

WOOD ANATOMY OF THE GENUS EUPLASSA AND ITS RELATION TO OTHER PROTEACEAE OF THE GUIANAS AND BRAZIL

ALBERTA M. W. MENNEGA

(*Botanical Museum and Herbarium, Utrecht*)

(received December 7th, 1965)

ABSTRACT

Three genera of the *Proteaceae* belonging to the tribe *Grevilleeae* occur in the Guianas and Brazil: *Roupala*, *Panopsis*, and *Euplassa*. The microscopical wood structure of one of these genera, *Euplassa*, has not been described before. Anatomically it proves to be nearly identical with *Panopsis* which it also resembles in general properties. *Roupala* differs in several respects. Within the genera differences are not fundamental and chiefly a matter of numbers and dimensions. A key to the genera is given.

The relation of these three genera with the two other members of the tribe in South America, *Orites* and *Gevuina*, is discussed.

INTRODUCTION

With the exception of MANIERI (1958) who included one unidentified species of *Adenostephanus* (a synonym of *Euplassa*) in his key to the principal timbers of Brazil, none of the handbooks or publications dealing with the anatomy of South or Central American woods mention the wood of *Euplassa* (ACOSTA-SOLIS, 1960; BASCOPE, 1962; KRIBS, 1928; RECORD and MELL, 1924; RECORD and HESS, 1943; WILLIAMS, 1936)¹). Miss CHATTAWAY (1948a) in her detailed study of the wood anatomy of the *Proteaceae* did not treat *Euplassa*, this genus not being considered to comprise any species developing into sizable trees. Neither did METCALFE and CHALK (1950) give any particulars about the genus in their account of the family. As our material contains several samples of *Euplassa* from large forest trees as well as samples from small trees, it seemed interesting to study the wood of this genus and to compare its structure with that of other genera of the *Grevilleeae*.

Furthermore it may be worth-while to note whether the results of comparison of the wood anatomy are in agreement with the views of JOHNSON and BRIGGS (1963) on the taxonomic interrelationship of the genera.

¹) BENOIST (1931) cited *Euplassa* among the genera of the *Proteaceae* known from French Guiana, but he did not give a description of the wood of this genus nor of the other genera.

MATERIAL AND METHODS

All wood specimens studied have been collected with herbarium vouchers. Most of the herbarium specimens, either originals or duplicates, are in the herbarium of the Utrecht Institute [U]. Nearly all specimens from Brazil belong to collections identified by SLEUMER (1954) and are cited in his treatment of the American *Proteaceae*; other specimens, mainly from Suriname and French Guiana, were identified by myself. The wood samples are cited fully with particulars about tree sizes at the end of the descriptions of each genus.

As far as possible the wood sections were prepared by microtome without previous treatment except boiling. Treatment with hydrofluoric acid was necessary only for *Roupala*. Stained and unstained sections as well as macerations were prepared. In order to make the presence of silica inclusions more noticeable sections were treated with crystalline phenol followed by eugenol.

For the testing of burning qualities a match-size splinter was taken from the heartwood.

The terminology of the descriptions agrees partly with the Glossary of the International Association of Wood Anatomists (1957), and is partly adapted to the special needs of this family. For classification of numbers and dimensions the recommendations of the Council of the International Association of Wood Anatomists (1937, 1939) have been followed. Besides average data for numbers and sizes the generally occurring lowest and highest figures have been added in brackets. Instead of the usual counting of the rays per mm on a tangential surface the uniseriats have been counted per sq. mm on a tangential section.

For the drawings of elements of macerated material a camera lucida with a magnification of 148 × was used. The photographs of the transverse surfaces at 10 × magnification were made from the blocks used for sectioning.

ANATOMY OF THE FAMILY

The main features of Proteaceous woods which can be observed by hand lens are:

Rays very wide and several millimeters high, conspicuous on all surfaces; vessels partly in tangential multiples or in tangential chains, always in contact with parenchyma bands which are contiguous with the vessels on their abaxial sides; the bands narrow, numerous, and parallel, usually more or less convex, with the concave side facing the bark, running as festoons between the broad rays; the vessels hardly ever in contact with the broad rays²⁾.

However, in two of the three genera treated here (*Euplassa* and *Panopsis*) the characteristic pattern is less pronounced, because the

²⁾ For microscopical details, see the paragraph: Remarks on the anatomy.

vessels are scarce and scattered, and the parenchyma bands, moreover, are often independent of the pores and nearly straight.

No generic descriptions are included. Though the differences between the species of one genus are not very important (as may be concluded from the descriptions of the species), the discrepancy between the number of species studied and the actually known numbers as given by SLEUMER (1954) does not seem to permit a detailed generic account. *Roupala* has 51 species, *Panopsis* 11, and *Euplassa* 20 species; of these 4, 2 and 4 respectively, were studied. The most important structural differences between the genera may be taken from the key.

KEY

- 1.a. Every parenchyma band associated with solitary vessels or vessel groups; fibres very thick-walled with extremely narrow lumen; intervascular pits 2-4 μ ; average length of vessel members 500 μ *Roupala*
- b. Parenchyma bands partly not associated with vessels; fibres moderately thick-walled with a lumen equal to or mostly exceeding the thickness of the walls; intervascular pits medium-sized; vessel members on the average 900 μ long 2
- 2.a. Uniseriate rays often over 6 cells high; parenchyma strands often consisting of 6 or 8 or more cells *Panopsis*
- b. Uniseriates rarely over 4 cells high; parenchyma strands mostly of 4 cells *Euplassa*

EUPLASSA Salisb.

Euplassa pinnata (Lam.) Johnst. (Plate I, fig. 1; Plate II, fig. 3; Plate III, A)

(syn. *Adenostephanus guianensis* Meisn.)

Heartwood pinkish brown, clearly differentiated from the cream-coloured, 1.5 to 3.5 cm wide sapwood; the wide rays very conspicuous on all surfaces, producing a silvery ribbon pattern on radial surfaces; texture rather coarse; grain straight; volume weight 0.60-0.70; a splinter of the heartwood burns in 4 out of 5 samples to grey ash, in Uw 4722 to charcoal.

Wood structure

Growth rings: Absent.

Vessels: A variable percentage solitary, others in tangential pairs or tangential rows of 3-4 (7) or in small clusters, rarely in radial pairs, scattered though often with a tendency to tangential arrangement, on average 5 (0-10) per sq. mm, in Uw 4722 more variable and in some places crowded, 9-18 per sq. mm; cross-section roundish or oval with greatest dimension tangentially, at least for solitary vessels;

tangential diameter on average 150 (75–250) μ but rather variable for the various samples, in the clusters often narrower; vessel elements on average 880 (690–1070) μ long, “tails” included, often of irregular form; perforations usually large, nearly horizontal or slightly oblique, sometimes in the narrow vessels as small openings in the lateral walls; wall 5–7 μ thick; intervascular pits alternate, nearly round, 6–7 μ , apertures included; occasionally with yellowish resinous contents.

Tracheids: Often present, associated with the vessel clusters, diameter 30–60 μ , length 800–1000 μ .

Fibre tissue: Walls moderately thick (5–8.5, μ), lumen always wider than the thickness of the walls, generally much wider, diameter 20–45 μ , fibre length on average 2430 (1500–3850) μ , in Uw 5754 the average length 3350 μ ; pits with very small borders and extended slitlike apertures, ca. 7 μ long, equally numerous on radial and tangential walls.

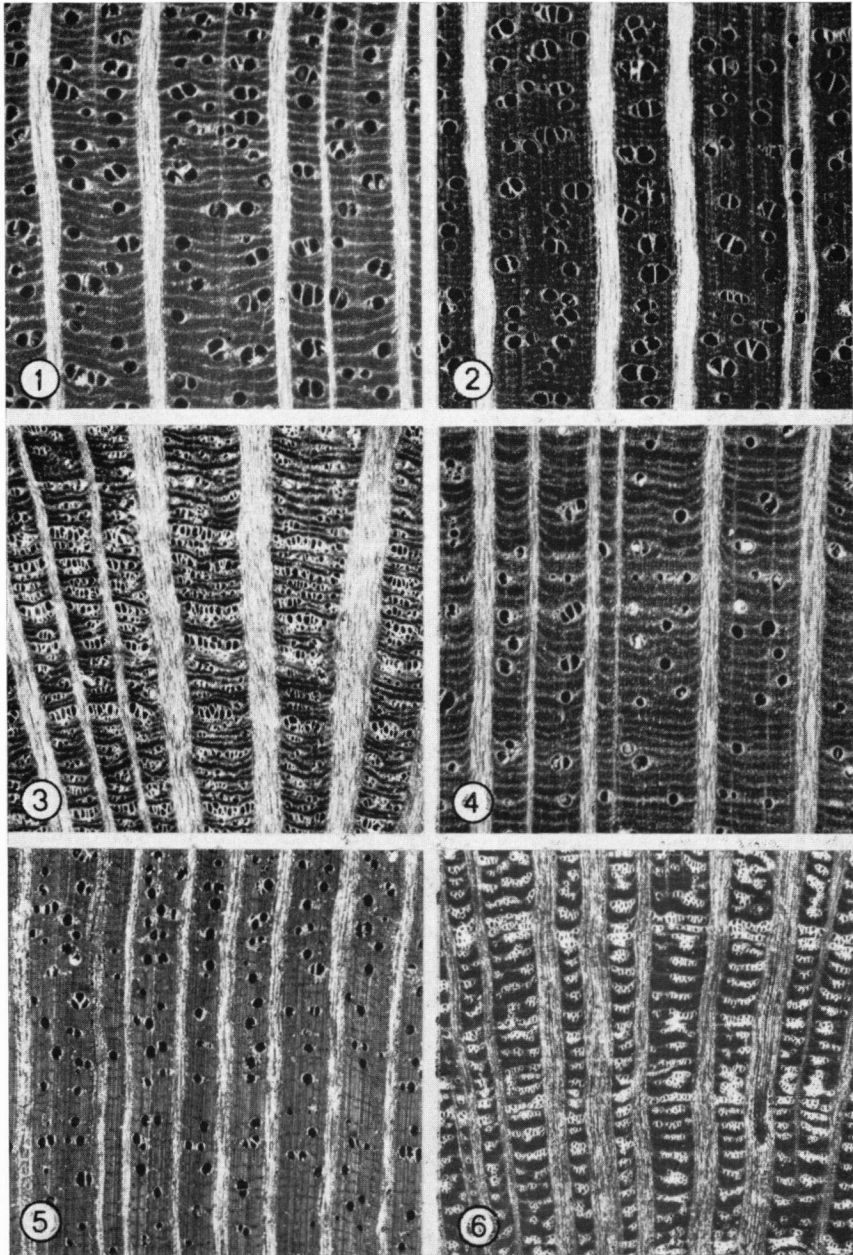
Rays: Of two sizes: uniseriates, composed of 1 to 2, or up to 4 square or upright cells, the upright cells mostly 100–160 μ axially; multiseriates mostly 10–15 (6–22) cells wide (or 325–450 μ and up to 800 μ); mostly 7–8 cm high, in Uw 5754 up to 1.5 cm; composed of procumbent cells of variable sizes, radially elongated low cells irregularly mingled with much shorter and higher, almost square cells, on tangential sections widest cells often more numerous in the middle of a ray; sheath cells locally present; margins usually formed by one, occasionally 1–4 rows of square or upright cells, the latter not over 150 μ high; pits to vessels rather scarce as the rays are rarely in contact with vessels, similar to the intervascular pits or larger and elongate; cells often with reddish brown contents, which may be concentrated around silica bodies; in one sample (Uw 1905) several rays with sclerified cells (Plate II, 3). Uniseriates 2–5 per sq. mm, wide rays 8–10 per cm.

Parenchyma: Predominantly banded, the bands partly associated with the vessels and vessel multiples in a very characteristic way adjoining them laterally and on the abaxial sides; the bands mostly 1–2 (4) cells wide, running, one pore width apart, fairly straight or slightly curved between the large rays, a few bands interrupted or ending blindly; paratracheal parenchyma may be present, beside where the bands are contiguous with the vessels as a few cells on the adaxial sides of the vessels or as a vasicentric ring of one cell layer; number of bands variable, on average 7 (5–10) per mm; strands mostly of 4 (2–8) cells; pits to vessels half bordered, generally similar to the intervascular pits, in part much larger and elongate; cells often with brown contents, sometimes with small silica bodies.

OTHER SPECIES

Wood specimens of three other species were available: *Euplassa madeirae* Sleum., *E. cantareirae* Sleum., and *E. inaequalis* (Pohl) Engl.

The samples of these species are nearly identical with *E. pinnata*



Transverse surfaces 10 ×.

Fig. 1. *Euplassa pinnata* (Lam.) Johnst. (Uw 5697); fig. 2. *Euplassa inaequalis* (Pohl) Engl. (Uw 7647); fig. 3. *Euplassa cantareirae* Sleum. (Uw 6920); fig. 4. *Panopsis sessilifolia* (Rich.) Sandw. (Uw 5810); fig. 5. *Panopsis rubescens* (Pohl) Pitt. var. *simulans*. Macbride (Uw 8264); fig. 6. *Roupala rhombifolia* Mart. (Uw 6919).

Plate I

Facing p. 120.

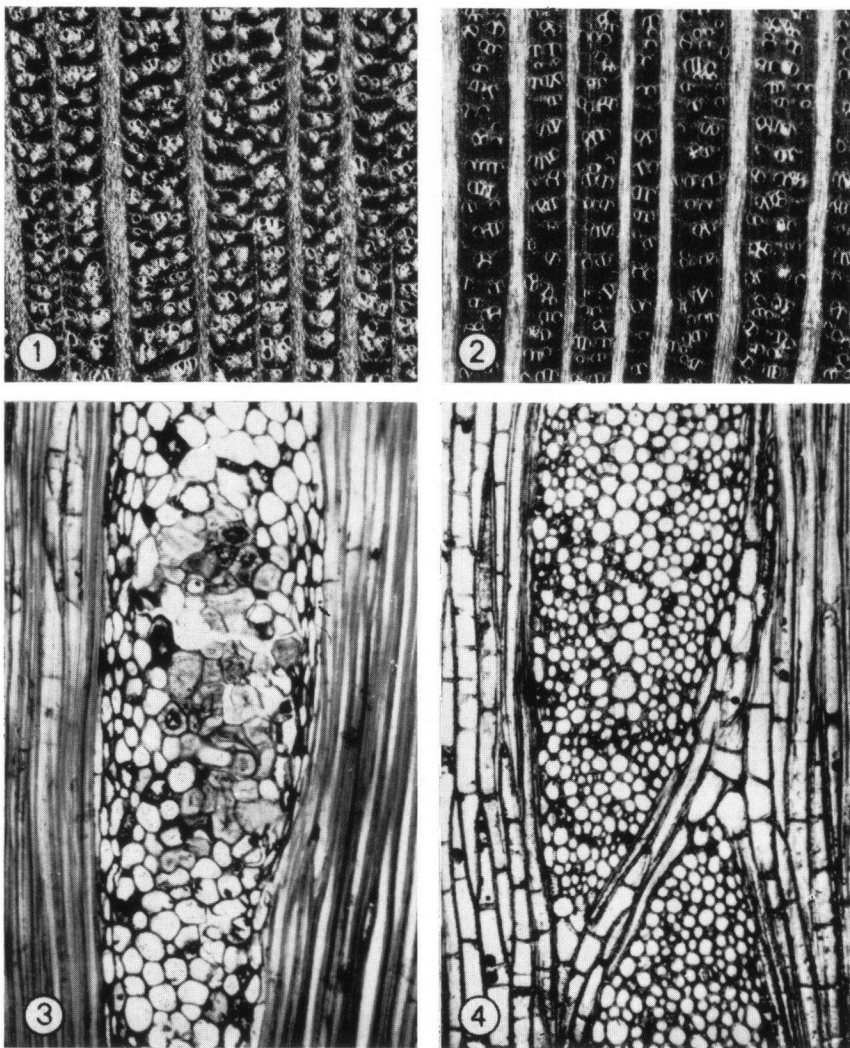
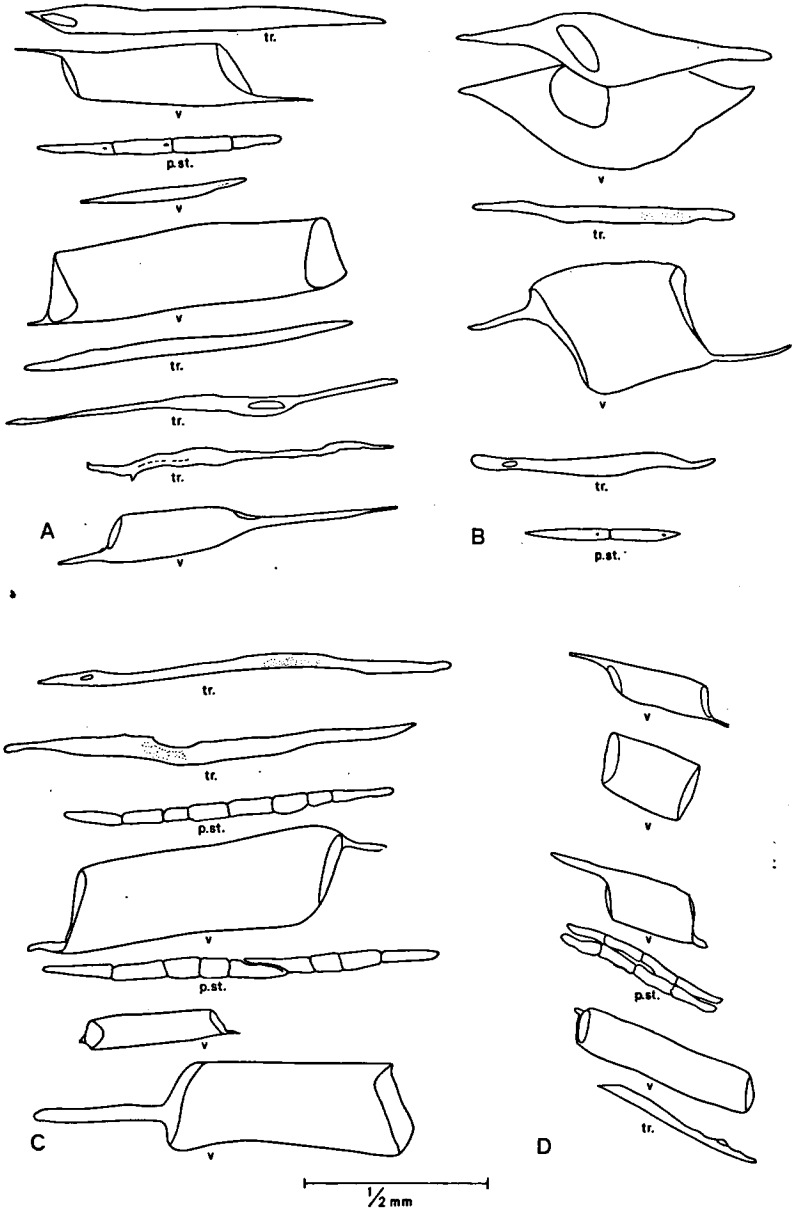


Fig. 1. *Roupala montana* Aubl. (Uw 249) transv. surf. 10 ×; fig. 2. *Roupala dielsii* Macbride (Uw 7833) transv. surf. 10 ×; fig. 3. *Euplassa pinnata* (Lam.) Johnst. (Uw 1905) tang. sect. 77 ×, large ray with sclerotic cells; fig. 4. *Panopsis sessilifolia* (Rich.) Sandw. (Uw 5810), tang. sect. 77 ×, superposed large rays separated by a few parenchyma strands.



Elements from macerated material, 148 \times .
 p. st. parenchyma strands, tr. tracheids, v. vessel elements
 A *Euplassa pinnata* (Lam.) Johnst.; B. *Euplassa madeirae* Sleum.; C. *Panopsis sessilifolia* (Rich.) Sandw.; D. *Roupala montana* Aubl.

Plate III

in general properties. Their volume weights are between 0.60 and 0.65; a splinter of the wood of *E. madeirae* burns to charcoal, splinters of the other samples burn to grey ash.

In anatomy there is close agreement between *E. inaequalis* (Plate I, fig. 2) and *E. pinnata*, except for the absence of silica inclusions.

E. cantareirae (Plate I, fig. 3) differs from *E. pinnata* in having more numerous and smaller vessels, on average 30 (14–55) per sq. mm, and 60 (20–100) μ wide, moreover arranged in long tangential chains between the broad rays. Furthermore the diameter of the fibres is on average 17 μ , max. 25 μ instead of the average of 30–35 μ in all other species; the large rays may be up to 26 cells wide; owing to the more numerous tangential chains of vessels the parenchyma bands are nearly always associated with the vessels.

E. madeirae (Plate III, B) has equally wide rays as *E. cantareirae*, in which silica bodies are apparently absent, otherwise the structure is similar to *E. pinnata*.

MATERIAL

Euplassa cantareirae Sleum.: Brazil – Uw 6920 (Reitz & Klein 6370 = HBR. 16373, Santa Catarina; 10 m high, diam. 5 cm).

Euplassa inaequalis (Pohl) Engl.: Brazil – Uw 7647 (Krukoff 6329 = USw 7647, Amazonas; tree 48 m high).

Euplassa madeirae Sleum.: Brazil – Uw 8167 (Krukoff 7086 = USw 8167, type Amazonas; tree 25 m high).

Euplassa pinnata (Lam.) Johnst.: Suriname – Uw 1905 (Lanjouw et Lindeman 2759, Nassau Mts; tree 9 m high, diam. 5 cm); Uw 4722 (Lindeman 7007, Nassau Mts; tree 18 m high, diam. 36 cm); French Guiana – Uw 5697 (BAFOG 1208, Cayenne; tree 32 cm diam., “lamoussaie blanc”), Uw 5754 (BAFOG 1266, Cayenne; tree 32 cm diam., “bois grage blanc”); Brazil – Uw 8969 (Terr. Federal de Amapá, Araguari 51685; diam. approx. 12 cm).

PANOPSIS Salisb.

Panopsis sessilifolia (Rich.) Sandw. (Plate I, fig. 4; Plate II, fig. 4; Plate III, C).

Sapwood greyish white to cream-coloured, 1.5–3 cm wide, clearly differentiated from the pinkish brown heartwood, lustre moderate, radial surfaces with an attractive ribbon pattern due to the conspicuous high rays; texture moderately coarse, grain straight; volume weight 0.63–0.69; a heartwood splinter burns to dark grey ash or to charcoal.

Wood structure

Growth rings: Absent.

Vessels: For 50 % or more solitary, the others in tangential pairs or in small clusters consisting of a few wide and several narrow vessels or tracheids, radial pairs rare; scattered, sometimes locally more numerous, on average 2–4 (0–12) per sq. mm; cross section round or oval with largest diameter in tangential direction, slightly angular, diameter variable, mostly 100–150 (45–230) μ ; vessel members often

strongly caudate or of irregular form, on average 900 (500–1350) μ long, longest in the sample with the widest vessels, perforations usually large and horizontal but also strongly oblique or occurring in lateral walls, in the narrow vessels often very small, oblique and one-sided; wall thickness 3–6 μ ; pits alternate, oval, 7 μ wide, apertures included; sometimes with brown contents.

Tracheids: Present in several samples, diameter on average 45 (25–60) μ , length equal to vessel members.

Fibres tissue: Fibres with thin to moderately thick walls, 4–7 μ , lumen at least as wide and mostly much wider than wall thickness, diameter 30 (18–40) μ ; length on average 2140 (1500–2880) μ ; pits with small borders and slit-like extended apertures (5 μ), numerous on radial and tangential walls.

Rays: Of two sizes; uniseriates composed of upright and square cells, occasionally also a few procumbent cells present, the upright cells 60 to 100 μ axially, number of cells mostly 1–8 (15); multiseriates 6–20 cells wide, mostly 200–300 (600) μ wide, height generally 4–5 mm, up to 7 mm; composed of procumbent cells of strongly variable dimensions, mostly radially elongated (120–240 μ) and very low (17 μ), but mixed with much higher and shorter, nearly square cells, on tangential section of very irregular sizes (Plate II, fig. 4); sheath cells locally; margins sometimes composed of one row of square cells, rarely of 2–3 rows, often two or even more rays nearly vertically superposed separated by only one or two oblique fibres or parenchyma strands (Plate II, fig. 4); cell walls usually heavily pitted, pits to vessels extremely scarce; cells often with reddish brown contents, in all samples small silica bodies are present; number of uniseriates 4 per sq. mm, in Uw 4399 11 per sq. mm, wide rays 5–10 per cm.

Parenchyma: Predominantly banded, the bands partly associated with the vessels – running in 1–2 (3) cells wide fairly straight, though slightly convex bands between the wide rays, occasionally bands interrupted; when in contact with vessels or vessel groups contiguous on the lateral and abaxial sides, or exclusively on the abaxial sides, a few paratracheal cells often present on the adaxial sides or the vessels completely enclosed by a vasicentric ring of one layer of cells; number of bands 6–8 per mm; strands mostly of 4–8 (2–12) cells; pits to vessels similar to the intervascular pits or larger and elongate; cells often with brown contents and small silica bodies.

OTHER SPECIES

Panopsis rubescens (Pohl) Pittier var. *simulans* Macbride (Plate I, fig. 5). The wood of this species closely resembles *P. sessilifolia* in its general characters, except for the greater volume weight (0.81). In anatomical structure it is very similar, except for the fibres which have slightly thicker walls and a narrower lumen, diameter on average 25 μ , and for the absence of silica bodies in the cells of the rays or the parenchyma.

MATERIAL

Panopsis sessilifolia (Rich.) Sandw.: Suriname - Uw 291 (Stahel, Wood herbarium 291, Saramacca R.; diam. unknown, over 13 cm), Uw 4399 (Lindeman 6413, Coppename R. near Bitagron; high 14 m, diam. 9 cm). Brit. Guiana - Uw 1039 (For. Dept. 3040, diam. unknown, over 16 cm); sections Yale 9476 (Persaud 71). Fr. Guiana - Uw 5810 (BAFOG 1322, Cayenne; diam. ca. 65 cm).

Panopsis rubescens var. *simulans* Macbride: Suriname - Uw 1960 (Lanjouw & Lindeman 2872, Nassau Mts; tree 25 m high, diam. 30 cm). Brazil - Uw 8264 (Krukoff 7236 = USw 8264 Amazonas, Humayta, tree 15 m high, ca. 19 cm diam.).

ROUPALA Aubl.

Roupala montana Aubl. (Plate II, fig. 1; Plate III, D)

Sapwood greyish brown with reddish hue, not clearly differentiated from the purplish brown heartwood, rather dull but with an attractive pattern on radial surfaces due to the prominent high rays with their silvery gloss; texture rather fine, grain straight; volume weight 0.83; a splinter of the heartwood burns to ash.

Wood structure

Growth rings: Absent.

Vessels: Predominantly solitary but also in radial pairs or more often in tangential pairs or multiples, occasionally in small clusters; in tangential arrangement accentuated by the association of all vessels on their abaxial sides with parenchyma bands; on average 19 (11-31) per sq. mm; cross section roundish or oval with longest axis in radial direction; tangential diameter on average 100 (40-140) μ ; vessel members rather often with long tapering "tails", medium-sized, 500 (260-600) μ long; perforations usually large and nearly horizontal, sometimes in a lateral position; cell wall 5 μ thick; intervascular pits crowded, alternate, very fine (4 μ), generally with coalescent apertures giving the impression of helical sculpturing of the vessel wall; occasionally with yellow contents.

Tracheids: Extremely scarce; of about the same length as the vessel members and mostly 35 μ wide.

Fibre tissue: Fibres with thick walls (8-13) μ , lumen hardly visible, diameter 17-27 μ ; moderately long, on average 1830 (1500-2190) μ ; pits with very small borders and rather short slit-like apertures, more numerous on radial than on tangential walls.

Rays: Nearly exclusively multiseriate; uniseriates scarce, composed of 1-2 (4) rows of square or upright cells, the latter mostly 70-100 μ long axially; multiseriates 7-25 cells wide (100-460 μ); mostly 4-5 mm high and up to 6 mm; consisting entirely of procumbent cells of various dimensions, usually with one, occasionally 2-4 marginal rows of square cells; sheath cells sometimes present; cells rather thick-walled; pits to vessels scarce, similar to the intervascular pits; cells often with reddish brown contents, small silica bodies often present. Number of uniseriates 2-4 per sq. mm; broad rays 9 per cm.

Parenchyma: In concentric convex bands, 1-4 cells wide forming a festoon between the broad rays, all bands in contact with vessels and

vessel multiples lining them exclusively on their abaxial sides; rarely a few cells paratracheal parenchyma on the adaxial sides; number of bands 3-4 per mm; strands mostly of 4-6 (2-8) cells; pits to vessels similar to the intervascular pits; cells usually with reddish brown contents, and often with small silica bodies.

OTHER SPECIES

Material was available of *R. cataractarum* Sleum., *R. dielsii* Macbride, and *R. rhombifolia* Mart.

In their *general properties* the agreement of all specimens with *R. montana* is very close. The *wood structure* resembles also rather closely this species, the chief differences being found in numbers and dimensions of the vessels, occurrence of tracheids, width of the parenchyma bands, and in the presence or absence of crystals, stone cells, and vertical resin ducts.

In *R. cataractarum* the vessels are more numerous, on average 30 (20-40) per sq. mm; diameter on average 47 (20-80) μ ; very small silica bodies often present in the procumbent ray cells; parenchyma bands mostly 4 cells wide and sometimes enclosing the vessels completely or at least a few cells of paratracheal parenchyma present on the adaxial faces of the pores.

In *R. dielsii* (Plate II, fig. 2) the two samples are nearly identical with *R. montana* and mutually much alike except for the stone cells in the wide rays present in Uw 7545, and apparently absent in the other sample. Differences with *R. montana* are the occurrence of small rectangular crystals in some of the procumbent ray cells, and occasional axial ducts of the same diameter as the vessel diameter which could be traced in both samples.

In *Roupala rhombifolia* (Plate I, fig. 6) the vessels are numerous, on average 50 per sq. mm, narrow, and mostly arranged in long tangential multiples, intervascular pits 2 μ ; tracheids numerous; the wide rays contain several clusters of sclerotic cells, and in some of the procumbent cells small rectangular crystals are present; the parenchyma is completely restricted to the abaxial, mostly 2 (4) cells wide bands.

MATERIAL

Roupala cataractarum Sleum.: Brazil - Uw 6918 (Reitz 6030 = HBR 16371, Santa Catarina; 4 m high, diam. 3.5 cm).

Roupala dielsii Macbride: Brazil - Uw 7545 (Krukoff 6194 = USw 7545, Amazonas; tree 15 m high); Uw 7833 (Krukoff 6633 = USw 7833, Amazonas; tree 21 m high).

Roupala montana Aubl.: Suriname - Uw 249 (Stahel, Wood herb. 249, Zanderij I; diam. 12 cm or more, "warirodan").

Roupala rhombifolia Mart.: Brazil - Uw 6919 (Reitz & Klein 6367 = HBR 16372, Santa Catarina; 10 m high, diam. 6 cm).

REMARKS ON THE ANATOMY

Tracheary elements. In all species investigated the perforations are simple, usually large and terminal, but sometimes oblique and lateral; in the narrow elements perforations are often very small. Those

elements resemble closely the vascular tracheids of the same dimensions with one or without any perforation. Vascular tracheids tend to be more numerous in specimens with the smallest vessel diameter and with numerous clusters. The form of the vessel elements may vary a great deal; the often very long and tapering "tails" are another characteristic feature of the investigated species (Plate III). The length of the tracheary elements is well above medium-size in *Panopsis* and *Euplassa*, where even a maximal fibre length of 3800 μ was observed in one sample.

Ray tissue. The very wide and high rays accompanied by a few very low uniseriades, which are not over a few cells high, form another character present in the three genera. The remarkable variation in the dimensions of the procumbent cells composing the wide part of the broad rays is more conspicuous in *Panopsis* and *Euplassa* than in *Roupala*, because in the latter genus the largest cells are nearly half the size of the largest cells in the two other genera. Upright cells occur in the uniseriades, in the marginal rows and occasionally as sheath cells; usually the axial dimension of these cells is not over three times the radial dimension.

The suggestion of axially superposed rays brought about by the "intersection" of large rays by a few oblique fibres or parenchyma strands (Plate II, fig. 4) is another feature common to all samples. It is very likely that new rays are formed here by the splitting of the wide rays, a process described by MISS CHATTAWAY (1933) for the *Sterculiaceae*. She suggested herself that a similar process might take place in the Grevilleoideae (CHATTAWAY, 1948a); this was afterwards confirmed for the rays of *Banksia* (CHATTAWAY, 1948b). Sclerotic ray cells were found in one specimen of *Roupala dielsii* and in *R. cataractarum*, also in one of the samples of *Euplassa pinnata*, but not in *Panopsis* for which genus CHATTAWAY (1948a) reported the occurrence of these cells. Small silica aggregates were observed in nearly all specimens though they were more numerous in one sample than in another. Their presence is often obscured by the accumulation of brown or orange cell contents around them. The dimensions of the silica bodies are variable, but usually not over 8 μ ; occasionally small particles like the crystal sand of silica described by BAMBER and LANYON (1960) in *Stenocarpus sinuatus* were observed. Small rectangular crystals were exclusively found in two species of *Roupala*. Oil cells reported to occur in *Roupala* (WILLIAMS, 1936) have not been found.

Parenchyma. It is rather difficult to say whether the banded parenchyma must be interpreted as apotracheal or paratracheal. In *Panopsis* and *Euplassa* those bands which are not connected with the vessels meet the requirements of apotracheal bands but the other bands, otherwise essentially similar except for their contact with the vessels, should be considered paratracheal. In my opinion the bands in contact with the vessels on their abaxial sides do not correspond to paratracheal parenchyma. I preferred therefore the term banded without further specification. As truly paratracheal I regard the cells or partial rings on the adaxial sides of the vessels. CHATTAWAY (1948a)

described the parenchyma lines in *Panopsis* as primarily apotracheal, reticulate, and as paratracheal in *Roupala*, where all the bands are associated with the vessels. She based her key to the genera of the *Grevilleoideae* on this deviation. She stated, however, in her discussion of the parenchyma distribution that the fundamental difference between the two types may be obscured when the bands are numerous and fine, and when at the same time the vessel chains are equally numerous so that practically no parenchyma bands are independent of the vessels. An example of such a type of parenchyma distribution is found in *Euplassa cantareirae* (Plate I, fig. 3), which has more numerous vessel chains than the other species of *Euplassa*.

Axial ducts. Intercellular canals of probably traumatic origin were observed in both samples of *Roupala dielsii*. The occurrence of these structures was reported for several Australian genera but so far not for any American species.

DISCUSSION

The descriptions of the wood anatomy and the key show that the structure of *Euplassa* is nearly identical to that of *Panopsis* while *Roupala* differs in various fundamental characters. It even seems quite well possible that further study of more species of both *Euplassa* and *Panopsis* would show the slight variation in the numbers of cells of the uniseriate rays and in the parenchyma strands, as well as the differences in the height of the broad rays, not to be a constant and reliable character for distinguishing the two genera.

Other genera belonging to the tribe *Grevilleeae* in South America are *Orites* (2 species) and *Gevuina* (1 species), both restricted to the Andean chain. No wood sample was available of *Orites*. Another member of the genus, *Orites excelsa* R. Br., occurring in Australia, was studied by Miss CHATTAWAY (1948a). She described the wood structure as identical with that of *Knightsia excelsa* R. Br., a member of the *Embothriaceae*. This implies that in general the structure resembles *Panopsis* except for the parenchyma bands which are always in contact with the vessels, and for the vessels arranged mostly in tangential chains.

Of *Gevuina avellana* Mol. a wood sample and detailed descriptions (TORTORELLI, 1956; WAGEMANN, 1948) were available. The structure has more affinity to *Panopsis* and *Euplassa* as far as the histology of the elements is concerned, e.g. the medium-sized intervacular pits, the relatively thin walled fibres with a large lumen. However, the arrangement of the vessels in long tangential chains and the constant association of all parenchyma bands with the vessel chains is again an indication that this species does not belong to the same group as *Panopsis* and *Euplassa*.

Considering exclusively the American members of the *Grevilleeae* the conclusion should be that in terms of wood structure *Panopsis* and *Euplassa* are very closely related; *Gevuina* and probably *Orites*, may be regarded as intermediates between them and *Roupala*.

This result is not in agreement with the suggested evolutionary

relationships based on comparative morphology published by JOHNSON and BRIGGS (1963) who believe *Roupala* to be most closely related to *Panopsis*, and *Euplassa* to *Gevuina*. These authors placed *Orites* in a different tribe.

However, in the *Proteaceae* wood structure is probably less important for deciding the limits of taxa above the rank of genus than for determining the position of a species within a genus, e.g. the discrepancies found by JANSSONIUS (1930) within the genus *Helicia*, and SLEUMER's (1955) description of a new genus, *Heliciopsis*, in which inter alia the two aberrant species were placed.

CHATTAWAY (1948a) noted two other aberrant species among her material of *Helicia*, one of them *H. diversifolia* White, with the same type of wood structure as the species now referred to *Heliciopsis*. However, *Helicia diversifolia* White, which species according to SLEUMER (1955) did not fit in *Helicia* was transferred by him to the monotypic genus *Hicksbeachia*. Here it seems rather out of place from the point of view of wood anatomy since *Hicksbeachia pinnatifolia* F. Muell., the other species, differs according to Miss Chattaway's description in several respects from the structure of *Helicia diversifolia*. However, Dr. Sleumer (personal communication) no longer holds the view that *Helicia diversifolia* is congeneric with *Hicksbeachia*. No taxonomic information was available to me on the other species cited by Miss Chattaway, *Helicia montana* Sym.

REFERENCES

- ACOSTA-SOLIS, M. 1960. Maderas economicas del Ecuador y sus usos. Quito.
 BAMBER, R. K. and J. W. LANYON. 1960. Silica deposition in several woods o. Nw. South Wales. *Trop. Woods* **113**: 48.
 BASCOPÉ VARGAS, F. 1962. Clave de identificacion macroscopica de algunas maderas dicotiledoneas de Latino America. *Bol. Inst. For. Lat. Amer.* No. 9: 16-101.
 BENOIST, R. 1931. Les bois de la Guyane française. *Arch. Bot.* **5**, Mém. 1: 49.
 CHATTAWAY, M. M. 1933. Ray development in the Sterculiaceae. *Forestry* **7**: 93-108.
 ———. 1948a. The wood anatomy of the Proteaceae. *Austr. J. Scient. Res. Ser. B.* **1**: 279-302.
 ———. 1948b. Note on the vascular tissue in the rays of *Banksia*. *J. Council Sc. Ind. Res.* **21**: 275-278.
 International Association of Wood Anatomists. 1937. Standard terms of length of vessel members and wood fibres. *Trop. Woods* **51**: 21.
 ———. 1939. Standard terms of size for vessel diameter and ray width. *Trop. Woods* **59**: 51-52.
 ———. 1957. International glossary of terms used in wood anatomy. *Trop. Woods* **107**: 1-36.
 JANSSONIUS, H. H. 1930. *Mikrographie des Holzes*, V. Leiden.
 JOHNSON, L. A. S. and B. G. BRIGGS. 1963. Evolution in the Proteaceae. *Austr. J. Bot.* **2**: 21-61.
 KRIBS, D. A. 1928. The Persaud collection of British Guiana woods. *Trop. Woods* **13**: 57.
 MANIERI, C. 1958. Identificação das principais madeiras de comercio no Brasil. São Paulo.
 METCALFE, C. R. and L. CHALK. 1950. *Anatomy of the Dicotyledons*. Oxford.
 RECORD, S. J. and R. W. HESS. 1943. *Timbers of the New World*. New Haven.
 RECORD, S. J. and C. D. MELL. 1924. *Timbers of Tropical America*. New Haven.

- SLEUMER, H. 1954. *Proteaceae americanae*. Bot. Jb. **76**: 139-211.
- . 1955. *Studies in Old World Proteaceae*. Blumea **8**: 1-96.
- TORTORELLI, L. A. 1956. *Maderas y Bosques Argentinos*. Buenos Aires.
- WAGEMANN, G. 1948. *Maderas chilenas*. Lilloa **16**: 263.
- WILLIAMS, L. L. 1936. *Woods of North Eastern Peru*. Field Mus. Nat. Hist. Bot. Ser. **15**: 98.