clog the abrasives. In French technical specifications, Tola plywood is approved for outdoor use or for the construction of formwork.

Drying

Air drying

Tola dries easily and fairly quickly ; the risk of splitting and deformation is slight.

Kiln drying

Dehumidification kiln

As a general indication, for wood 22 mm thick, 10 days are required to lower the moisture content of the wood from 55 % to 13 %, in accordance with the following table :

Moisture content of wood (%)	Temperature dry bulb (°C)	Temperature wet bulb (°C)	Relative humidity of air (%)
55	40	40	100
45	40	38	90
24	40	37	80
13	40	37	80

Note: this table gives pieces without drying defects, apart from some slight end splits. Its application to thicknesses of between 22 and 54 mm should give satisfactory results.

Conventional kiln

In conventional drying, the following table may be used for pieces up to 38 mm thick:

Moisture content of wood (%)	Temperature dry bulb (°C)	Temperature wet bulb (°C)	Relative humidity of air (%)
Green	57	50	70
50	57	48	60
40	60	47	50
30	65	49	40
20	75	53	30

For thicknesses between 38 and 75 mm, the relative humidity must be increased by 5 % for each step. For thicknesses over 75 mm, it must be increased by 10 % for each step.

Conclusion : Tola dries rapidly and easily, without any special difficulty.

The risk of splitting and deformation is minimal.

Fastening

Nails and screws can be inserted easily, and are held well. The risk of splitting is very slight.

Gluing

Trials with vinyl glues have given satisfactory results. In general, Tola can be glued without difficulty with all glues in common industrial use.

The future use of this wood for making glued laminated beams should prove particularly worthwhile (it is a lightweight and fairly durable wood which dries easily).

Machining

Tola can be machined without any special difficulty. Machining requires the use of an efficient dust extraction system associated with the equipment because of the possible irritant effect of dust.

Finishing

Tola is easily sanded, but the presence of resin in the sapwood may cause the belts to clog quickly.

Paints and varnishes can be applied without any special difficulty.

CONCLUSIONS AND USES

By reason of its moderate durability, attractive appearance, and ease of sawing, drying and machining, Tola is suitable for many uses other than those requiring very high-level mechanical characteristics. For example, it may be used for the manufacture of:

- furniture
- garden furniture, fences
- mouldings
- interior joinery
- wainscoting
- exterior joinery (treated because of non-clearly detectable sapwood)
- roller-blind shutters
- ships' masts and other nautical components
- coffins.

By reason of the good general shape of the logs, Tola is particularly suitable for the manufacture of:

- decorative veneers
- plywood veneers for all purposes (structural, packaging, formwork, decoration).

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