LEAF ANATOMICAL AND MICROMORPHOLOGICAL CHARACTERS OF SOME MALAYSIAN *PARASHOREA* (DIPTEROCARPACEAE)

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NORAINI T & CUTLER DF. 2009. Leaf anatomical and micromorphological characters of some Malaysian *Parashorea* (Dipterocarpaceae). The leaf anatomy of the genus *Parashorea* from Malaysia was investigated to determine the taxonomic value of their leaf anatomical and micromorphological characters. In this study eight species representative of *Parashorea* were selected. Results from this study showed that glandular trichomes consisting of 2–16 cells, and simple, unicellular and tufted trichomes were found to be present in all *Parashorea* species, indicating that the presence of these types of trichomes are of taxonomic value for this genus. However, the number of trichome cells is of little taxonomic value. The presence of papillose epidermal cells and the type of stomata ornamentation can be diagnostic and used to identify some species. Similarities in most of the leaf anatomical characters such as the cyclocytic stomatal complex, straight to curved anticlinal epidermal walls adaxially and abaxially and the outline of leaf margins throughout the genus show a well-defined botanical group in *Parashorea*.

Keywords: Dipterocarps, leaf anatomy, leaf micromorphology, systematic leaf anatomy

NORAINI T & CUTLER DF. 2009. Ciri anatomi dan mikromorfologi daun beberapa spesies *Parashorea* di Malaysia (Dipterocarpaceae). Kajian anatomi daun ke atas genus *Parashorea* di Malaysia telah dijalankan untuk melihat nilai taksonomi pada ciri anatomi dan mikromorfologinya. Lapan spesies mewakili genus *Parashorea* telah dipilih. Hasil kajian menunjukkan bahawa kehadiran trikom berkelenjar yang mempunyai dua hingga 16 sel, trikom ringkas unisel dan trikom berlengan mempunyai nilai taksonomi bagi genus ini. Bagaimanapun nilai taksonomi bagi bilangan sel pada trikom adalah rendah. Kehadiran sel epidermis papilos dan jenis ornamentasi pada stoma boleh menjadi ciri diagnostik dan boleh digunakan untuk pengecaman beberapa spesies. Ciri anatomi yang serupa seperti kompleks stoma siklosit, dinding epirdermis antiklin yang lurus hingga melengkung pada bahagian adaksial serta abaksial daun, dan bentuk tepi daun menunjukkan kesamaan yang jelas antara spesies dalam genus *Parashorea*.

INTRODUCTION

Parashorea Kurz is a small but widely distributed genus which occurs from Myanmar, Southern China, through the Malay peninsula, Sumatra, Borneo and to the Philippines. It consists of about 13 species with three species endemic to Peninsular Malaysia (*P. densiflora* Sloot et Sym., *P. globosa* Sym. and *P. stellata* Kurz). *Parashorea* is a well-defined taxon with close botanical affinity to *Shorea* (Ashton 1982). *Parashorea* has as much claim to be included in *Shorea, Anthoshorea, Richetioides* or in some other sections as a genus in its own right (Dayanandan *et al.* 1999). Kajita *et al.* (1998) constructed a molecular phylogeny of the Dipterocarpaceae based on nucleotide sequences of the *mat*K, *trn*L intron and the *trn*L-*trn*F intergenic spacer region in chloroplast DNA and found that *P. lucida* is a sister to most of the *Shorea* species. The identification of Dipterocarpaceae species based on sterile materials such as herbarium specimens alone may sometimes result in wrong identification. Hence, there is a need for the use of anatomical evidence in addition to leaf morphological characteristics in species identification. The overall objective of this study was to determine whether or not leaf anatomical and micromorphological characters in *Parashorea* could be of taxonomic value in systematic and diagnostic investigations.

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MATERIALS AND METHODS

Fresh specimens used in this study were obtained from the arboretum at the Forest Research Institute, Kepong, Malaysia and the Pasoh Forest Reserve, Negeri Sembilan, Malaysia. Herbarium specimens were obtained from the Herbarium, Royal Botanic Gardens, Kew, UK. For the Malaysian specimens, eight *Parashorea* species with several replicates were employed in this study. The voucher specimens were deposited at the Royal Botanic Gardens, Kew, UK and the Universiti Kebangsaan Malaysia Herbarium, Malaysia for future reference. A full list of the species studied and the localities from which they were collected is given in the appendix.

Fixation, embedding and sectioning were made following Johansen (1940) and Sass (1958) with suitable modifications. Fresh materials were fixed in A:A (25% acetic acid:70% ethanol at 1:3). Dried herbarium materials were boiled, then fixed using the same solution. Leaf specimens were sectioned with a sliding microtome at 20–30 μm thickness and stained in 1% Safranin in 50% alcohol and 1% Alcian Green in 100 ml purifying water with three drops of acetic acid. Sections were made from the middle and marginal parts of the leaf lamina using Reichert sliding microtome (manufactured in Germany). Epidermal peels were prepared by mechanical scraping and stained in Safranin. For venation studies, leaves were cleared in 70% alcohol with a drop of hydrochloric acid, dehydrated and stained in 1% Basic Fuchsin in 6% KOH. All slides were mounted in Euparal after dehydration. Photomicrographs of sections and epidermal peels were made using either a Leitz Diaplan polarizing microscope fitted with a JVC CCD camera or Reichert Polyvar 2 Microscope fitted with a digital camera. Images were processed using Analysis Docu Software (soft-imaging system). All slides were deposited in the anatomy section at the Jodrell Laboratory, Royal Botanic Gardens, Kew, UK and at the Microtechnique Laboratory, Universiti Kebangsaan Malaysia, Malaysia.

For observations on micromorphology, portions of fixed leaves, about 3 to 5 mm^2, were washed, dehydrated, mounted on stubs and coated with gold palladium using an Edwards sputter coater to provide a coating of about 15–20 nm thick. The specimens were examined in a 2.7Å field emission of Cambridge Instruments Stereoscan 360 scanning electron microscope (manufactured in the UK).

RESULTS

Results on the leaf anatomical study are shown in Figures 1–4. Figure 1 shows the adaxial and abaxial epidermal layers of *Parashorea* species under light microscopy. Figure 2 presents the abaxial epidermis of *Parashorea* species under scanning electron microscopy. Figure 3 presents the transverse section of the leaf lamina showing papillosae epidermal cells, mucilaginuous idioblasts, glandular and tufted trichomes, solitary crystals below the adaxial epidermal cells, solitary crystals along a vein, glandular trichome under light microscopy and scanning electron microscopy, tufted trichomes and overarching epidermal cells. Finally, Figure 4 presents the transverse sections of the leaf margin. The significant leaf anatomical characters are given in Table 1.

Leaf surface

Wax: Smooth, with granules in *P. lucida* and *P. parvifolia*. **Abaxial cuticular sculpturing:** Anticlinal walls raised into straight to curved broad ridges in *P. lucida*, *P. parvifolia* and *P. tomentella*. Epidermal cell outlines obscured by the high density of low domed papillae in *P. densiflora* (Figure 2a). The surface sculpturing appears to be striate and composed of small micropapillae in *P. globosa* (Figure 2b), *P. malaanonan, P. smythiesii* (Figure 2c) and *P. stellata* (Figure 2d). **Epidermal cells:** Anticlinal walls of both surfaces, straight to slightly curved (Figure 1). **Stomatal complexes:** Hypostomatic; cyclocytic (Figure 1), with four to eight subsidiary cells. Outlines of the guard cell pairs, elliptic. Cuticular rims narrow, overarching epidermis in *P. parvifolia* (Figure 3h), *P. lucida* (Figure 3i) and *P. tomentella* (Figure 3j). Stomata randomly distributed between veins. **Trichomes:** Simple, unicellular, sparsely scattered. Papillae in *P. densiflora* (Figure 2a), *P. globosa* (Figure 2b), *P. malaanonan, P. parvifolia, P. smythiesii* (Figure 2c) and *P. stellata* (Figure 2d). Tufted trichomes with 2 to 50 arms (Figures 3f and g). Glandular trichomes with 2 to 16 cells (Figures 3d and e). **Venation:** Marginal closed; areole endings, closed and ends not swollen (Figures 2e–h).

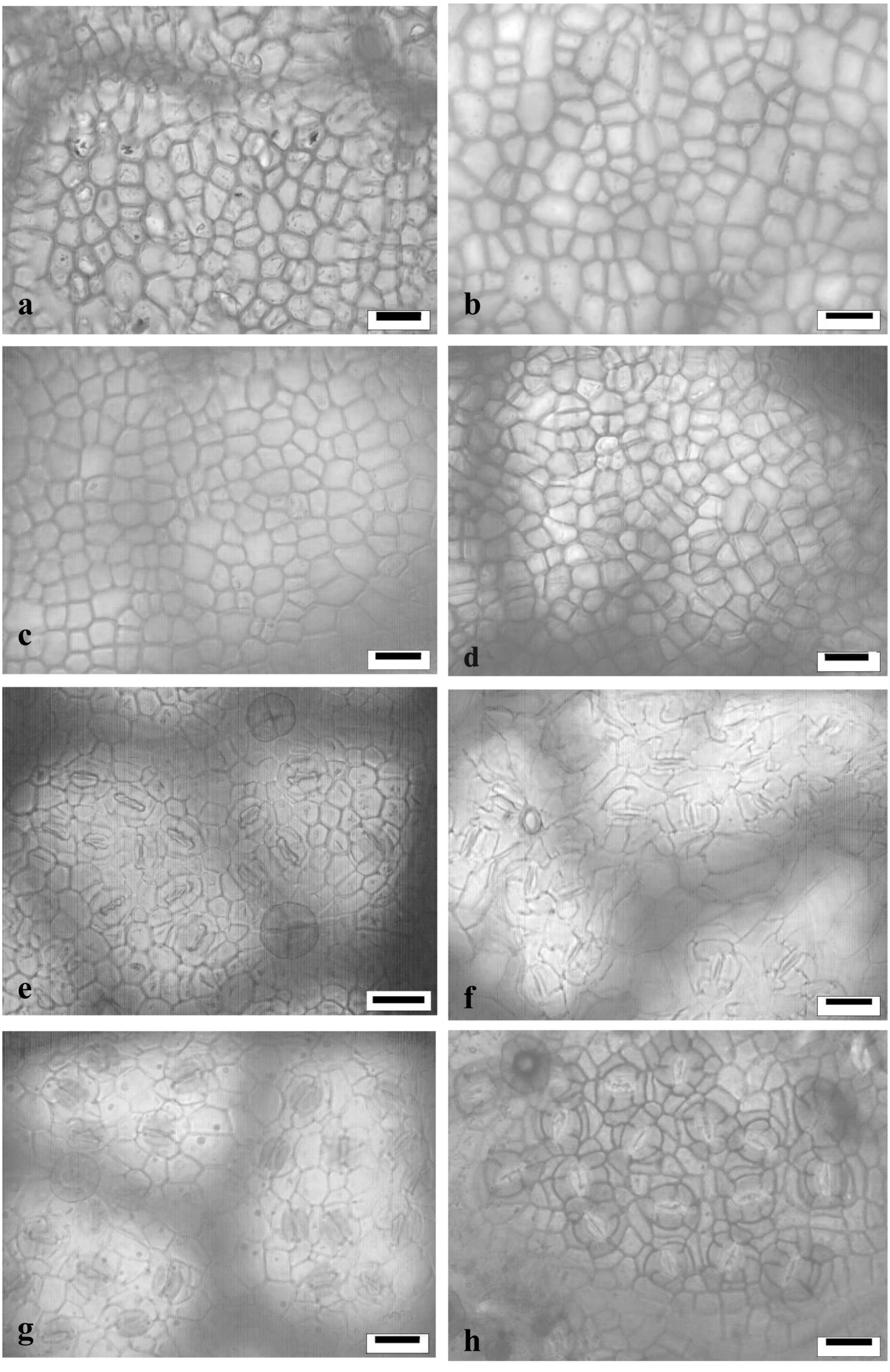

Figure 1 Adaxial and abaxial epidermal layers of *Parashorea* species under light microscopy: adaxial~~(a~~) *P. globosa,* (b) *P. lucida,* (c) *P. stellata,* (d) *P. tomentella;* abaxial~~(e~~) *P. lucida,* (f) *P. malaanonan,* (g) *P. parvifolia,* (h) *P. stellata*. Scale bar 20 µm.

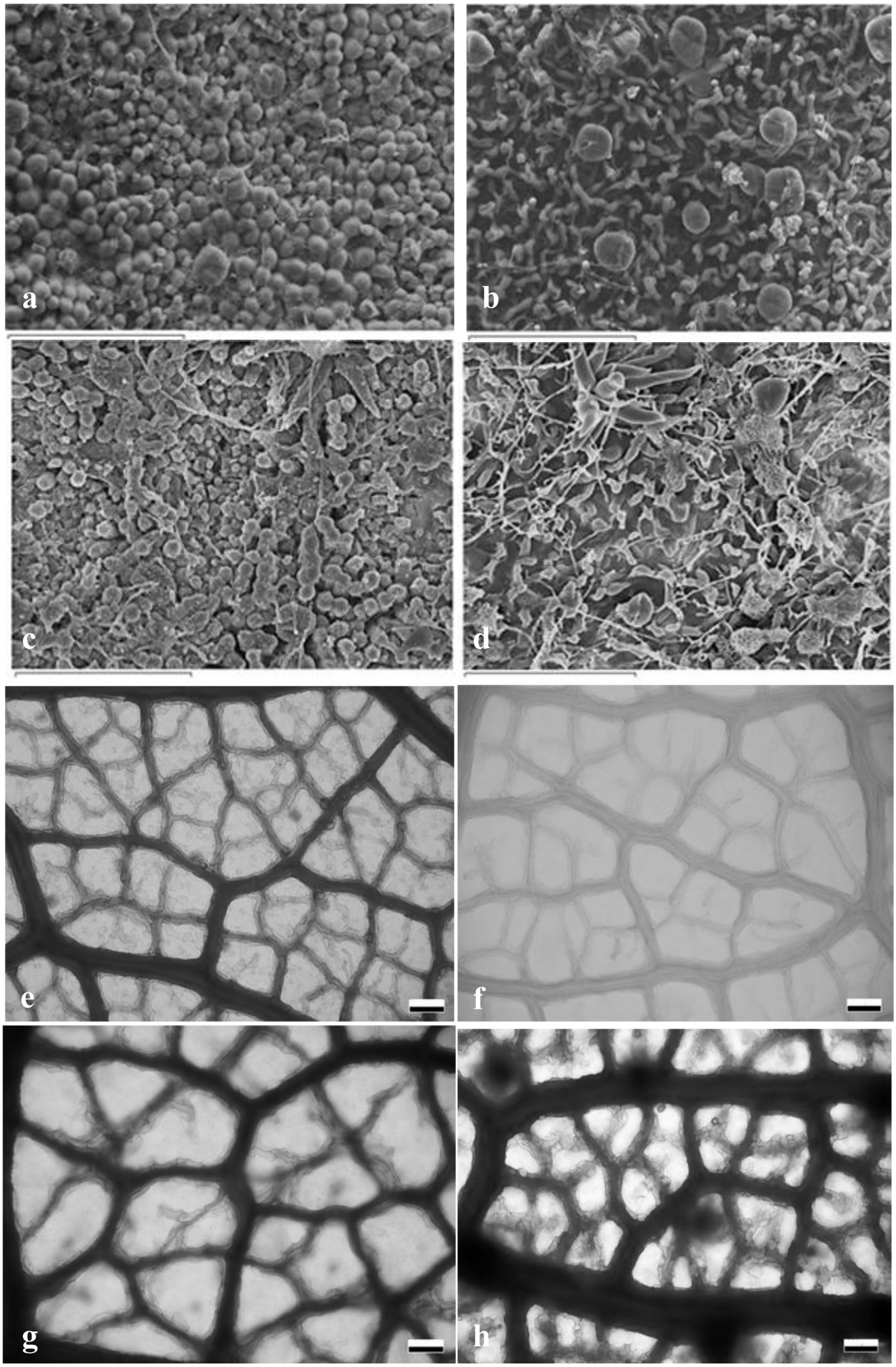

Figure 2 Abaxial epidermis of *Parashorea* species under scanning electron microscopy (SEM): (a) *P. densiflora,* (b) *P. globosa,* (c) *P. smythiesii,* (d) *P. stellata*; areoles venation under light microscopy: (e) *P. densiflora,* (f) *P. lucida,* (g) *P. malaanonan,* (h) *P. stellata.* Scale bar 100 µm.

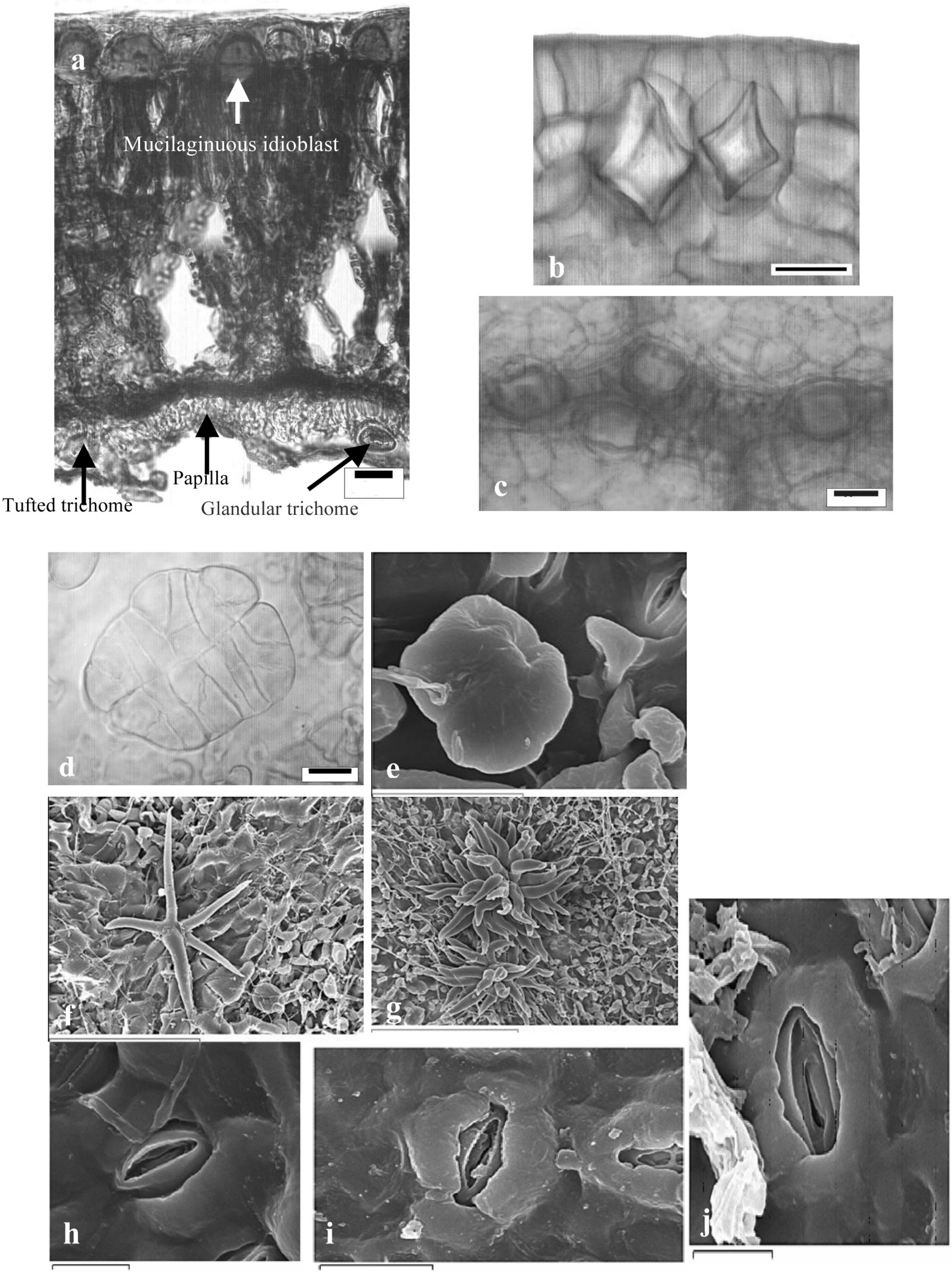

Figure 3 (a) Transverse section of the lamina in *P. densiflora* showing papillosae epidermal cells, mucilaginuous idioblasts, glandular and tufted trichomes, (b) solitary crystals below the adaxial epidermal cells, (c) solitary crystals along a vein, (d) glandular trichome under LM, (e) glandular trichome under SEM, (f)–(g) tufted trichomes, (h)–(j) overarching epidermal cells in (h) *P. parvifolia,* (i) *P. lucida,* (j) *P. tomentella*. Scale bar 10 μm, (f)–(g): 100 μm.

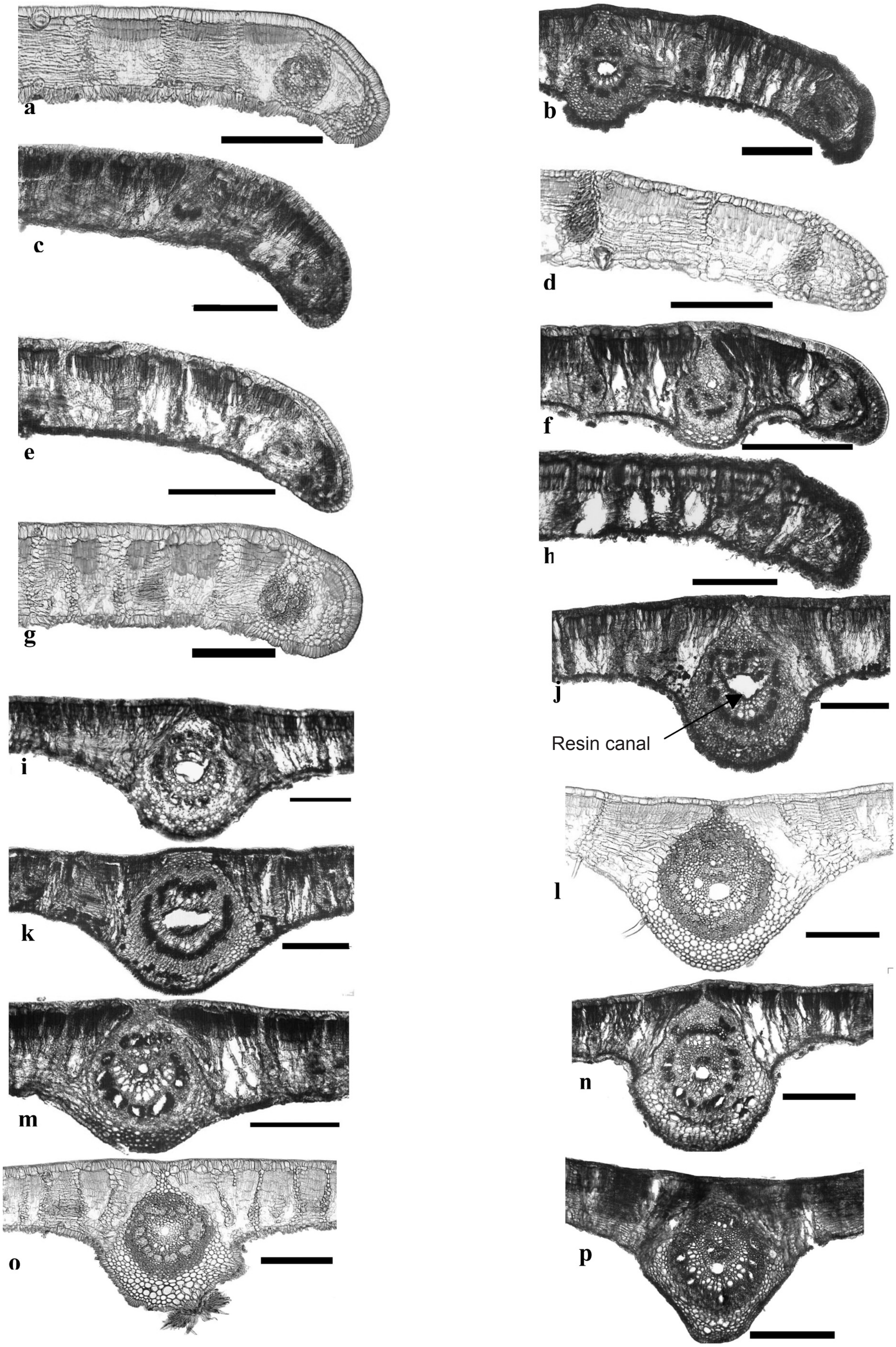

Figure 4 Transverse sections of the leaf margin in *Parashorea* species: (a) *P. densiflora,* (b) *P. globosa,* (c) *P. lucida,* (d) *P. malaanonan,* (e) *P. parvifolia,* (f) *P. tomentella,* (g) *P. stellata,* (h) *P. smythiesii*; leaf lamina: (i) *P. densiflora,* (j) *P. globosa,* (k) *P. lucida,* (l) *P. malaanonan,* (m) *P. parvifolia,* (n) *P. tomentella,* (o) *P. stellata,* (p) *P. smythiesii*. Scale bar 200 μm.

Table 1 Significant leaf anatomical characters in *Parashorea*

Species	Feature of epidermal sculpturing (SEM)*	Photomicrographs of stomata	Types of papillose abaxial epidermis
P. densiflora	2	Epidermal cells surrounding the stomata are flattened	Lithops
P. globosa	3	Lateral lobes have striae at right angles and parallel to the long axis	Cone-like
P. lucida	1	Epidermal cells surrounding the stomata produce overarching lobes that appear distinct	Non-papillose
P. malaanonan	3	Epidermal cells surrounding the stomata are flattened	Cone-like
P. parvifolia	1	Epidermal cells surrounding the stomata produce overarching lobes that appear fused	Non-papillose
P. smythiesii	2	Epidermal cells surrounding the stomata are flattened	Lithops
P. stellata	3	Epidermal cells surrounding the stomata are flattened	Cone-like
P. tomentella	3	Epidermal cells surrounding the stomata produce overarching lobes that appear distinct	Globular

*SEM = Scanning electron microscopy; 1 = anticlinal walls raised into broad straight to curved ridges, periclinal walls sunken; 2 = anticlinal walls sunken, papillose periclinal walls raised

Lamina transverse section

Outline: Margin, rounded (Figures 4a–h). **Epidermal cells:** Adaxial cells, two to three times taller than wide except in *P. tomentella* where they are more or less isodiametric. Hypodermis absent. Abaxial cells, isodiametric and rectangular cells occur together. **Stomata:** Superficial in *P. globosa*, *P. lucida* and *P. parvifolia*, sunken in *P. densiflora*, *P. malaanonan*, *P. smythiesii*, *P. stellata* and *P. tomentella*. **Chlorenchyma:** Palisade cells in three to five layers occupying $\frac{1}{3}$ to $\frac{1}{2}$ of leaf thickness, each cell two to five times taller than wide. Spongy mesophyll cells in about two to seven layers, rounded, with small or large intercellular spaces. **Vascular bundles:** Primary vein phloem more or less complete. Primary and secondary vascular bundles arranged in one row, approximately equidistant from the abaxial and adaxial epidermal layers. Bundle sheaths in primary vascular bundles, inner sheath; sclerenchyma cells completely ensheathing the vascular bundles, outer sheath parenchyma cells in one or two layers confined to the flanks of the bundles. In secondary vascular bundles; inner sheath sclerenchyma cells present as an adaxial and abaxial cap of the vascular bundles; outer sheath one layer of parenchyma cells confined to the flanks of the vascular bundles. **Girders:** Opposite every primary vascular bundle; sclerenchymatous adaxially, cells in abaxial rib parenchymatous, cell walls slightly lignified (3–4 sclerenchyma and 23–44 parenchyma cells wide), girders twice as wide as tall; girder outline is widest at the vascular bundle, trapezoid or with concave flanks; opposite secondary vascular bundles, sclerenchymatous adaxially and abaxially (1–2 sclerenchyma cells wide), girders as tall as wide to twice as tall as wide, girder outline widest at the vascular bundle. **Resin canals:** One resin canal opposite every primary vascular bundle. **Cell inclusions:** Druses, solitary crystals, alongside or close to the primary veins; mucilaginous idioblasts present in the mesophyll and parenchyma cells sparsely to densely scattered.

DISCUSSION AND TAXONOMIC IMPLICATIONS

Epidermal cells

Anticlinal walls of lamina epidermal cells under light microscopy

The lamina surface has been the subject of more investigations than other plant surfaces, and since many of the variable features are constant within taxa they often have taxonomic applications (Stace 1969, Rudall 1992). From observations of lamina surfaces, the anticlinal wall of the adaxial and abaxial epidermal cells is straight or curved which, therefore, appears to be a common character state for this genus.

Epidermal cells under light microscopy

All *Parashorea* species studied have one layer of epidermal cells. In this study, the term 'rectangular' is used as an alternative to polygonal or palisade-like epidermal cells. In the transverse sections epidermal cells are generally either isodiametric or rectangular, being two to five times wider than tall and this is in agreement with the observations of Metcalfe and Chalk (1950). The lower epidermal cells are normally smaller than the upper. The outer periclinal cell walls are cutinized.

Cuticular wax and epidermal sculpturing under scanning electron microscopy

Epidermal sculpturing has provided little systematic information but has considerable diagnostic value. Cuticular sculpturing may be a diagnostic character of some species (Stace 1965, Wilkinson 1979, Wu *et al.* 2005). In fact the character of cuticular sculpturing in *Parnassia* could serve as a criterion for diagnosis to species level (Wu *et al.* 2005). In this study, the epidermal surfaces revealed a number of important micromorphological characters and these characters exhibited interesting interspecific variations that are of significance for species identification. A preliminary study under light microscopy of the adaxial lamina surfaces showed very few taxonomically significant characteristics, i.e. the surfaces being smooth, possibly owing to the thick cuticle, lack of stomata and almost complete absence of trichomes. On the other hand, when the leaf abaxial surface was viewed under the SEM at low magnification, a high diversity in the 'cellular patterns' and the distribution of idioblastic elements such as trichomes, glands and stomata was readily recognized. The appearance of the cuticular wax was smooth, granular or crustose and did not provide much information either for classification or identification. For convenience and easy reference, the epidermal sculpturing is categorized into three types as listed below.

(1) Feature 1 = anticlinal walls raised into broad straight to curved ridges, periclinal walls sunken
(2) Feature 2 = anticlinal walls sunken, papillose periclinal walls raised into irregular domes
(3) Feature 3 = anticlinal walls cannot be differentiated, papillose periclinal walls but not domes.

A papillose abaxial epidermis was found in six species (*P. densiflora, P. globosa, P. malaanonan, P. smythiesii, P. stellata* and *P. tomentella*). Although the presence and prominence of papillae are diagnostically unreliable since they vary with climate or distribution of the species, there are various morphologically distinct types of papilla which can be used for diagnoses (Wilkinson 1979). In this study a few types of papillae were identified. The lithops type with all the epidermal cells domed as reported by Wilkinson (1979) in a few unnamed plant species was seen in *P. densiflora* and *P. smythiesii* and a modification of the cone-like type of papilla was found in *P. globosa, P. stellata* and *P. malaanonan*. The similarity between the species studied in their cuticular sculpturing of the abaxial surface indicates a probable close interrelationship between certain species. For example, a pronounced but moderately coarse to fine micropapilla is present in *P. densiflora, P. globosa, P. malaanonan, P. smythiesii, P. stellata* and *P. tomentella* indicating the close relationship between species in the genus *Parashorea*.

Stomatal complexes

The pattern of stomata in this present study was classified as scattered, crowded or arranged in a more or less circular or semi-circular pattern. This result agrees with the observation of Tewary and Serkar (1985) for their leaf epidermal studies of Indian *Vateria* and *Vatica*. Surface distribution patterns of stomata based on their orientation and dispersion are found to be fairly stable and hence could be taxonomically useful (Solereder 1908, Metcalfe & Chalk 1950, Tomlinson 1961, Stace 1965, Rajagopal 1979).

All the species examined are hypostomatic. This finding agrees with that of Metcalfe and Chalk (1950), Solereder (1908) and Tewary and Serkar (1985). However, the subsidiary cells are not always well-defined (Metcalfe & Chalk 1950). Solereder (1908) and Metcalfe and Chalk (1950) reported the type of stomata in Dipterocarpaceae as being paracytic but in this study *Parashorea* is characterized by cyclocytic stomata. Stomata in *Parashorea* are superficial and sunken in some species. In general, sunken and superficial stomata are related to habitat preference of the species and environmental adaptations. The presence of sunken stomata is usually an ecological adaptation related to control of water loss under direct exposure to wind and solar radiation. Where stomata are sunken, guard cells are placed at the base of a stomatal pit and this arrangement prevents water loss through the stoma (Das & Ghose 1997, Mbagwu & Edeoga 2006). The correlation between sunken and superficial stomata and their potential taxonomic and ecological significance still needs to be established. All *Parashorea* species investigated have guard cell pairs with an elliptic outline. It is, therefore, evident that types of stomatal complexes and guard cell pair outline have a significant taxonomic value in *Parashorea*.

Photomicrographs of stomata also show an interesting feature that may be of diagnostic value, i.e. in *P. lucida*, the epidermal cells surrounding the stomata produce overarching lobes that appear distinct whereas in *P. parvifolia* and *P. tomentella* they are fused and in *P. globosa* the lateral lobes have striae at right angles and parallel to the long axis. From these observations, stomatal features as seen under the scanning electron microscopy could be useful for identification especially at the species level.

Lamina transverse sections

Primary veins

All *Parashorea* species possess primary vascular bundles which are completely ensheathed by sclerenchyma cells. The primary vascular bundles possess an outer sheath of one or two layers of parenchyma cells confined to the flanks of the vascular bundles. This study showed that sclerenchyma cells which completely surround the primary and secondary vascular bundles in the lamina are common character states for all *Parashorea* species studied.

The outline and extent of the penetration of girders or strands of sclerenchyma is usually of taxonomic significance although the amount in a given species is liable to vary with the habitat. This variation, however, does not affect the form in which the sclerenchyma is present (Cutler 1969). Girders, either parenchymatous or sclerenchymatous, occur in all the *Parashorea* species investigated. The species are similar to one another with respect to girder occurrence and form, implying that it could be a generic character.

Lamina margins

Parashorea species studied showed interspecies similarity. The outline of the transverse sections of the margin is obtuse and rounded and is thus not a useful character for species identification.

Trichomes

The indumentum in the Dipterocarpaceae was reported to consist of simple unicellular trichome, tufted trichome and various glandular trichome (Solereder 1908, Metcalfe & Chalk 1950). However, there is no specific information on the distribution of trichome type within species or genera. In this present study glandular trichomes with 2 to 16 cells were found to be present in all *Parashorea* species indicating that this trichome type is common to the genus but the number of cells in the head often varies from 2 to 16 and, therefore, is of little value for species identification.

Simple unicellular trichomes are common and present in all species of *Parashorea* investigated. This trichome type can be long or short, and has either thick walls with a narrow lumen or less thickened walls and a wider lumen. Tufted trichomes are present in almost all species except in *P. lucida* and *P. parvifolia*. The presence of tufted trichomes has been reported by Solereder (1908) and Metcalfe and Chalk (1950).

Resin canals

The most outstanding anatomical characteristic throughout the genus is the presence of resin canals. Resin canals have been recorded in the petiole of some *Parashorea* species by Metcalfe and Chalk (1950) but there was no previous study of resin canals in the lamina. In all the species studied, resin canals occur adjacent to the pole of the primary vascular bundle in the lamina and can be used as a common character for *Parashorea* species studied. However, further study needs to be done to other *Parashorea* species.

Cell inclusions

Mucilaginous cells are sometimes found in rows in the ground tissue of the petiole and midrib of certain species of *Hopea* and *Shorea* and in the lateral veins of *Neobalanocarpus heimii* (Metcalfe & Chalk 1950). Mucilaginous idioblasts were observed in all the species examined and their presence varied from being very sparsely scattered to very dense, grouped in the epidermal cells in the lamina, most abundant in the upper epidermis, or more rarely in the lower epidermis or mesophyll (chlorenchyma or bundle sheath). This observation has also been reported by Gregory and Baas (1989). Two types of calcium oxalate crystals were observed in all the species studied, namely, druses and solitary crystals of varying sizes in idioblasts situated immediately below the upper epidermis. Solitary calcium oxalate crystals were mostly observed immediately below the adaxial epidermal cells or in the mesophyll cells immediately adjacent or close to the primary and secondary veins. They are also present in the palisade and spongy mesophyll cells, but mostly situated immediately adjacent or close to the primary veins. The presence of calcium oxalate crystals is common in the eudicotyledons (Dickison 2000) especially in woody plants (Wu & Huang 1997).

CONCLUSIONS

Results of the study revealed a number of interesting features with some characters which could be of taxonomic and diagnostic values. A papillose abaxial epidermis, for instance, indicates close interrelationship between certain species in this genus. Features of stomata may be diagnostic in *P. lucida* with the epidermal cells surrounding the stoma producing overarching lobes and with striae in *P. globosa*. In conclusion, leaf anatomical evidence can be used for identifying certain species in *Parashorea* and provides some support for taxonomic conclusions made using morphological characters.

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Appendix Details of specimens of *Parashorea* species investigated in this study

Species	Code	Locality	Source	Collector and date* of collection
Parashorea densiflora v. Slooten & Symington	NN18	Pasoh Forest Reserve, Negeri Sembilan	Fresh specimen	Nor Nafizah 07.07.03
	NN24	Pasoh Forest Reserve, Negeri Sembilan	Fresh specimen	Nor Nafizah 04.07.03
	NN54	FRIM Kepong Arboretum, Selangor	Fresh specimen	Nor Nafizah 05.07.03
	FMS32387	Kali Forest Reserve, Mersing, Johore	RBGK Herbarium United Kingdom	Symington 23.10.34
P. globosa Symington	25414	Kledang Sayong, Chepun Valley, Perak	RBGK Herbarium United Kingdom	Symington April 1931
	BB32754	Panngabean, Sumatera, Indonesia	RBGK Herbarium United Kingdom	Unknown 21.07.41
P. lucida Kurz	SAN95283	Belurun, Sabah	RBGK Herbarium United Kingdom	Amin, Gambio 06.04.83
P. malaanonan (Blanco) Merr.	21739	St. Lucia, Pinayas, Tawau, Sabah	RBGK Herbarium United Kingdom	Unknown -
	76053	Bengkoa Forest Reserve, Sabah	RBGK Herbarium United Kingdom	Sheat, Minjulu 08.09.72
	K50456	Pangi Tenom, Sandakan, Sabah	RBGK Herbarium United Kingdom	Sadaui 21.05.66
	NN47	FRIM Kepong Arboretum, Selangor	Fresh specimen	Nor Nafizah 31.07.03
P. parvifolia Wyatt-Smith. ex. P. S. Ashton	76226	Mount Templer Forest Reserve, Sabah	RBGK Herbarium United Kingdom	G. Shea, 22.09.76
	3159	Ulu Limbang, Bt. Antu, Ulu Sebayang, Sarawak	RBGK Herbarium United Kingdom	P. S. Ashton 17.05.58
	WKM1614	Lamunin, Tutong, Brunei	RBGK Herbarium United Kingdom	Rosli, Hj. Jili 16.11.89
P. smythiesii Wyatt-Smith. ex P. S. Ashton	BRUN3169	Bt. Biang, Brunei	RBGK Herbarium United Kingdom	–
	BRUN472	Unknown	RBGK Herbarium United Kingdom	P. S. Ashton 07.11.57
P. stellata Kurz	5611	Larut, Perak	RBGK Herbarium United Kingdom	Slooten 1930
	7505	Larut, Perak	RBGK Herbarium United Kingdom	King 1885
	NN55	FRIM Kepong Arboretum, Selangor	Fresh specimen	Nor Nafizah 05.07.03
P. tomentella (Symington) Meijer	SAN21532	Sepilok Forest Reserve, Balau Compartment Sandakan, Sabah	RBGK Herbarium United Kingdom	Meijer 27.04.60
	SAN96625	Kg. Kapuakan, Labuk, Sugut, Sabah	RBGK Herbarium United Kingdom	Aban, Dewol 18.04.83

RBGK = Royal Botanic Garden Kew; FRIM = Forest Research Institute of Malaysia; *date.month.year