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## Keywords

Wood · Dermatitis · Allergic · Irritant · Occupational · Chemical · Identification · Classification · Trade · Carpenters

## 1 Core Messages

- The incidence of wood dermatitis is quite small although it may be greater due to underreporting in countries from which no reports reach the public. The literature concerns commonly only case reports.
- Woods cause allergic and irritant dermatitis, often with an airborne pattern. Contact urticaria, photocontact dermatitis, and erythema multiform are uncommon or rare.
- In most cases, occupational dermatitis caused by wood occurs in individuals working with raw wood such as cabinetmakers, carpenters, sawmill workers, and lumberjacks. Fine sanding of wood is extra risky.
- The chemical substances responsible for allergic reactions are mostly benzo-, naphtho-, furano-, and phenanthrene quinones, stilbenes, phenolic compounds, and terpenes.
- The chemical substances responsible for the majority of nonallergic reactions are alkaloids, glycosides, anthraquinones, saponins, phenols, and flavonoids.
- Botanical identification of the suspected wood is essential; otherwise a description of the case is useless and proper advice to the patient often difficult. Trade names are often confusing and misleading. Almost always the help of a wood taxonomist is required for botanical identification.

## 2 Introduction

Besides providing lumber, furniture, plywood, and veneer, wood is the source of pulp board and paper and of hundreds of chemicals derived from cellulose, lignin, and certain resins. Wood is also a major source of the world's fuel. The global consumption of wood reached a maximum in the 1980s; since then, this level of use has been maintained or may even be decreasing. However, the number of species offered has diminished remarkably. The largest timber resources are in the Amazon Basin, Central Africa, and Southeast Asia.

In most cases, occupational dermatitis caused by wood occurs in individuals working with raw wood, such as cabinetmakers, carpenters, sawmill workers, and lumberjacks (Cabanillas et al. 2006). A special risk arises, however, when fine sanding is done. Allergic dermatitis resulting from contact with finished wood items is seen rarely. It may develop after contact with wooden jewelry, wooden footwear, and especially parts of musical instruments, e.g., mouthpieces and chin rests. For the individual earning a living by playing an instrument, such an allergy is of considerable importance as it can lead to inability to play. The actual incidence of wood dermatitis is quite small, although it might be greater in countries, from which no reports reach the public. Commonly, the literature only records single cases or observations from local regions.

Irritation of the skin may arise from bristles, hair, thorns, or leaves (bamboo, palm) or from constituents of the sap (latex) as well as resins of species belonging to the Anacardiaceae, Apocynaceae, Euphorbiaceae, Moraceae, and

Coniferae. Some timbers stain the skin when contact occurs with freshly cut wood, e.g., old fustic. Powders from the bark or heartwood, e.g., of araroba, brigalow, and tagayasan, may evoke rashes, stain the skin, and color the hair. Lesions from splinters of afrormosia, Douglas fir, greenheart, limba, mansonina, and redwood are notoriously slow to heal and commonly become infected. The compounds responsible for the majority of nonallergic reactions are toxic alkaloids, glycosides, anthraquinones, saponins, phenols, flavonoids, coumarins, and other toxic constituents. Some irritant reactions are due to certain timbers that contain strong irritant allergens in very high concentrations, e.g., Pao ferro.

Contact urticaria has been observed from several woods, such as ash, larch, limba, oak, obeche, pine, ramin, spruce, and teak (Schmidt 1978; Beck et al. 1984; Kanerva et al. 1998). **A design and technology teacher developed a severe episode of generalized hives, periorbital and lip swelling, throat tightness, rhinitis, and giddiness. Patch testing revealed meranti sawdust (50% pet) to be the cause, in a rare case of occupational contact urticaria caused by wood dust** (Koh et al. 2016). Trees may become infected with caterpillars or bear lichens on their bark, which may cause occupational dermatitis in workers trimming and debarking trees or thinning branches (“wood cutter’s disease”) (Katzenellenbogen 1955; Storrs et al. 1976; Aalto-Korte et al. 2005). Photosensitizing furocoumarins are present in wood species of the Rutaceae and Flindersiaceae (Mitchell and Rook 1979; Pires et al. 1999). Cases of photocontact dermatitis are extremely rare (Serrano et al. 2008).

Generally, allergic sensitization comes from the heartwood. The sapwood seldom contains sensitizing constituents. The chemical substances responsible for allergic reactions are mostly benzo-, naphtho-, furano-, and phenanthrene quinones, but stilbenes, phenolic compounds, and terpenes may also induce specific hypersensitivity. A list of genuine wood constituents known to cause allergic contact dermatitis is found in Table 1.

Allergic contact dermatitis from wood dust often resembles airborne contact dermatitis (Fig. 1). Besides, the fine dust, created during the

various working processes, may collect in the clothing at the neckline, at the trouser’s ends, and in the tops of the socks. The shoes or boots may become heavily contaminated with dust and are a source of perpetual exposure. Initially, the dermatitis appears on exposed areas of the skin, e.g., the dorsa of hands, the forearms, the neck, and the eyelids. The first symptom is itching. Often these first eruptions are ignored and improve or even disappear during periods away from work. With continued exposure, the dermatitis gradually becomes worse; larger areas of the skin become involved, and the symptom-free periods become shorter. Finally, the dermatitis becomes widespread and resembles other generalized dermatoses, such as chromate and poison ivy dermatitis, mycosis fungoides, actinic reticuloid, and exfoliative dermatitis. In rare cases the clinical picture is not contact dermatitis but erythema multiforme-like (Pao ferro, cocobolo wood) or lymphomatoid contact dermatitis (teak) (Veien and Hausen 2000; Shimizu et al. 2000; Ezzedine et al. 2007).

Diagnosis is made by evaluation of the patient’s occupational history, the clinical appearance of the dermatitis, the botanical nature of the wood, and patch testing. Patch testing with sawdust or filings, mixed 10% by weight in petrolatum, is usually reliable (Mitchell and Rook 1979; Stingeni et al. 2008); the sawdust should be freshly ground. Irritant reactions may occur, especially with teak and Pao ferro. Because of the possible irritant nature, controls are necessary. An appropriate number to use is 20 persons; however, some recommend 50 to be more reliable. The sensitizing constituents named in Table 1 are not commercially available.

Botanical identification of the suspected wood is essential; otherwise, a description of the case is useless. Trade names, especially those of tropical and subtropical species, are often confusing, insufficient, and misleading. For example, a common name, such as rosewood or satinwood, refers to several different and completely unrelated species. Few workers know with any degree of certainty the species they are working with. Almost always, the help of a wood taxonomist is required. In such a case, a solid wood sample, not wood dust, should be available for botanical identification.

**Table 1** Known contact allergens in wood species

Botanical name	Trade name	Contact allergen	Patch test concentration (%)
<i>Acacia melanoxylon</i> R. Br.	Australian blackwood	Acamelin, melacacidin	1 (both)
<i>Brya ebenus</i> DC	Cocus	7,8-dihydroxy-2',4',5'-trimethoxyisoflavan	1
<i>Calocedrus decurrens</i> (Torr.) florin	Incense cedar	Thymoquinone	0.1
<i>Chlorophora excelsa</i> Benth and Hook.	Iroko, kambala	Chlorophorin	10
<i>Cordia</i> spp.	Cordia, canaleta, freijo	Cordiachromes	0.1
<i>Dalbergia latifolia</i> Roxb.	East Indian rosewood	Different dalbergiones	1
<i>Dalbergia melanoxylon</i> Guill and Perr.	Grenadill	Different dalbergiones	1
<i>Dalbergia nigra</i> All.	Brazilian rosewood	Different dalbergiones	1
<i>Dalbergia retusa</i> Hemsl.	Cocobolo	Obtusaquinone, (R)-4-methoxydalbergion	1
<i>Diospyros celebica</i> Bakh.	Macassar	Macassar quinone	1
<i>Distemonanthus benthamianus</i> Baill.	Ayan, movingui	Oxyyanins A and B	1 (both)
<i>Grevillea robusta</i> A. Cunn.	Australian silky oak	Grevillol	0.1
<i>Khaya anthotheca</i> C. DC	Khaya mahogany	Anthothecol	1
<i>Machaerium scleroxylon</i> Tul.	Pao ferro, caviuna vermelha	(R)-3,4-dimethoxydalbergion	0.01
<i>Mansonia altissima</i> A. Chev.	Mansonia, beacuteteacute	Mansonone A	0.1
<i>Paratecoma peroba</i> Kuhlm.	Peroba	Lapachol	1
<i>Pinus</i> spp., <i>Picea</i> spp.	Pine, spruce, fir	Colophony, rosin	20
<i>Tectona grandis</i> L.	Teak	Deoxylapachol	0.01
<i>Thespesia populnea</i> (L.) Sol.	Milowood	Mansonone X	3
<i>Thuja plicata</i> Donn. ex D. Don	Western red cedar	Thymoquinone	0.1

**Fig. 1** Airborne contact dermatitis due to teak wood dust

Prevention of contact dermatitis caused by woods is difficult. Dust control with proper ventilation is very important. Protective clothing should be worn and must cover the exposed areas. Only seldom can a strong sensitizing species be substituted by a less sensitizing one.

In case a worker has to change his job, retraining should not include occupations that bear the risk of recurrent allergic contact dermatitis. Cross-reactions might occur in woodworkers sensitive to quinonoid wood constituents. After changing job to that of a gardener, florist, nursery worker, or even pharmacy assistant, relapses may occur resulting from related quinones in ornamental plants or extracts handled occupationally.

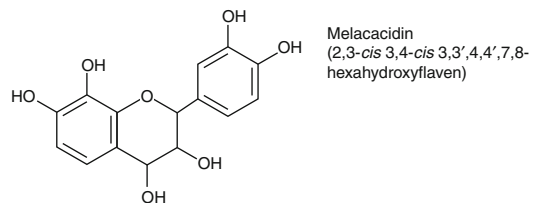
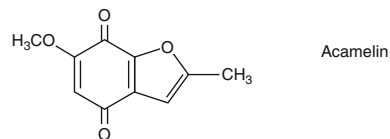
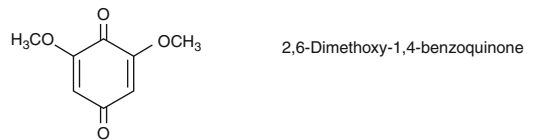
New observations on dermatitis caused by woods have been reported. In several instances, the use of saunas constructed with western red cedar (*Thuja plicata*) was found to cause irritant contact dermatitis (Huilaja et al. 2016). A teacher who worked with cocobolo wood (*Dalbergia retusa*) developed irritant contact dermatitis (Jensen et al. 2016). African ebony (*Diospyros crassiflora*) elicited irritant contact dermatitis of the neck and arms in a 52-year-old woodworker. The woodworker was also diagnosed with episodic facial eczema and periorbital edema (Wlodek and Lovell 2014). A list of allergic contact dermatitis cases is found in Table 2.

The following description concerns the most common wood species that may cause dermatitis. For more extensive information, the reader is referred to the books by Mitchell and Rook (1979), Hausen (1981), the treatise by Woods and Calnan (1976), the chapter on wood by Cronin (1980) and Zug and Marks (1999), and the literature survey of the National Institute for Occupational Safety and Health (NIOSH) (Anonymous 1987).

### 3 *Acacia melanoxylon* R. Br. (Leg.-Mimosaceae) Australian Blackwood

Australian blackwood (*Acacia melanoxylon*) is the most important timber for almost every purpose in Australia. Even fences and musical instruments are manufactured from it. Cases of

allergic contact dermatitis in joiners, furniture makers, and house- and boatbuilders have been reported since 1925. Besides acamelin and 2,6-dimethoxy-1,4-benzoquinone functioning as minor allergens, the main sensitizer is a new hydroxyflavan named melacacidin (Hausen et al. 1990a). In Australia, even the wife of a joiner who was making cabinets in his house suffered from allergic contact dermatitis, although the working room was in the basement (Tilsley 1990). Occasionally the wood is exported to Europe (Correia et al. 1992). Melacacidin is also responsible for occupational dermatitis seen in the workers handling koa wood (*Acacia koa*) (Knight and Hausen 1992).



### 4 *Bowdichia nitida* Benth (Leg.-Papilionaceae) Sucupira

Sucupira from Brazil is best suited for structural purposes and is mostly used in Europe for flooring. It gains some interest for turned articles and as a veneer for inlays in high-class furniture. Cases of occupational contact dermatitis have been described by Freise (1932), Dantin-Gallego et al. (1952), Heyl (1966), and Goncedilalo (1992) in joiners and flooring manufacturers. The heartwood contains at least five quinonoid constituents, of which two could be identified: dimethoxy-benzoquinone and bowdichione (Hausen et al. 1972; Brown et al.

**Table 2** Recent cases of allergic contact dermatitis

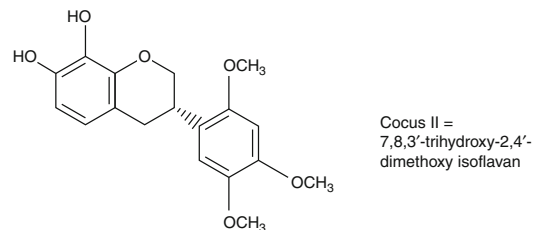
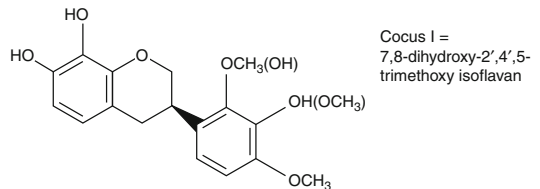
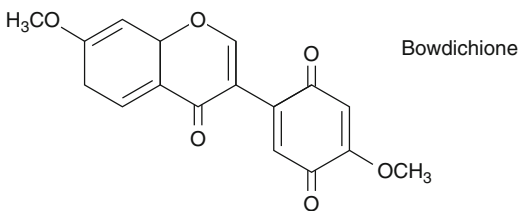
Patient: anatomical site(s)	Wood species: botanical name	Contact allergen	Patch test (conc %),	Controls	Clinical follow-up		
	Trade name		Result (+/-)				
38 yof: hands, fingers	(1) <i>G balsamiferum</i> , <i>F sylvatica</i>		(10.0 pet), + [both]	0/4	Complete avoidance of woods resulted in the remission of skin lesions		
	European beech						
	(2) <i>Quercus robur</i>						
	Common oak						
61 yom woodwork teacher: face, hands, arms, genitals	<i>Dalbergia retusa</i>	Obtusaquinone, (R)-4-methoxydalbergion	(1.0 pet), ++		Avoidance of wood resulted in rapid clearance of dermatitis		
	Cocobolo wood						
<b>Sauna use</b>	<i>Thuja plicata</i>	Thymoquinone	(1) <i>Thuja P.</i> (0.1 pet), ++		(1) Towel use and corticosteroid ointment relieved symptoms		
60 yom: back, buttocks, calves, posterior thighs, upper arms	Western red cedar		Fragrance mix (8.0 pet), ++				
			Nickel sulfate (5.0 pet), ++				
			Oakmoss absolute, ++				
51 yof: face, upper back, buttocks, thighs			(2) <i>Thuja P.</i> , ++				
			Colophony (10.0 pet), ++				
			Balsam of Peru (25.0 pet), +				
65 yom: back, posterior upper arms and thighs			(3) <i>Thuja P.</i> , ++			(3) Eczema persisted for 3+ months	
45 yof teacher: right elbow, upper arm, back, left upper arm			(4) <i>Thuja P.</i> , ++			(4) 0/10	(4) Topical corticosteroid ointment was prescribed, and saunas were avoided. Two-week follow-up revealed dramatic healing of skin
			Nickel sulfate (5.0 pet), +++				
		Cobalt chloride (1.0 pet), +					
		Formaldehyde (1.0 aq), +					
52 yom woodworker: episodic facial eczema, periorbital edema, neck, arms	<i>Diospyros crassiflora</i>	Macassar quinone	(1.0 pet), +	0/10			
	African ebony						
50 yom: severe vascular dermatitis of the hands, arms, face, chest, genitals	<i>Machaerium scleroxylon</i>	(R)-3,4-dimethoxydalbergione	(1) Pao ferro (10.0 pet), +++		(1) Oral methylprednisolone needed to clear eruption		
			Black walnut (10.0 pet), +				
30 yom woodworker: itchy skin, dyspnea of the hands, forearms, face	Santos rosewood		(2) Pao ferro (10.0 pet), +++				

(continued)

**Table 2** (continued)

Patient: anatomical site(s)	Wood species: botanical name	Contact allergen	Patch test (conc %),	Controls	Clinical follow-up
	Trade name		Result (+/-)		
44 yom sawyer: progressive dermatitis on the face, hands, generalized to body	<i>Vatairea guianensis</i>		Faveira amargosa (10.0), +++	0/11	0.1% mometasone ointment relieved dermatitis
			Sapupira, +++		
	Beech, +++				
	Guariuba, +++				
	Faveira amargosa				

1974). A third, still unknown, quinone seems to be related to the dalbergiones, as cross-reactivities have been observed in a sucupira-sensitive patient (Hausen 1981).



## 5 *Brya ebenus* Benth (Leg.-Papilionaceae) Cocus

Cocus is a small tree from the West Indies used for making musical instruments, particularly flutes, recorders, and clarinets. It also serves for making interior turnery, cutlery handles, fancy articles, sawn veneers, and wooden breakfast platters. Although of small diameter, it has been imported from Jamaica and Cuba for more than a century as one of the most valuable woods.

Occupational contact dermatitis has been observed not only in flute makers who saw and sandpaper the wood but also in flutists playing instruments manufactured with this wood. Typically, the allergic lesions of the latter are swollen lips and mouths (Crocker 1903; White 1903; Meister 1934).

A reinvestigation of the wood was prompted by the recurrent lesions (swollen lips) developing in a young girl studying the flute. Two hydroxyisoflavans were identified eliciting ++ to +++ reactions at a 1% test concentration (Hausen et al. 1991).

## 6 *Calocedrus decurrens* (Torr.) Florin (Cupressaceae). Incense Cedar

The incense cedar tree, native to California and Oregon, is used for the manufacture of pencils, fence posts, boarding, venetian blinds, chests, and toys. Cases of contact dermatitis have been described by Calnan (1972). Positive reactions were obtained with thymoquinone;  $\beta$ -thujaplicin remained negative. Incense cedar contains up to 4% of thymoquinone (for structure, see *Thuja plicata*).

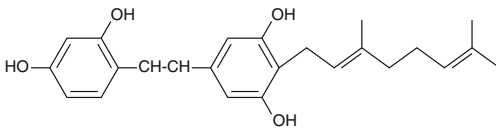
## 7 *Chlorophora excelsa* Benth and Hook. (Moraceae). Iroko, Kambala

The West African timber, iroko, kambala, is used frequently as a substitute for teak because it possesses many of the desirable features of *Tectona*

*grandis*. For decades it has been in demand due to its strength and durability for construction work, especially in making windows and door frames and in shipbuilding.

Occupational contact dermatitis has been described since 1910 (Schulz 1957; Jung 1967; Beer 1970; Pereira Marques 1989; Hinnen et al. 1995). In 1949, King and Grundon isolated a hydroxy stilbene, named chlorophorin, which was revealed to be a moderate sensitizer (Schmidt 1963; Hausen 1981). Its structure, first elucidated by King and Grundon (1950), was corroborated in 1986 by Krohn et al.

Chlorophorin



## 8 *Cordia millenii* Baker. Cordia

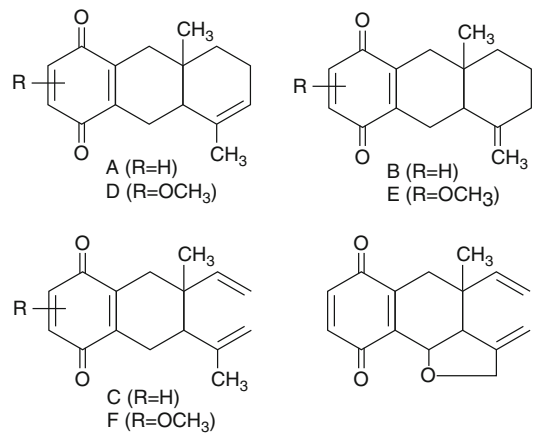
### 8.1 *Cordia gerascanthus* R. BR. (Boraginaceae). Canalete

### 8.2 *Cordia goeldiana* Huber. Freijo

*Cordia goeldiana* from Brazil, also often called Brazilian walnut, and *Cordia gerascanthus* derived from Venezuela form together with *Cordia millenii* and *Cordia platythyrsa* Baker from tropical Africa a group of valuable timbers with moderate durability. Due to their lightweight, softness, and low strength, they are used mainly for interior work, furniture, and joinery. Only the Brazilian species are also suitable for boatbuilding and exterior constructions.

Although used abundantly, only two published reports of occupational contact dermatitis are known (Schwartz 1931; Rackett and Zug 1997). However, the author has also seen four cases, which remain unpublished. In these cases, a typical airborne contact dermatitis developed due to bad air exhaust conditions in workers who manufactured balcony breastwork and moldings. Cordiachromes A and E, both 0.1% in petrolatum, were positive.

Cordiachromes



## 9 *Dalbergia latifolia* Roxb. East Indian Rosewood

### 9.1 *Dalbergia melanoxylon* Guill. and Perr. Grenadill

#### 9.1.1 *Dalbergia nigra* All. Brazilian Rosewood

*Dalbergia retusa* Hemsl. (*D. Obtusa* Lec.) Cocobolo (Leg.-Papilionaceae)

The different *Dalbergia* species provide most valuable woods used for high-class furniture, cabinetwork, inlay work, and parts of musical instruments.

#### Cocobolo

Cocobolo derives from Central America; it is strong, hard, compact, fairly heavy, easy to work with, and of extreme durability. It holds a supreme position in the cutlery trade, especially in knife handles, but also serves for brush backs, chessmen, scientific instruments, bulbs of billiard cues, wooden bracelets, wooden jewelry, and interior turnery. Cocobolo is especially used for musical instruments; 90% of all recorders manufactured before World War II were made from cocobolo. Descriptions of occupational dermatitis occurring in workers manufacturing hairbrushes, knife handles, and recorders have been published just as often as allergic reactions of the lips and fingertips in those playing the instruments (Neisser 1907; MacKee 1913; Modlmayer 1931; Steinbrink 1950; Schulz and Dietrichs 1962; Hausen



and Muumlnter 1983; Rackett and Zug 1997; Correale and Marks 2002; Guancho and Prawer 2003; Moratinos et al. 2005). The responsible allergens belong to the class of neo-flavonoids, named dalbergiones. In cocobolo, obtusaquinone and (*R*)-4-methoxydalbergion play a major role, while (*S*)-4'-hydroxy-4-methoxydalbergion plays only a minor role (Hausen 1997; Rojas-Hijazo et al. 2007).

### Grenadill

As a hard and heavy blue-black colored wood, grenadill or African blackwood is mainly imported from Mozambique, Zimbabwe, Togo, and Senegal. Its use comprises knife handles, brush backs, chessmen, truncheons, flutes, clarinets, oboes, chanters of bagpipes, and some types of recorders.

Cases of dermatitis have been described since 1934 and have been observed in clarinet makers and in knife-handle turners (Meister 1934; Woods and Calnan 1976; Hausen et al. 1984). The responsible allergens are (*S*)-4-methoxydalbergion, (*S*)-4'-hydroxy-4-methoxydalbergion, and (*S*)-3'-hydroxy-4,4'-dimethoxydalbergione (Schulz et al. 1979).

### East Indian and Brazilian Rosewood

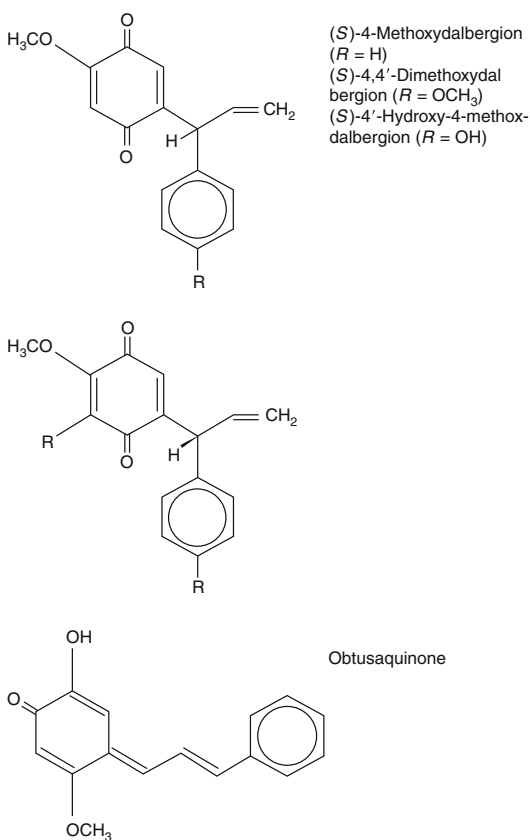
Although of different origins, both rosewoods are used for similar purposes and contain the same main sensitizers. The timbers are of attractive appearance when cut from old stems. Imports are few but steady. This wood is used for high-class furniture and cabinetwork, handles, decorative veneers, wooden jewelry (bracelets, necklaces), inlay work, and especially musical instruments, such as flutes, recorders, piano cases, pegs, bridges of violins, and chin rests (Fig. 2). Occupational contact dermatitis has been observed in cabinetmakers, knife grinders, as well as by the use of knives, e.g., in butchers, and chin rests by professional violinists (Gougerot and Blamoutier 1929; Pontes de Carvalho 1956; Findlay 1972; Cronin and Calnan 1975; Holst et al. 1976; Woods and Calnan 1976; Martin et al. 1980; Haustein 1982; Hausen 1985; Gallo et al. 1996; Athavale et al. 2003; Viardot-Helmer et al. 2008; Gomez-Muga et al. 2009).

The responsible sensitizers (*R*) and (*S*)-4-methoxydalbergion, (*S*)-4,4'-dimethoxydalbergion,



**Fig. 2** “Fiddler’s neck”: allergic reaction due to contact with a wooden chin rest (Rosewood)

and (*S*)-4'-hydroxy-4-methoxydalbergion do not only occur in the species named above, but also in *Dalbergia stevensonii* STANDLEY, which has been found also to cause occupational contact dermatitis (Woods and Calnan 1976; Bottenbruch et al. 1988). Hinf3D.



**10** *Diospyros celebica* Bakh.  
Macassar

**10.1** *Diospyros crassifolia* Hiern.  
African Ebony

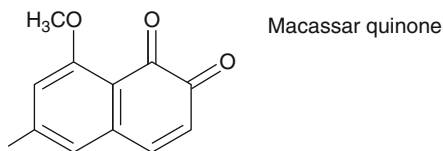
**10.1.1** *Diospyros ebenum* Koenig.  
Ceylon Ebony

*Diospyros melanoxylon* Roxb. Coromandel  
(Ebenaceae)

Ebony is the name for wood species belonging to the genus *Diospyros*. Most prized are those with a deep black heartwood, extreme hardness, and durability. Ebony species are used for cabinet and inlay work, piano and organ keys, organ stops, violin fingerboards and pegs, parts of string bows (“frogs”), and bagpipes.

Macassar has been long in use for expensive rulers. Occupational dermatitis may occur, but reports are found rarely in the literature. Buschke and Joseph (1927) observed hand eczema in a cabinetmaker due to macassar ebony, while Bleumink and Nater (1974) obtained positive patch tests to an ethanol extract of *Dalbergia melanoxylon* in 4 of 20 patients suffering from airborne contact dermatitis due to tropical woods.

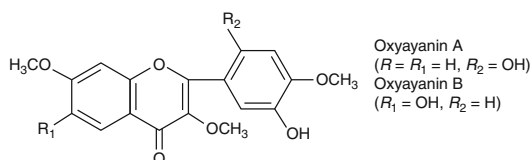
In Macassar, a precursor of a sensitizing naphtho-ortho-quinone (Macassar quinone) is found as the main constituent. Besides, more than 17 different naphthoquinone derivatives (diospyrin derivatives) have been isolated, which possess possibly allergy-inducing properties (Zakaria et al. 1984; Zhong et al. 1984).



**11** *Distemonanthus benthamianus*  
Baill. Ayan (Leg.  
Caesalpiniaceae)

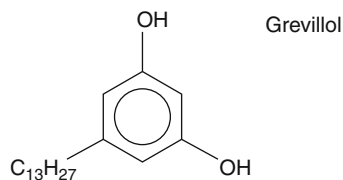
Movingui or Ayan is used for domestic flooring, frames, windows, and cabinetmaking. It is also imported from West Africa to England, where it is

mainly used for coffins. In four carpenters, strong patch test reactions were seen with 2 of the 12 known flavonoids: oxyyanins A and B (Morgan and Thomson 1967). These flavonoid constituents were not tested in 13 other patients mentioned by Orsler (1969) or by Woods and Calnan (1976).



**12** *Grevillea robusta* A. Cunn.  
Australian Silky Oak  
(Proteaceae)

Australian silky oak is native to the fifth continent, but it is also grown in Africa, Sri Lanka, India, and the United States. Flooring, furniture, and plywood are the main uses, but the tree is also required for telegraph poles and as a shade tree. *Grevillea* poisoning is a common term for occupational dermatitis that develops from the sap contracting the skin during sawing (May 1960; Adams and Gimenezarnau 1991; Knight and Whitesell 1992; Cook and Freeman 1997). Bracelets made from *Grevillea* wood grown in India and shipped to the United States and other countries were shown to be the source of allergic contact dermatitis (Hoffman et al. 1985; Larsen et al. 1992). The responsible allergen is grevillol, a phenolic compound with a long side chain, which very much resembles the sensitizing urushiols from poison ivy.



**13 *Khaya grandiflora* DC. African Mahogany**

**13.1 *Khaya ivorensis* A. Chev. Kahya Mahogany**

**13.1.1 *Khaya anthotheca* C. DC. Krala**

***Khaya senegalensis* A. Juss.**

Dry Zone Mahogany (Meliaceae)

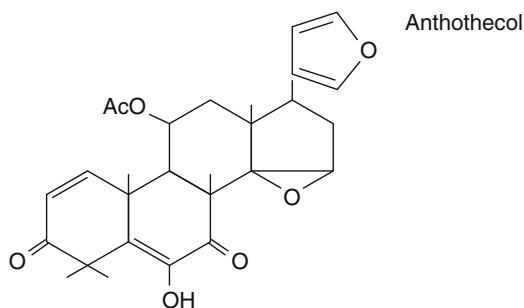
All four *Khaya* species are timbers of West Africa. They serve as a substitute for South American mahogany, especially for cabinets, furniture, boat-building, molding, and other purposes for which a good-quality wood is required.

Outbreaks of contact dermatitis caused by these woods have been described by Morgan (Morgan and Wilkinson 1965; Morgan and Thomson 1967; Morgan et al. 1968), Wilkinson and colleagues (Wilkinson 1968, 1971; Wilkinson et al. 1980), Shevljakov (1974), Orsler (1969), and Hjorth (1961). The author also observed two cases in which airborne contact dermatitis developed to the sawdust of African mahogany. Patch tests with a 10% ethanol extract were positive.

The responsible sensitizers are not yet known. One of the allergenic constituents seems to be anthothecol, found in *K. anthotheca* up to 0.03% (Morgan and Orsler 1967). In addition, *K. anthotheca* and *K. ivorensis* contain the weak sensitizer 2,6-dimethoxy-1,4-benzoquinone (see *Acacia melanoxylon*)

**14 *Machaerium scleroxylon* Tul. Pao Ferro (Leg.-Papilionaceae). "Santos"-Palisander. Caviuna Vermelha**

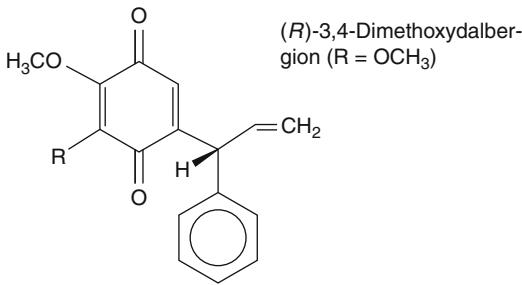
The wood of Pao ferro closely resembles true Brazilian rosewood in appearance and physical properties and, thus, is frequently used as a substitute or often simply mistaken for real rosewood. In Europe, Pao ferro is used for furniture, veneers (Fig. 3), television sets, knife handles, recorders, and multiple other purposes. Occupational contact dermatitis has been reported not only from its native country Brazil but also from Denmark, Great Britain, Germany, Italy, and Spain. Altogether, more than 100 cases have been described in the literature (Miranda Bastos and Matos Filho 1962; Morgan et al. 1968; Conde-Salazar et al. 1980; Hausen 1982; Sak et al. 1983; Beck et al. 1984; Roed-Petersen et al. 1987; Rackett and Zug 1997; Scheman et al. 1999; Shimizu et al. 2000; Correale and Marks 2002; Stingeni et al. 2008).



**Fig. 3** Hemorrhagic contact dermatitis caused by Pao ferro

Active sensitization occurred in two nurses who had been used as controls and patch tested with the pure wood dust. The responsible contact allergen is (*R*)-3,4-dimethoxydalbergion. This constituent is the strongest sensitizer within the group of dalbergiones (Schulz et al. 1979). Its safe patch test concentration is 0.01%!

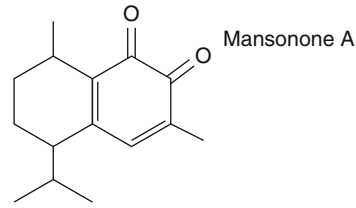
In some Pao ferro samples collected from different woodworking factories, up to 4.9% were detected in the heartwood (Hausen 1983). Thus, a patch test with the sawdust itself should strictly be avoided. Pao ferro is the most hazardous commercial timber in the wood-working industry. (*R*)-3,4-dimethoxydalbergion does not occur in the related *Dalbergia* species.



## 15 *Mansonia altissima* A. Chev. *Mansonia*, *Beacuteteacute* (*Sterculiaceae*)

The attractive durable wood of the *Mansonia* tree is imported from Nigeria and Ghana and is used as a substitute for walnut. Outbreaks of occupational contact dermatitis have been described since 1936 in hundreds of cases, of which only some can be cited (Horner and Wigley 1936; Bourne 1956; Sandermann and Dietrichs 1959; Hanslian and Kadlec 1965; Nava et al. 1975).

The responsible allergens belong to the class of sesquiterpenoid mansonones, of which mansonone A, a red *ortho*-quinone, is the main (strong) sensitizer (Schulz et al. 1979). Interestingly, some of these quinones, e.g., mansonones E and F, occur in the elm species (*Ulmus hollandica*), making the tree resistant to Dutch elm disease.



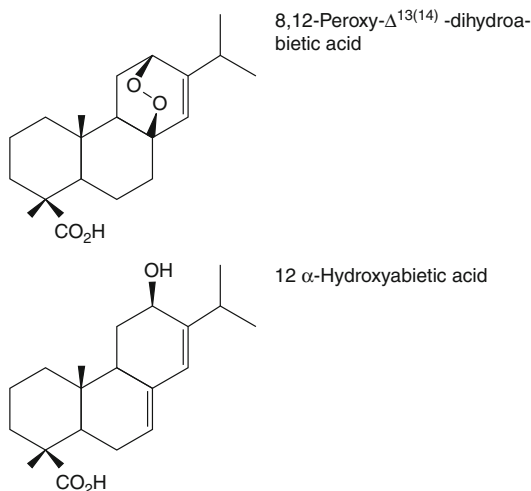
## 16 *Pinus* spp. Pine

### 16.1 *Picea* spp. Fir, Spruce (*Pinaceae*)

Pine and spruce are the common names used for hundreds of species of conifers belonging to the genus *Pinus* and *Picea*, members of the *Pinaceae* family. Principally, most of these timbers are found in the northern hemisphere. Pine and spruce species are the source of wood balsam which, after separation of the volatile part (turpentine), yields rosin (colophony). Rosin consists of 90% resin acids and 10% neutral components.

Resin acids such as abietic and dehydroabietic acid oxidize easily under common conditions, e.g., oxygen, daylight, and room temperature, to give (auto) oxidative degradation products, which are more or less strong sensitizers. From more than 30 constituents detected in degraded tall oil resin (by-product in the paper and pulp industry) and colophony of different origins, 8,12-peroxy- $\Delta^{13}$ -(14)-dihydroabietic acid and 12  $\alpha$ -hydroxyabietic acid contribute a great deal to colophony allergy by means of both their sensitizing capacity and their determined concentration in the mixture of degradation products (Hausen et al. 1990b).

Occupational contact dermatitis has been seen in numerous cases and may occur, for example, in joiners, woodworkers, farmers (De Cock et al. 2000), clerks handling paper and newspapers, females using epilation wax (O'Reilly and Murphy 1996), handball players using adhesive wax (Hausen and Kuhlwein 1983), and in many other situations (Hinnen et al. 1995; Karlberg et al. 1996; Majamaa and Vijanen 2004; Booken et al. 2006). The importance of occupational contact dermatitis due to colophony is demonstrated by its rank in the hit list of the most common contact allergens where it reached the fifth or sixth place in recent years (Brasch et al. 1996). For further details, see ► Chap. 41, "Colophony: Rosin in Unmodified and Modified Form".



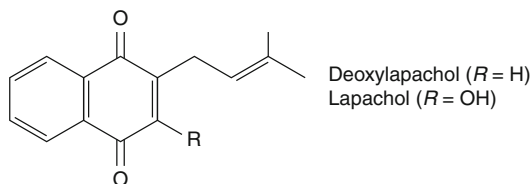
### 17 *Tectona grandis* L. Teak (Verbenaceae)

Teak wood is one of the most valuable timbers of the world. While native to Burma, India, Thailand, and Malaysia, it also has been planted in South Africa and the West Indies. Due to its strong durability, it is used in furniture, exterior joinery, flooring, fittings, door and window frames, rails, shipbuilding, bridges, and wharves. Teak is resistant to termites and chemicals and, therefore, can be used outdoors and for laboratories too.

Occupational contact hypersensitivity has been observed as early as in Ancient Egypt, where ships were built with teak from India. More recent descriptions dated back to the last century and continue until the 1970s, when it became one of the most common sensitizers in the wood industry (Woods and Calnan 1976; Ezzedine et al. 2007; Rao and Balachandran 2010).

The primary sensitizer is a simple naphthoquinone, named deoxylapachol (Sandermann and Simatupang 1962). Compared with other plant allergens, deoxylapachol is one of the strongest sensitizers found in nature (Schulz 1967). Patch testing with sawdust may produce false-positive reactions due to its highly irritant properties. Deoxylapachol may actively sensitize when not patch tested in its safe concentration of 0.01%. Another major constituent of teak is lapachol, equipped with a blocking

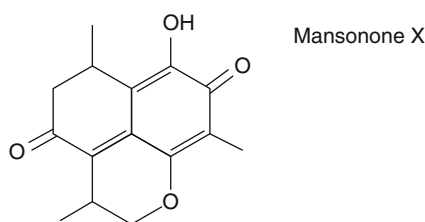
hydroxy group at the quinonoid ring which may be tested 1% in petrolatum. Cross-reactions between deoxylapachol and lapachol are obligatory.



### 18 *Thespesia populnea* (L.) Sol. Milwood (Malvaceae)

Milwood is a small tropical tree distributed widely throughout the tropics and in many areas of the United States, including California, Florida, and Hawaii. Primarily, it is used for making bowls, bracelets, carved tikis, and furniture. Among the different mansonones that are known sensitizers from *Mansonia altissima*, milwood contains a new sesquiterpenoidal quinone, named mansonone X (Milbrodt et al. 1997).

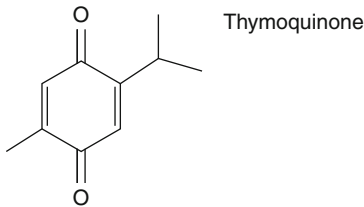
Persistent occupational contact dermatitis has been observed in a Hawaiian bowl turner who was shown to be allergic to the mentioned constituent, mansonone X. This compound showed a moderate sensitizing capacity in experiments with guinea pigs (Hausen et al. 1997).



### 19 *Thuja plicata* Donn. ex D. Don Western Red Cedar (Cupressaceae)

The western red cedar tree is native to the west coast of the United States but exported all over the world, especially to Australia, Japan, and Europe. It is a timber of good stability useful for constructions, venetian blinds, boatbuilding, planking, paneling, and framing. Besides many cases of

bronchial asthma due to the sawdust, observations of occupational allergic contact dermatitis have also been reported (Orsler 1969; Bleumink et al. 1973; Burry et al. 1973). Suskind (1967) succeeded in sensitizing guinea pigs with different extracts of the wood. Thymoquinone must be considered as the main contact sensitizer, showing a high sensitizing capacity in guinea-pig experiments (Hausen 1981). The safe patch test concentration is 0.1% in petrolatum.



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