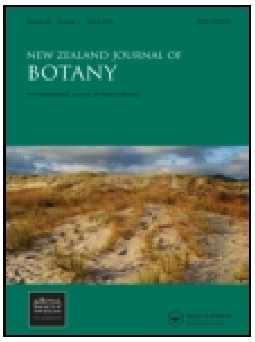

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Wood Anatomy of the Dicotyledons Indigenous to New Zealand
8. Corynocarpaceae*

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ABSTRACT

Wood anatomy of *Corynocarpus laevigatus* J.R. et G. Forst. is described. Growth rings are not evident. Vessels are solitary or in multiples of 2–6. They are storied, and have simple perforation plates and fine spiral thickening. Intervascular pits are mainly alternate and angular. Pits leading to rays are infrequent but similar to intervascular pits. Axial parenchyma is abundant and storied. It occurs as discontinuous paratracheal bands, and also is vasicentric. Intercellular spaces are associated with paratracheal bands. Each parenchyma strand consists of two cells but fusiform cells are common. Crystals are sparse or absent. Rays are noded, wide, and tall. They are heterogeneous with procumbent cells intermingled with upright and square cells. Uniseriate tails are mainly composed of 1–2 upright cells. Rays are mainly 6–23 cells wide. Uniseriate rays are rare or absent. Sheath cells are frequent. Crystals are present in ray parenchyma. Some crystal-bearing cells are enlarged. Fibres are thick to very thick-walled. They show an occasional tendency towards a storied arrangement. Simple to almost simple pits occur on tangential and radial walls.

INTRODUCTION

Corynocarpus is the sole genus of the family Corynocarpaceae. It comprises four species: *C. australasica* C. T. White occurring from New Guinea and Aru Island to North Queensland in Australia; *C. laevigatus* J. R. et G. Forst. in New Zealand and adjacent islands; *C. dissimilis* Hemsl. in New Caledonia; *C. similis* Hemsl. in the New Hebrides (Ingle 1956). Although Willis (1966) provided a similar geographic distribution, he indicated that *Corynocarpus* may have four to five species.

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The fruits of *C. laevigatus* were at one time eaten by the Maoris after prolonged soaking or steaming to remove a toxic constituent (Skey 1872). *Corynocarpus* wood does not have commercial value because the trees are fairly small (Ingle 1956). Heimsch (1942) and Metcalfe & Chalk (1950) described the wood anatomy of *C. laevigatus* and Ingle (1956) provided a generalised anatomical description of wood of the above four species.

Material and Methods

The collection data of the trees examined are given below:

Species	*Height* (m)	*Dbh* (cm)	*Locality*
	4.6	10	New Plymouth
C. laevigatus	3 6*	8	Palmerston North
	7.3	16.5	Kaikoura, Marlborough

*One of multiple leaders of a 12 m-tall tree.

Selection of wood samples and other procedures used in this investigation are similar to those described earlier (Patel 1973). Age of stems could not be determined because growth rings were not evident. Moreover, it was not possible to count rays in an area of 1 mm² because the rays in *C. laevigatus* are often very tall. An area of 11 mm² was selected to accommodate rays of different sizes. The final result is expressed as an average per 10 mm², and not per 1 mm².

Results

Corynocarpus laevigatus (karaka, kopi)

Distributed in North and South Islands in coastal and lowland forest to about latitude 44°S; also found in the Chatham Islands and the Kermadecs (Allan 1961). Tree up to 15 m in height (Cheeseman 1925, Allan 1961); trunk up to 60 cm in diameter (Cheeseman 1925, Allan 1961). Bark grey or light grey.

Coloured heartwood absent from the present material. Wood white or light brown to pink. Commercial value nil.

Microscopic structure

The frequency and dimensions of vessels and fibres are given in Table 1.

Growth rings not evident. Vessels markedly variable in frequency but not zonate (Figs 1–4); markedly variable in arrangement (Figs 1–4), oblique pattern sometimes present; angular; solitary, in radial or

TABLE 1—Frequency and dimensions of vessels and fibres

Species	VESSELS												FIBRES			
	Number/mm²				*Tangential diameter (µm)*				*Length (mm)*				*Length (mm)*			
	Range	Mean	SD	CV%	Range	Mean	SD	CV%	Range	Mean	SD	CV%	Range	Mean	SD	CV%
C. laevigatus	11–37	20	9.29	46.8	34–105	67	14.84	22.3	0.14–0.31	0.22	0.03	13.1	0.53–1.41	0.91	0.18	20.2

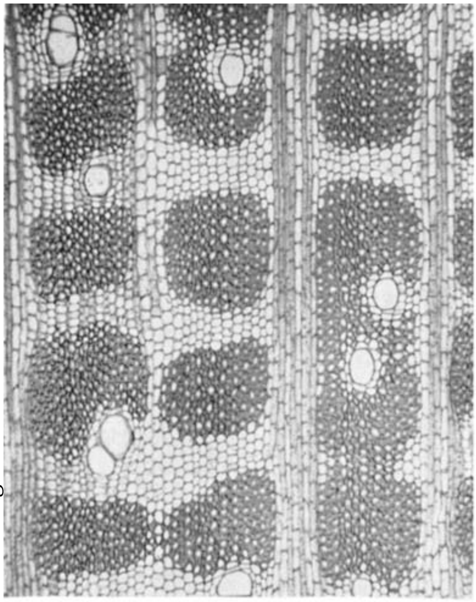


FIG. 1—*C. laevigatus* TS ×50. Vessels few, evenly distributed. Axial parenchyma in tangential paratracheal bands. Rays slightly noded.

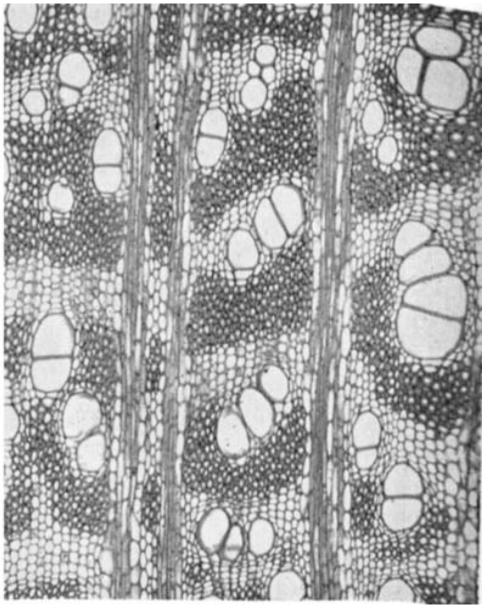


FIG. 2—*C. laevigatus* TS ×50. Vessels num ous, in multiples. Axial elements show tendency towards oblique arrangement.

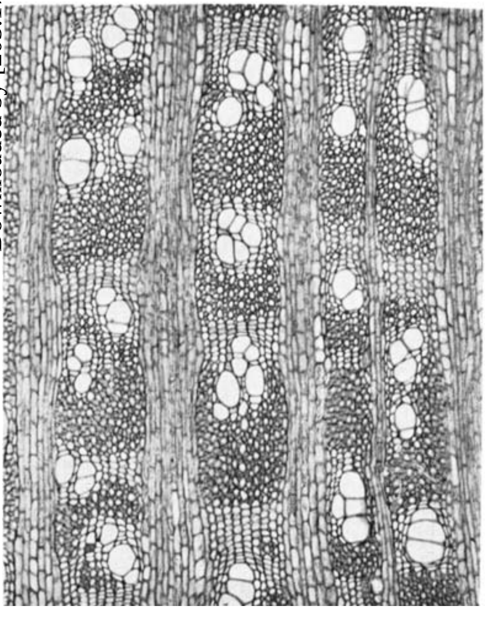


FIG. 3—*C. laevigatus* TS ×50. Vessels numerous, evenly distributed with tendency towards grouping. Axial parenchyma slightly dark due to protoplasmic contents. Rays noded.

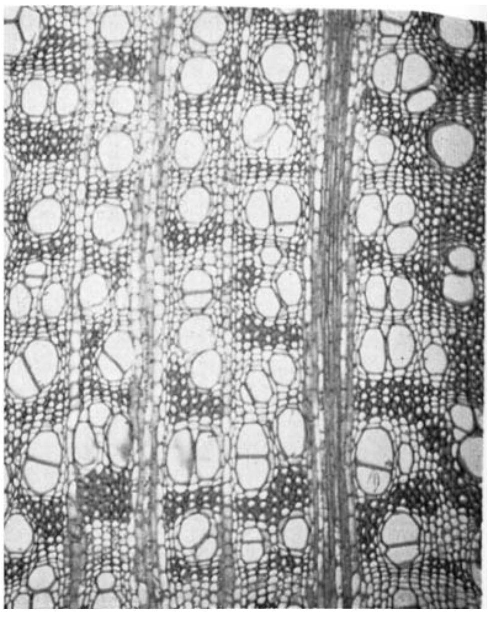


FIG. 4—*C. laevigatus* TS ×50. Vessels num ous, evenly distributed. Fibres fewer than Figs 1–3.

oblique multiples of 2–4, clusters of 3–6, occasionally in tangential pairs; average 20/mm² (range 11–37); average 67 μm in tangential diameter (range 34–105); average 0.22 mm in length (range 0.14–0.31); storied; perforation plates simple; intervascular pits mainly alternate (Fig. 5), angular sometimes radially elongated; pits 5–8 μm in diameter; fine spiral thickening present (Fig. 6); tyloses or gummy deposits absent; pits to rays infrequent but similar to intervascular pits (Fig. 7), 5–8 μm in diameter. AXIAL PARENCHYMA abundant; predominantly in discontinuous paratracheal bands (tangential, oblique, or anastomosing) up to 16 cells wide, with intercellular spaces, vasicentric, rarely scanty paratracheal; storied (Fig. 8), mainly 2 cells/strand, fusiform cells common, rarely 3 cells/strand; rhomboidal or other angular shaped crystals in fusiform (Fig. 9) and strand parenchyma sparse or absent; size variable; 1–8/cell; each crystal in poorly or well-developed loculus, occasionally free. RAYS noded (*see* Figs 1, 3); heterogeneous with procumbent, upright and square cells intermingled; uniseriate tails mainly composed of 1–2 upright cells; mainly 6–23 cells wide (Fig. 10), 1–3 seriates rare or absent, 4–5 seriates sparse or absent; multiseriates average 3/mm line (range 2–5); average 9/10 mm² (range 5–16); average 2.15 mm in height (range 0.49–7.73); dissected rays often present; axially united rays rare; sheath cells frequent, rhomboidal or other angular shaped crystals of different sizes present (Fig. 11); crystal-bearing cells sometimes enlarged; mainly one/cell within a loculus, occasionally up to 6 crystals/cell; crystals occasionally zonate. FIBRES thick to very thick-walled; average 0.91 mm in length (range 0.53–1.41); occasional tendency towards storied arrangement; simple to almost simple pits present on tangential and radial walls.

DISCUSSION

Growth rings are not evident in *C. laevigatus* but the wood is regarded as diffuse-porous. The secondary xylem of *C. laevigatus* exhibits a marked variability in the arrangement and frequency of its component tissues, i.e., vessels, axial parenchyma, rays, fibres (Figs 1–4). Each tissue responds to changes which occur in one or more of the other tissues. In Fig. 1, for example, vessels are solitary or in radial pairs and are widely spaced, whereas axial parenchyma and fibres are arranged in discrete groups or islands with more or less regular outline. In Fig. 2 all axial elements exhibit a more or less oblique pattern. Vessels are more numerous, and fibres fewer in Fig. 2 than in Fig. 1. In Fig. 3 vessels show a tendency towards grouping, the proportion of rays to that of the remaining tissue appears to be greater here than in Figs 1, 2, and 4. Vessels are more numerous, and fibres fewer in Fig. 4 than in Figs 1–3. These observations illustrate the limitations of anatomical data based on a study of one or two wood samples.

Vessel elements are derived from storied fusiform initials. They do not increase in length during their development, and therefore, retain

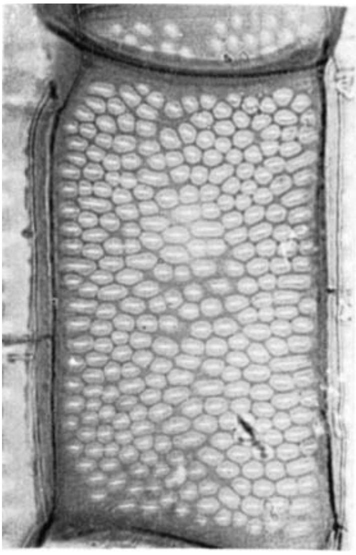


FIG. 5—*C. laevigatus* TLS $\times$325. Intervascular pits mainly alternate, angular.

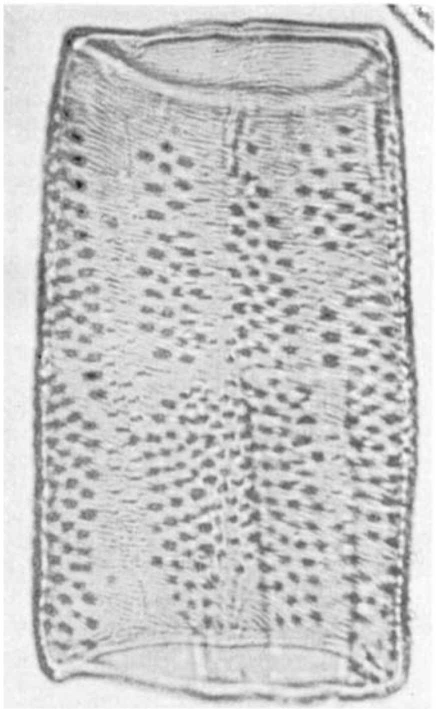


FIG. 6 (top right)—*C. laevigatus*. Isolated cell $\times$300. Vessel element with fine spiral thickening. T s-versely oriented simple pe ı-tions in end walls.

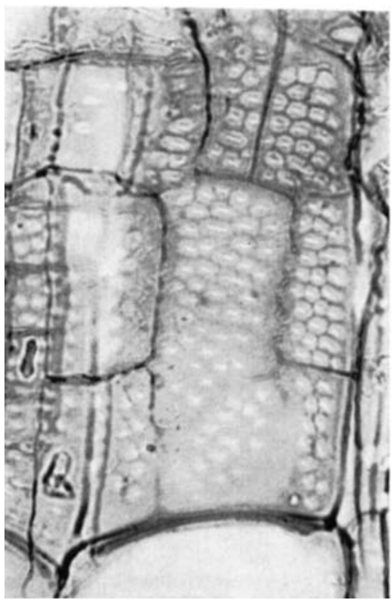


FIG. 7—*C. laevigatus* RLS $\times$325. Vessel pits to rays similar to intervascular pits.

FIG. 10 (bottom left opposite)—*C. laevigatus* TLS $\times$50. Rays up to 16 cells wide.
FIG. 11 (bottom right opposite)—*C. laevigatus* RLS $\times$96. Ray parenchyma with crystals. Two crystal-bearing cells are enlarged.

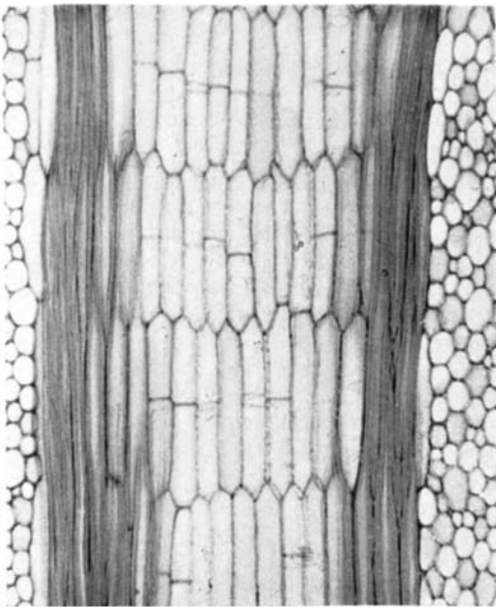


FIG. 8—*C. laevigatus* TLS ×120. Axial parenchyma in horizontal seriation.

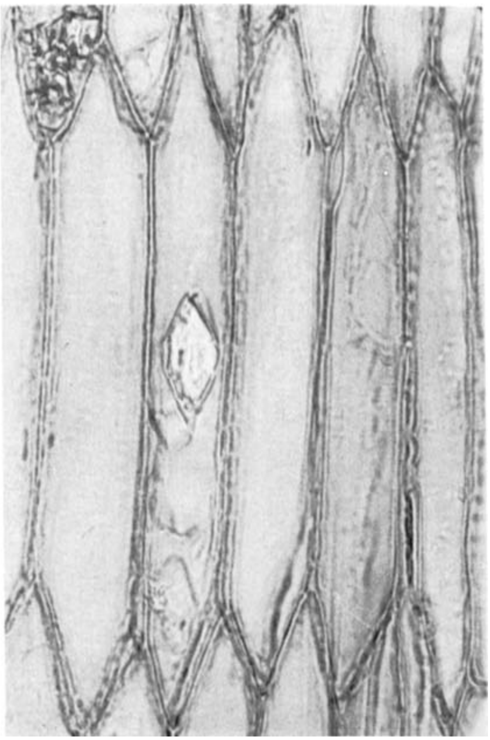
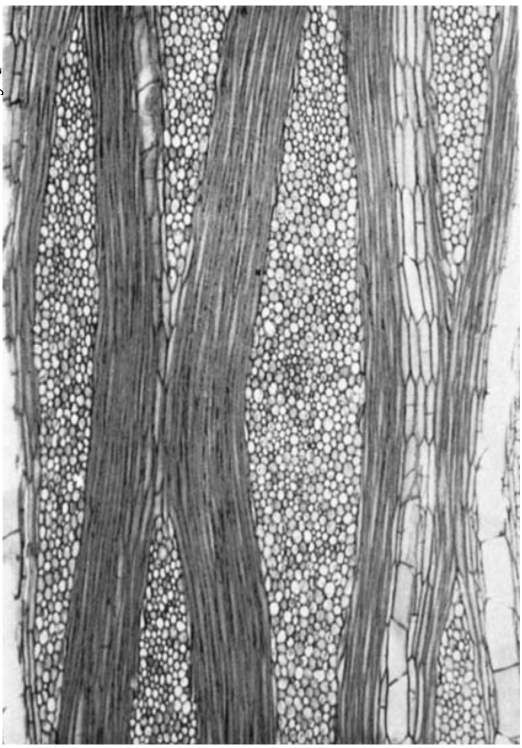
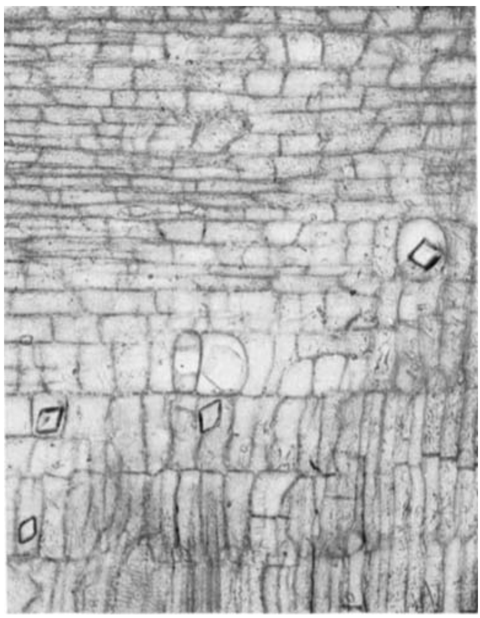


FIG. 9—*C. laevigatus* TLS ×480. Rhomb crystal in fusiform parenchyma.





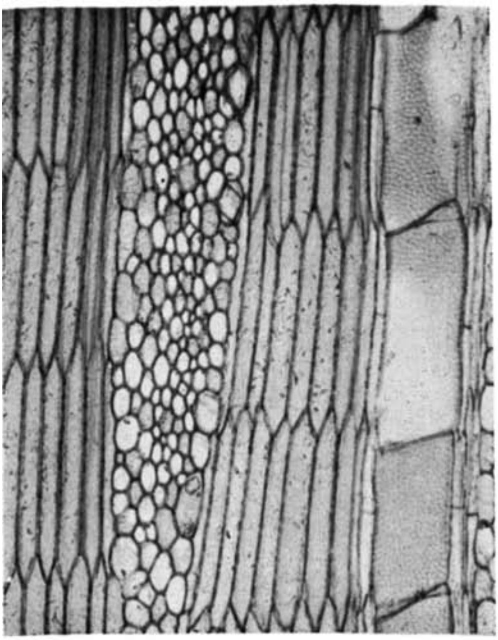


FIG. 12—*C. laevigatus* TLS ×120. Storied axial parenchyma predominantly fusiform. Parenchyma touching vessel elements have two cells per strand.

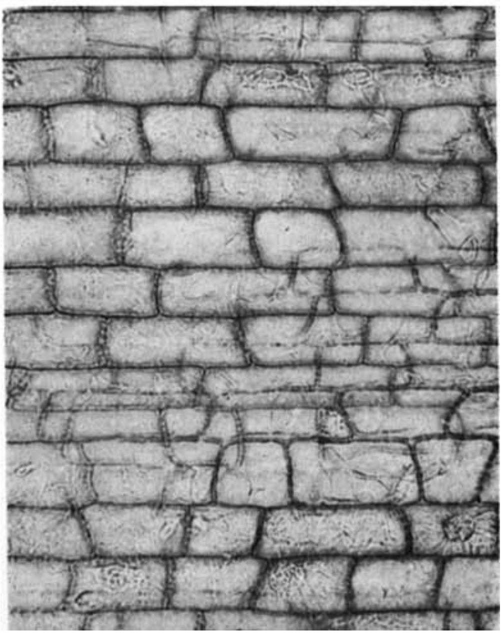


FIG. 13—*C. leavigatus* RLS ×189. Radially elongated procumbent cells.

their horizontal seriation. These elements are short (average 0.22 mm), with simple perforations which are transversely oriented, and terminal. Tails or ligules, which are occasionally present, are rudimentary.

Axial parenchyma is storied (Heimsch 1942, Metcalfe & Chalk 1950, Ingle 1956) and abundant. According to Metcalfe & Chalk (1950) parenchyma bands in *C. laevigatus* are apotracheal. The present work supports the observation (Heimsch 1942, Ingle 1956) that they are paratracheal. Axial parenchyma occurs mostly in strands of 2 cells but fusiform cells are frequent (Metcalfe & Chalk 1950, Ingle 1956). This is so in the present material where a few regions of axial parenchyma contained predominantly fusiform cells (Fig. 12). There appeared to be no structural difference between banded parenchyma and vasicentric parenchyma except that intercellular spaces frequently occurred in the former.

Rays in *C. laevigatus* are wide, noded, and conspicuous in transverse section. Narrow rays which sometimes appear in this view are, in fact, the upper and lower tapering ends (TLS) of wide rays. The noding usually occurs when rays are in contact with axial parenchyma bands which also tend to widen in the region of contact. Noding occurred in a few tangential areas which appeared similar to ring boundaries, although I have not been able to find conclusive evidence to confirm the presence of such boundaries. Noding of rays in *C. laevigatus* appears to be associated with differences in pressures exerted by tissues surrounding the rays. Pressure exerted by the thick-walled fibres on the contiguous thin-walled rays tends to inhibit the enlargement of at least some ray cells during their early stages of development. As a result, such areas in rays appear constricted whereas parts of rays which are in contact with a soft tissue like axial parenchyma are not restricted in their capacity to enlarge. In a number of dicotyledonous species vessels are known to constrict, or push away, rays to some extent during their development when they increase considerably in diameter, but this does not produce noding in rays. However, in *C. laevigatus* the contact between vessels and rays appears to be infrequent.

Rays are exclusively multiseriate, and heterogeneous. Their placement into one or more of the three heterogeneous types (I, II, III) is not possible because procumbent, square, and upright cells are intermingled. If the rays were classified mainly on the length of uniseriate tails in relation to that of the multiseriate parts, then they would be termed heterogeneous type II–III. Although procumbent cells in *Corynocarpus* are reported to be absent or reduced in length (Ingle 1956), I found typical procumbent cells in every sample of *C. laevigatus* examined (Fig. 13). Metcalfe & Chalk (1950) also recorded procumbent cells in this species.

It is often difficult to distinguish between some sheath cells, and some storied axial parenchyma touching the rays. Examination of tangential longitudinal sections indicates that at least some sheath cells are derived from fusiform initials which are similar to storied axial parenchyma in length and shape. There is further evidence that the upper and lower margins (tails) of rays contain cells derived from fusiform initials.

Metcalfe & Chalk (1950) reported that crystals of calcium oxalate are restricted to the square cells of rays in *C. laevigatus*. In the present material, similar crystals are present in upright, square, procumbent, and sheath cells of rays. They are, however, infrequent in procumbent cells. Crystal-bearing cells of rays are sometimes enlarged (Ingle 1956) with a tendency to become slightly rounded. Metcalfe & Chalk (1950) and Ingle (1956) recorded solitary crystals in rays. Although most crystals in rays of *C. laevigatus* occur singly, sometimes up to 6/cell are found.

Kirk (1889) noted that the wood of *C. laevigatus* is non-durable. This may be so, probably because it consists of a large proportion of parenchymatous tissue whose carbohydrate contents would provide a readily available food source for the establishment of wood-destroying organisms.

The taxonomic position of *Corynocarpus* has always been uncertain (Metcalfe & Chalk 1950). This genus was assigned to the Anacardiaceae in the Bentham and Hooker classification. Engler (*see* Hemsley 1903) excluded *Corynocarpus* from the Anacardiaceae because it lacks resin canals, and placed it in a separate monogeneric family Corynocarpaceae. Hemsley (1903) did not regard the absence of resin canals as an important feature, and therefore preferred to retain *Corynocarpus* in the Anacardiaceae. There are, however, further important differences between *Corynocarpus* and the Anacardiaceae. I support the view (Metcalfe & Chalk 1950, Ingle 1956) that wood anatomy does not show any relationship between *Corynocarpus* and the Anacardiaceae. Metcalfe & Chalk (1950) suggested that *Corynocarpus* wood shares several anatomical features with that of the Berberidaceae (*Berberis, Mahonia, Nandina**). However, anatomical description of the secondary xylem of the Berberidaceae provided by Metcalfe & Chalk (1950) also includes some features (e.g., rays homogeneous, axial parenchyma absent) which do not indicate close affinity with *Corynocarpus*. According to Ingle (1956) *Corynocarpus* bears a strong resemblance to group B of *Sterculia* in the Sterculiaceae, which is botanically unrelated to *Corynocarpus*. Recent work in taxonomy has failed to place the Corynocarpaceae in an appropriate order (Cronquist 1968, Takhtajan 1969).

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*Now placed in the monogeneric Nandinaceae (*see* Willis 1966).

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