

Vegetative anatomy of *Finschia* Warb. and its place in Hakeinae[‡] (Proteaceae)

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Abstract

The leaf anatomy of three species of *Finschia* included in the subtribe Hakeinae (Proteaceae) is described. The stem-node-leaf continuum is described in *F. chloroxantha* Diels and *F. rufa* Warb.. Within the genus, features of the leaf epidermis make it possible to distinguish species and are consistent with synonymy between *F. rufa* and *F. carrii* (Sleumer) C.T.White. Anatomical characteristics are compared with those of *Grevillea* and *Hakea* and similarities that might support relationships are discussed.

Introduction

Finschia comprises three Papuan species and is currently recognised as a member of tribe Embothrieae, subtribe Hakeinae (Proteaceae) (Weston & Barker 2006). All *Finschia* species are trees with buttressed trunks, often raised on stilt roots. *Finschia ferruginiflora* is restricted to the Eastern Highlands and Western Highlands of Papua New Guinea; *Finschia rufa* is known from Madang, Morobe, Eastern Highlands and Western Highlands, Central and Milne Bay districts of Papua New Guinea (Foreman 1995); and *Finschia chloroxantha* is more widely distributed in Papua New Guinea (Conn & Damas 2006+) and extending to the Aru Islands, Solomon Islands, New Hebrides and Palau Islands.

Finschia Warb. was circumscribed by Warburg (1891) but became the object of controversy in the first half of the twentieth century. Lauterbach (1913) distinguished *Finschia* from *Grevillea* R.Br. but Diels (1916) rejected the separation of the two genera on the grounds that, although characters of the fruits were described, fruits of neither *F. rufa* nor *F. chloroxantha* had been seen. Sleumer (1939) included *Finschia* in *Grevillea* R.Br. and gave a key to the New Guinea species. White (1949) revised the genus, amended Warburg's description, described a new species and proposed a new combination. He delimited four species, *F. rufa* Warb., *F. carrii* (Sleumer) C.T.White, *F. ferruginiflora* C.T. White and *F. chloroxantha* Diels but Foreman (1995) subsequently decided that *F. rufa* and *F. carrii* were synonymous.

[‡]In the original title this was cited as "Grevilleae" but the editorial committee chose to use the more recent classification of Weston and Barker (2006) on the recommendation of the referees.

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The wood anatomy of *Finschia* has been reported on in general works (Furuno 1977, Ilic 1991, Metcalfe & Chalk 1950, Streimann 1969). Chattaway (1948) included the genus in her study of the wood anatomy of the Proteaceae but no account of the leaf and nodal anatomy of *Finschia* has been published.

A list of the specimens studied, including details of collectors and locations, is given in appendix A.

Methods

Methods were those used to study the anatomy of leaves and nodes of *Hakea* (Catling & Gates 1995a, b). Material of herbarium specimens was reconstituted by boiling in water for 10 minutes, and mounted in a split cork and sections 20µm thick cut using a Reichert OME microtome. Sections were cleared in sodium hypochlorite solution, stained with safranin and alcian blue, dehydrated in a graded alcohol series, cleared in Histoclear and mounted in DePex or Canada Balsam.

Observations

Finschia chloroxantha

Stem

Stems included in the stem-node-leaf continuum measured 3-4 mm in diameter and were surrounded by 5-6 layers of superficial cork. The epidermis was disrupted. The cortex was 5-11 cells wide, complementing the size of fibre caps associated with vascular bundles; mostly unligified but contained some lignified cells and groups of large sclereids; some cells contained tannin. There was a more or less continuous ring of pericyclic sclerenchyma. As well as fibres, this included sclereids which often, though not necessarily, coincided with medullary rays. Vascular tissues were eustelic to weakly siphonostelic and a continuous cambial zone was recognisable. There were interxylary fibres. Pith was lignified and included many large groups of sclereids, especially near developing leaf traces.

Node

Leaf traces spanned only a short distance between the stele and the petiole. They did not extend into adjacent nodes. Traces were recognised by increased numbers of vessels in stelar bundles. At higher levels, modified xylem consisted of simple vascular elements and unligified parenchyma. Below nodes, near leaf traces, stelar bundles divided and merged. Outside the leaf traces, the cortex was wider and enclosed numerous sclereids.

In the specimen collected by *Powell*, ten nodes were examined. Lateral traces and eight median traces were continuous with single stelar bundles. In two nodes, in the median position, two stelar bundles were modified. In three nodes examined in *BSIP5577*, there was a single stelar bundle associated with each lateral trace. In one node, in the median position, there was a complex of three bundles. In one of the nodes in *NGF9123*, there was a single modified stelar bundle in the position of each lateral leaf trace, in the other, there were four on one side and three on the other. In the median position, three or six bundles were modified.

Leaf base

Leaves were petiolate.

The base of the petiole was first recognised by an absence of cork and by an abscission layer within the stem (Fig. 1). In fibre caps associated with leaf traces, cells were dispersed and mixed with parenchyma (Fig. 1). No sclerenchyma crossed the abscission layer. Towards the lamina there were increased amounts of lignified parenchyma and fibres within the petiole and, where the median leaf trace crossed the abscission layer, there was a weakly-developed fibre cap ahead of it (Fig. 1). Above this, the trace divided and there was a fibre cap associated with each branch. Lateral leaf traces were within the cortex.

At this level, within the stele, one or two small bundles on either side of the median leaf gap had modified xylem. At higher levels, they passed into the petiole where they were inversely orientated and completed a ring of vascular bundles.

Lateral leaf traces entered the petiole. Near the abscission layer, they branched and some tissues formed small vascular bundles on the margins of the leaf base, outside the main circle. There were numerous sclereids in the petiole and in the cortex of the stem, many in a broken line close to the adaxial side of the abscission layer (Fig. 2).

Where the petiole became separate from the stem, it contained a ring of small bundles. Bundles in the abaxial arc had well developed abaxial fibre caps and smaller groups of adaxial fibres. Small groups of abaxial and adaxial fibres were associated with each inverted bundle. Towards each margin there were two or three closely associated small bundles (Fig. 3).

Petiole

Towards the lamina, lateral bundles and bundles towards the abaxial surface were in a broad arc. Abaxial fibre caps were partially merged; adaxial fibres were in discreet groups.

Towards the adaxial side, in three of the five specimens examined, there were well defined inverted bundles (Fig. 4). In material collected by *Powell* and in *NGF 9123*, groups of vascular tissues were less precisely orientated. In material collected by *Powell*, these vascular groups were not seen in the distal region of the petiole; occasional vascular elements occurred among adaxial fibres.

At lower levels towards the base of the petiole, there were adaxial and abaxial fibres associated with each inverted group of vascular tissues. At higher levels, there was a continuous band of adaxial fibres.

Transition from petiole to leaf

Towards the distal end of the petiole, there were 2 adaxial marginal extensions. Two lateral bundles were separated from the main arc by unligified parenchyma (Fig. 5).

In *BSIP5577* and *Akorra 238*, inverted bundles occurred in lower levels of the leaf although they were not seen at the centre.

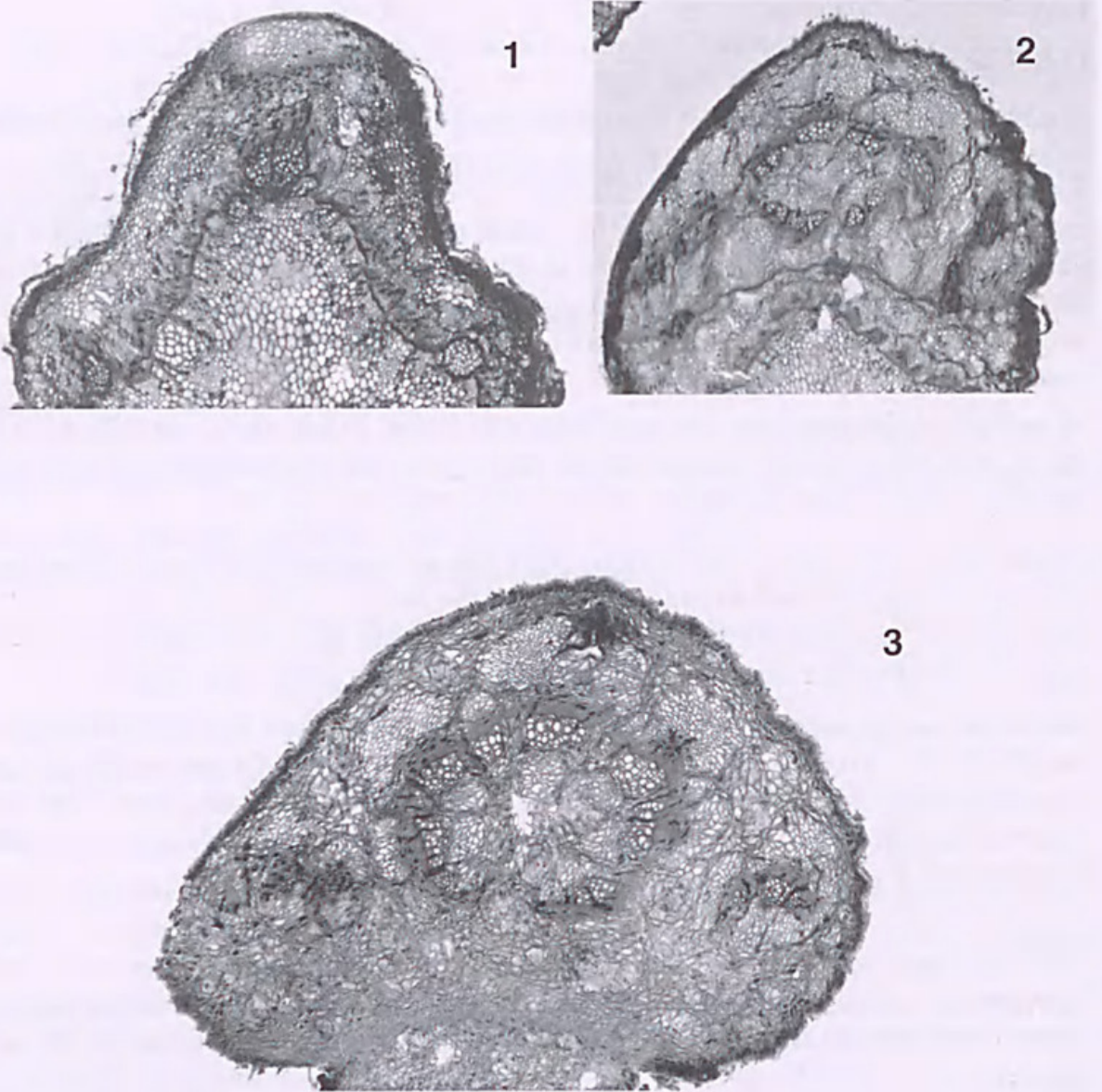


Fig 1. *Finschia chloroxantha* (NGF9123); transverse section of node showing an abscission layer and the absence of cork. No sclerenchyma crosses the abscission layer. There is a weakly-developed fibre cap below where the median leaf trace crosses the abscission layer. (c. $\times 30$).

Fig 2. *Finschia chloroxantha* (NGF9123); transverse section of leaf base showing the lateral leaf traces entering the petiole. Near the abscission layer, they form small vascular bundles on the margins of the leaf base, outside the main circle. There are numerous sclereids in the petiole and in the cortex of the stem, many in a broken line close to the adaxial side of the abscission layer. (c. $\times 25$).

Fig 3. *Finschia chloroxantha* (NGF9123); transverse section of leaf base where the petiole separates from the stem; it contains a ring of small bundles. Bundles in the abaxial arc have well-developed abaxial fibre caps and smaller groups of adaxial fibres. Small groups of abaxial and adaxial fibres are associated with each inverted bundle. Towards each margin there are two or three closely associated small bundles. (c. $\times 30$).

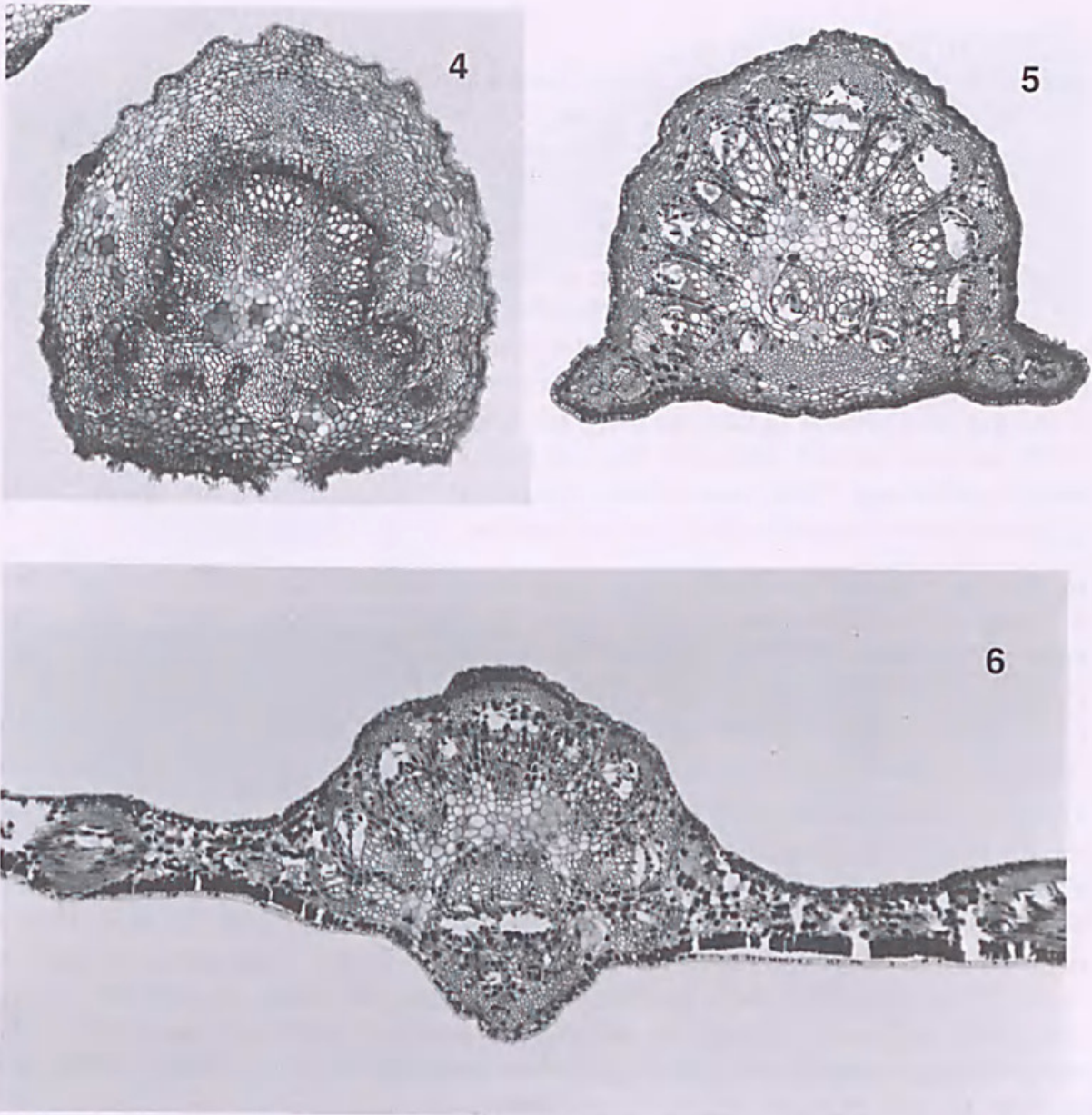


Fig 4. *Finschia chloroxantha* (NGF9123); transverse section of petiole; lateral bundles and bundles towards the abaxial surface are in a broad arc. Abaxial fibre caps are partially merged; adaxial fibres are in discrete groups. (c. $\times 30$).

Fig 5. *Finschia chloroxantha* (NGF10358); transverse section of leaf base. Towards the distal end of the petiole, there are 2 adaxial marginal extensions. Two lateral bundles are separated from the main arc by unlignified parenchyma. (c. $\times 30$).

Fig 6. *Finschia chloroxantha* (NGF10358); transverse section of midrib. All palisade cells contain tannin, some cell walls are lignified. Abaxial to the palisade, are 10-12 rows of mesophyll cells which are more spongy nearer the surface. One subepidermal row contains tannin. Main bundles are predominantly collateral with abaxial phloem. At the midrib, there is an abaxial arc of bundles of various sizes, each with an abaxial fibre cap. (c. $\times 30$).

Leaf

In outline, in transverse section, abaxial and adaxial surfaces were parallel. Margins were hardly recurved. The leaf was thicker over main veins. At the midrib, the abaxial side of the leaf was convex and there was a pointed adaxial ridge.

Leaves were dorsiventral. The abaxial epidermis consisted of a single row of irregularly rectangular cells. In surface view, anticlinal walls were sinuous. The stomata were brachyparacytic, only occurred on the abaxial surface and were not sunken below the general level of the epidermis. In the adaxial epidermis, cells were more regularly rectangular and anticlinal walls straighter. Outer epidermal walls were cutinised on the adaxial surface and at margins and more weakly cutinised on the abaxial surface. T-shaped hairs, similar to those in many members of the Hakeinae (Heide-Jorgensen, 1978) occurred on both surfaces. The bases of these were not sunken and they were mostly deciduous. There were small, occasional, collapsed glandular hairs. Some epidermal and mesophyll cells contained crystals.

In material collected by *Powell* and in *NGF10358*, palisade consisted of a single row of upright cells interrupted at main veins. In *BSIP5577* and *Akorra 238*, cells were taller and narrower. In *NGF9123*, there was a second, irregular row of square cells. All palisade cells contained tannin. Some cell walls were lignified. There were pronounced pits in anticlinal walls. Abaxial to the palisade, were some 10–12 rows of mesophyll cells which were more spongy nearer the surface. One subepidermal row contained tannin.

Main bundles were predominantly collateral with abaxial phloem. At the midrib, there was an abaxial arc of bundles of various sizes, each with an abaxial fibre cap (Fig. 6). In all the specimens, there was some merging and dividing of fibres and vascular tissues. The number of bundles in the arc varied from 9–16. In three specimens there were 5 main bundles. In *NGF10358* there were 9 bundles of more or less equal size and, in *NGF9123* and *BSIP183*, there was considerable fusion of tissues. Adaxial fibres were associated with vascular groups. Bundles were separated by lignified parenchyma cells, some of which contained tannin. There were some 5–7 rows of abaxial unlignified cortical parenchyma; a morphologically distinct subepidermal row contained tannin. In *NGF10358* and *BSIP183*, there were fewer rows of abaxial cortical parenchyma and, in *NGF 9123*, the subepidermal row was less distinct.

On the adaxial side of the midrib, there was a band of fibres (Fig. 7). In different specimens, cell walls were of different thicknesses and were more or less lignified. Among the fibres, there were occasional tracheary elements. Adaxial to the fibres were 2–3 rows of cortical parenchyma. In two specimens, *NGF10358* and *BSIP183*, there were inverted vascular tissues on the abaxial side of adaxial fibres. In *NGF10358*, there was a tangentially spread group of inverted tissues and, adaxial to this, 3–4 bundles which were not precisely orientated. In *BSIP183*, there was some merging of inverted tissues which were seen as separate vascular bundles in the petiole.

Large unlignified or weakly lignified parenchyma cells filled the centre of the midrib and, among them, there were groups of large sclereids.

Towards the leaf margins, palisade was reduced and, close to the margin, there were small round parenchyma cells some of which contained tannin. A short distance from the margin, within the mesophyll, there were fibres and small vascular bundles (Fig. 8). Across the width of the leaf, bundles of various sizes had well developed abaxial and adaxial fibre caps. In the largest, fibres were separated from epidermides by 3 or 4 rows

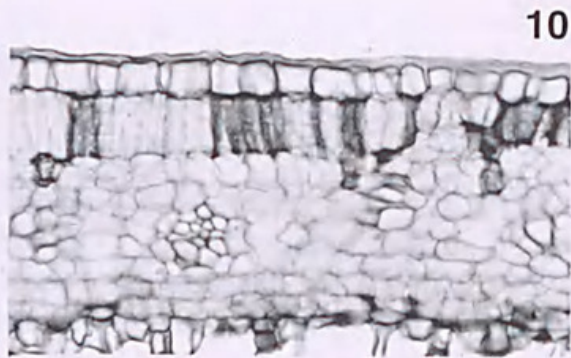
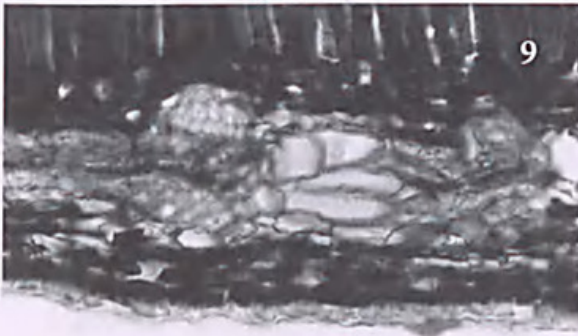
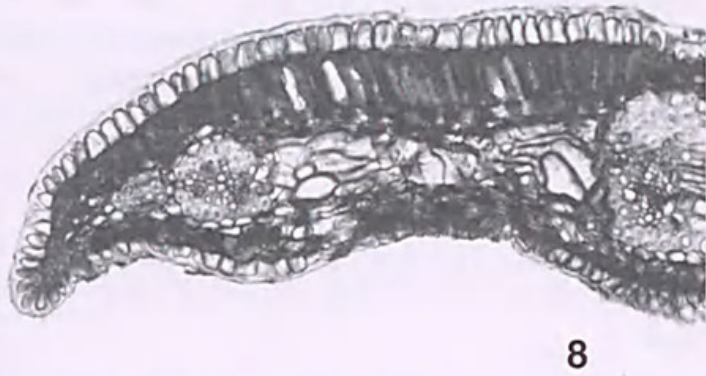
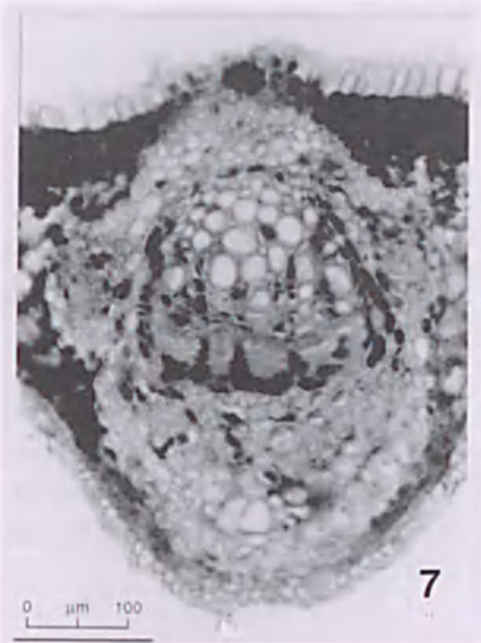


Fig 7. *Finschia rufa* (LAE59040); transverse section of main vein. Main bundles are predominantly collateral with abaxial phloem; there is an abaxial arc of bundles of various sizes, each with an abaxial fibre cap. There is some merging and dividing of fibres and vascular tissues. Adaxial fibres are associated with vascular groups. Bundles are separated by lignified parenchyma cells some of which contain tannin. On the adaxial side of the midrib, there is a band of fibres. (c. $\times 160$).

Fig 8. *Finschia chloroxantha* (NGF9123); transverse section of leaf margin. Palisade is reduced towards the margins and, close to the tip, there are small round parenchyma cells some of which contain tannin. A short distance from the tip, within the mesophyll, there are fibres and small vascular bundles. (c. $\times 80$).

Fig 9. *Finschia chloroxantha* (NGF9123); transverse section of leaf. Across the leaf, bundles of various sizes have well developed abaxial and adaxial fibre caps. In the largest, fibres are separated from epidermises by 3-4 rows of parenchyma. Near others, palisade is more or less modified. The smallest bundles are within the mesophyll. Large tracheary elements are associated with vascular bundles or occur in groups among mesophyll cells. (c. $\times 160$).

Fig 10. *Grevillea papuana* (NGF38967) transverse section of leaf. Some heavily lignified palisade cells, some with irregular ends, intrude among other cells, and resemble columnar sclereids. (c. $\times 50$).

of parenchyma. Near others, palisade was more or less modified. The smallest bundles were within the mesophyll. Large tracheary elements were associated with vascular bundles or occurred in groups among mesophyll cells (Fig. 9).

Finschia rufa

The description below only records features in which *F. rufa* differed from *F. chloroxantha*. The description of *F. chloroxantha* can be used for other features.

Node

Hartley 13201 was a small specimen. One node was examined. At lower levels, in the position of one lateral leaf trace, there were two stelar bundles but these merged before leaving the stele. The specimen collected by *Powell* was larger. There was secondary thickening in the stem and petiole. Several adjacent nodes were examined. In all of them, there was a single stelar bundle associated with each leaf trace.

Petiole

In the material collected by *Powell*, where the petiole was separate from the stem, the abaxial arc contained 25–28 bundles and, in the adaxial line, there were 9 inverted bundles and 3 in which tissues were not precisely delimited and orientated. The arrangement of inverted bundles was similar throughout the petiole.

In *Brass 25899*, near the base of the petiole, there were one or two inverted bundles and one bundle in which tissues were not precisely orientated. Towards the lamina, there was one approximately inverted bundle on either edge of a broad adaxial band of fibres. In *Hartley 13201*, at the distal end of the petiole, inverted vascular tissues were not in collateral bundles; elements were dispersed among fibres and parenchyma.

Transition from petiole to leaf

In the material collected by *Powell*, in the midrib, in the lowest third of the leaf, there were inverted bundles. At higher levels, adaxial vascular tissues were randomly orientated or dispersed.

In *Brass 25899* and *Hartley 13201*, within the leaf, inverted bundles were hardly recognisable.

Leaf

Abaxial epidermal cells were more or less rectangular and were covered with a close pattern of wax granules. Anticlinal walls were hardly sinuous. Especially over veins, on both surfaces, epidermal cells contained tannin.

On the adaxial surface, there were occasional, robust, T-shaped hairs. Over veins, hairs were more numerous.

The basal cells of hairs on the abaxial surface were similar to others in the genus but the two arms of the terminal cell were elongated and a persistent dense indumentum covered the surface.

No glandular hairs were seen in *F. rufa*.

In all the specimens examined, there was a weakly developed second row of square palisade cells.

At the midrib, in *Brass* 25899, there were some 3-4 rows of abaxial cortical parenchyma. There was no distinct, subepidermal layer. There were no inverted bundles. In material collected by *Powell*, in sections from the centres of three leaves, there were occasional vascular elements among adaxial fibres but, in two leaves, there were three or four adaxial amphivasal bundles.

Finschia ferruginiflora

The description below only records features in which *F. ferruginiflora* differed from *F. rufa*.

Petiole

In available material, there were no inverted bundles. Towards the adaxial side, there was a broad band of well lignified fibres. Among the fibres, there were vascular elements.

Leaf

Abaxial epidermal cells were more or less rectangular. Anticlinal walls were hardly sinuous. Nearly all adaxial epidermal cells contained crystals. T-shaped hairs were occasional and often deciduous. Where complete hairs were seen, terminal cells were elongated and their walls were thin. No glandular hairs were found in *F. ferruginiflora*.

In *Manner & Street* 255, there was a single row of tall, narrow palisade cells; some had lignified walls. Ends of cells were irregular and there was evidence of intrusive growth. On both sides of the spongy mesophyll, there were one or two rows of square, regular cells. These characteristics of the palisade and spongy mesophyll were present but not as distinct in *Robbins* 817.

Particularly in *Manner & Street* 255, at the midrib, the subepidermal row of cells was not continuous and distinct and the central parenchyma was well lignified.

Discussion

It was possible to identify the three species in the genus using leaf epidermal features. The epidermal cells on the abaxial leaf surface of *F. chloroxantha* had distinctly sinuous anticlinal walls, whereas those of *F. rufa* and *F. ferruginiflora* were barely sinuous. Among the three species, the covering of wax granules on the abaxial surface was unique to *F. rufa* and glandular hairs were found only in *F. chloroxantha*. T-shaped hairs with elongated terminal cells formed a permanent dense indumentum on the abaxial surface of *F. rufa*. In *F. ferruginiflora*, there were persistent T-shaped hairs with elongated thin-walled terminal cells. The same epidermal features were consistent with the synonymy of *F. rufa* and *F. carrii*.

F. ferruginiflora and *F. rufa* grow in inaccessible habitats and, even in herbaria, specimens are few. It is desirable to examine more material to confirm the consistency of these features.

There were differences in palisade among the specimens examined but variation in *F. chloroxantha* and the plasticity of this feature generally made it inadvisable to attribute taxonomic significance to character states.

There was within-species variability in the node and in the persistent or ephemeral inverted vascular bundles in the petiole and leaf. No nodal material of *F. ferruginiflora* was available and the short length of petiole in *Manner & Street* 255 did not include the proximal region. In two specimens of *F. rufa* there were inverted bundles in the petiole but, in the lowest levels of the leaf, the tissues were dispersed. In material collected by *Powell*, inverted bundles were seen in the lowest third of the midrib. In five specimens of *F. chloroxantha*, there were inverted bundles at the proximal end of the petiole but, in material collected by *Powell*, this arrangement of vascular tissues was not seen at the distal end. At the centre of the leaf, inverted bundles were seen only in *BSIP183* and *NGF10358*. Differences in structure were not associated with particular localities in this widely distributed species.

In nodes, modifications in more than one vascular bundle in the positions of some leaf traces might well have been symptoms of the frequent merging and dividing of stelar tissues rather than significant differences in the nodal pattern common to all the specimens examined. This does not necessarily exclude the taxonomic significance of multiple bundles at the generic level.

Finschia differs from *Grevillea* in having indehiscent drupaceous fruits, and *Hakea* is distinguished from *Grevillea* by its heavy follicular fruits, the pericarps of which have secondary thickening formed by cambial activity (McGillivray 1993). McGillivray quoted Weston (pers. comm.) who suggested that these features were derived, and this has been corroborated by unpublished molecular analyses on *Grevillea*, *Hakea* and *Finschia* (P. Weston pers. comm.). In *Grevillea*, most nodes had three lacunae (Catling & Gates 1998) which raises the question whether the nodes in *Finschia* are apomorphic, having gained traces which gave rise to inverted bundles, or plesiomorphic with other members of the subtribe having lost these tissues. The presence of midribs with multiple bundles (including inverted bundles) is quite homoplasious within the family (Dillon 2002). Of all other species in the subtribe which have been examined (Catling & Gates 1995a, b; 1998) only *Hakea baxteri* and *H. brownii* had nodes in which small stelar bundles were continuous with inverted bundles in the petiole and leaf. Within *Hakea*, these species were in the *Obliqua* group (Barker, 1990). The anatomy of the leaves of these *Hakeas* was different from the leaf anatomy of *Finschia* (Catling & Gates 1995a). *Hakea* is generally accepted to be derived with respect to *Grevillea*. Even so, *Finschia* shares some anatomical similarities with *Hakea*.

Of 41 specimens of 30 taxa examined in *Grevillea*, there were additional bundles in the node in only two species. In *G. insignis* there were 4 lacunae and 4 traces and, in *G. glauca*, there were two stelar bundles in the position of each lateral leaf trace in two adjacent nodes. In 47 specimens of 31 species of *Hakea*, there were additional bundles in seven species.

In *Hakea*, inverted bundles occurred in the petiole, or leaf base, of 17 specimens of 10 species whilst, in *Grevillea*, they were found only in *G. wickhamii*, *G. laurifolia*, *G. insignis* and *G. glauca*. Although some anatomical characteristics of *G. laurifolia* were unlike other species of Group 1 in McGillivray's (1993) classification, taxonomists are convinced that the species is central in this group. Of the specimens examined in the genus, only *G. wickhamii* had inverted bundles in the midrib in sections from the centre of the leaf. In *G. insignis*, there were amphivasal bundles in the midrib complex. Taxonomically, *G. laurifolia*, *G. wickhamii*, *G. glauca* and *G. insignis* are not thought to be close to one another or to *Finschia*.

In *Finschia* there was a concentration of sclereids close to the adaxial side of the abscission layer. Similar tissue patterns were found only in *Grevillea insignis*, *G. sparsiflora*, *G. acuaria* and *G. pauciflora* and in all the specimens from Groups 7 and 8 of McGillivray (1993) in which a complete node was examined. In *Hakea*, with the exception of *H. linearis*, the feature occurred in all the nodes studied. *G. sparsiflora*, *G. acuaria* and *G. pauciflora* are recognised to be closely related and have similar anatomy in which several features are different from other species in the genus (Catling & Gates 1998). Group 8 included four species that share some unusual anatomical characteristics with some species of *Hakea* (Catling and Gates 1998). In Group 7, six species of *Grevillea* were examined. *G. robusta*, *G. meisneri* and *G. papuana* shared similarities, some of which were found in *Finschia*. *G. robusta* grows in rain forests and along creeks in Queensland and Northern New south Wales. *G. papuana* and *G. meisneri* are endemic to Papua New Guinea and New Caledonia respectively. *G. glauca* grows in Queensland and Papua New Guinea. It differs from other species in the group in having amphistomatic, isobilateral leaves and bundle sheaths which contained silica bodies. In spite of these differences, McGillivray (1993) placed *G. glauca* in this group. Unusually in the genus, but like some specimens of *Finschia*, *G. glauca* had additional bundles in the position of leaf traces in the node.

In *G. robusta*, *G. papuana* and *G. meisneri*, leaves were dorsiventral and shared similarities in structure (Catling & Gates 1998) which, in their overall tissue patterns were similar to those in *Finschia*. In *G. papuana*, some heavily lignified palisade cells, some with irregular ends which intruded among other cells, resembled columnar sclereids (Fig. 10). This feature was seen also in *G. glauca* and in *F. ferruginiflora*, it was well developed in *Manner & Street 255*. Columnar sclereids were not found in other species of *Grevillea* but were a consistent feature of *Hakea* (Catling & Gates 1995b) especially in the Needlewoods and in the third sub division of the genus (Barker 1990). Although there were reorientated vascular tissues in the leaf bases of *G. meisneri* and *G. robusta*, the examination of series of sections showed that they were not homologous with inverted bundles in *Finschia*.

This examination of the anatomy of *Finschia* was a part of early studies to investigate some groups of the Proteaceae in which leaf anatomy had not previously been described. Similarities between *Finschia* and some species of *Grevillea*, placed together in Group 7 in McGillivray's (1993) classification, would support the relationships among these taxa proposed by some taxonomists although the distinctly different nodal structure needs some explanation. Similarities shared by *Finschia*, some species of *Hakea* and species such as *Grevillea insignis* and *G. wickhamii* might be significant but it is necessary to study more species and more specimens before proposing hypotheses.

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Appendix A. Specimens Examined

Legend: F = *Finschia*; G = *Grevillea*. Regions examined: 1 = Stem, 2 = Node, 3 = Petiole, 4 = Centre leaf, 5 = Leaf margin

Species	Collector	Location	Regions examined
<i>F. chloroxantha</i> Diels	K. Powell s.n.	Unitech. Campus, University of Technology, Lae, Morobe, PNG	1,2,3,4,5
	K.J. White NGF10358	Oriomo River, Western, PNG	3,4,5
	J.J. Havel & J. Dobson NGF9123	Bulolo, Morobe, PNG	1,2,3,4,5
	Whitmore Collection BSIP5577	Baga Island, New Georgia Group, Solomon Islands	1,2,3,4,5
	R.S. Walker & C.T. White BSIP183	Kolombangara Island, New Georgia Group, Solomon Islands	3,4
	Akorra 238	No locality	4,5
<i>F. rufa</i> Warb.	K. Powell s.n.	Bulolo Forestry College, Morobe, PNG	1,2,3,4,5
	S. Isles LAE59040	S of Manumu village, Central, PNG	5
<i>F. rufa</i> Warb.	Brass 25899	Waikaiuna, Normandy Island, Papuan Islands, PNG	3,4,5
		T.G.Hartley 13201 Near Perosa, c. 18 miles SW of Okapa, Eastern Highlands, PNG	1,2,3
<i>F. ferruginiflora</i> . C.T. White	R.G. Robbins 817	Asaro Valley, Eastern Highlands, PNG	4
	H. Manner 225 & W. Street	Jimi valley, Western Highlands, PNG	3,4,5
<i>G. papuana</i> Meisn.	E.E. Henty, R. Isgar & M. Galore NGF38967	Oksapmin, West Sepik, PNG	3,4,5,6



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