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Leaf morphology and anatomy of 7 varieties of Ficus deltoidea (Moraceae)

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Abstract: The extreme morphological variations and unclear boundaries between varieties can lead to the misleading identification of *Ficus deltoidea* Jack (Moraceae) varieties. This has encouraged many taxonomists and botanists to study the variation within *F. deltoidea*. Thus, correct identification of *F. deltoidea* varieties is important, as several morphological and anatomical characters are variety-specific. The present study aims to evaluate the morphology and anatomy of leaf in 7 varieties of *F. deltoidea*, namely var. *deltoidea*, var. *angustifolia*, var. *trengganuensis*, var. *bilobata*, var. *intermedia*, var. *kunstleri*, and var. *motleyana*. It also aims to contribute to the identification of the varieties based on the matured leaf characters. The results reveal varying morphological characters in the type of leaf shape, size, surface texture, margin, midrib dichotomous, and petiole length. Moreover, variations in anatomical characters concerning the structures of the lamina, leaf epidermis, and midrib are also demonstrated.

Key words: Ficus deltoidea, leaf, varieties, morphology, anatomy, Moraceae

1. Introduction

Ficus deltoidea Jack (Moraceae), locally known as 'Mas Cotek' among the Malays, is a complex species of subgen. Ficus, section Ficus, and subsect. Frutescentiae Sata (Sata, 1944), which contains more than 25 species available in the Sino-Himalayan and western Malesia regions (Berg, 2003). Among the many species, the most important are the trees with milky latex that contain important ingredients used in traditional medicine and Ayurvedic formulations (Babu et al., 2010). Ficus deltoidea is native and widely distributed throughout Malaysia, Thailand, Sumatra, Java, Kalimantan, Sulawesi, and Moluccas (USDA, 2007). The plant is often recognized by its unique syconia (figs), midrib dichotomous, golden dots on the upper surface of the lamina, leafy twigs or periderm not persistent, and milky latex. In Malay traditional medicine, the dried leaves are marketed as an herbal tea. The decoction of the leaves is believed to improve blood circulation and have aphrodisiac activity and antioxidant and antidiabetic properties (Norhaniza et al., 2007; Sulaiman et al., 2008; Adam et al., 2011).

The 7 varieties of *Ficus deltoidea*, namely var. *deltoidea* Corner, var. *angustifolia* (Miq.) Corner, var. *trengganuensis* Corner, var. *bilobata* Corner, var. *intermedia* Corner, var. *kunstleri* (King) Corner, and var. *motleyana* (Miq.) Corner, found in the Malay Peninsula of Malaysia were described by Kochummen (1978). Despite their close morphological similarity, it is argued that several morphological and anatomical characters are variety-specific and useful for varietal identification. Both qualitative and quantitative morphological characters of leaves (shape, length, surface texture, midrib dichotomous, gland densities at the forked midrib, and subsequent dichotomies of the midrib, petiole length, and indumentum densities) and anatomical characters (lamina, leaf epidermis, and midrib) are particularly discriminative. However, the leaf morphology is probably the most variable and shows heterophylly in the species (Nashriyah et al., 2012). The young plants and mature plants of the same variety often display different states of leaf characters. These extreme variations and unclear boundaries between varieties create misleading identifications of *F. deltoidea* varieties.

The anatomy of the leaf was first used for systematic reasons by Duval-Jouve (1875), who stressed the usefulness of epidermal structures in plant taxonomy. The study of the foliar epidermis of *Ficus* L. revealed a number of important anatomical characters that are of taxonomic significance (Sonibare et al., 2006). The epidermis contains 3 main cell types, namely pavement cells, guard cells, and subsidiary cells, which surround the trichomes and stomata. Although the importance of foliar epidermal anatomy for classification has been discussed in detail by

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many authors (Dixon, 2002; Sonibare et al., 2006; Khan et al., 2011; Mavi et al., 2011; Szymura and Wolski, 2011; Ergen Akçin et al., 2013), *F. deltoidea* varieties have not yet been included in any report. Therefore, this study is the first attempt to exhibit interesting leaf anatomy together with morphological characters for identification of 7 *F. deltoidea* varieties, thus providing the basis of interspecific classification of *F. deltoidea*.

2. Materials and methods

2.1. Plant materials

A total 45 accessions of *F. deltoidea* varieties were collected from Malaysia (Table 1). The distribution of *F. deltoidea* varieties based on the samples seen during the course of the study is shown in Figure 1. These samples are currently in cultivation at the Centre for Herbal Germplasm and Taxonomy, Faculty of Agriculture and Biotechnology, Gong Badak Campus, Universiti Sultan Zainal Abidin.

2.2. Morphological study

Quantitative and qualitative morphological data were obtained from the observation of adult plants as measured after each plant set fruits (syconia). We studied the leaf shape, length, surface texture, midrib dichotomous, gland densities at the forked midrib, and subsequent dichotomies of the midrib, petiole length, and indumentum densities.

2.3. Anatomical study

Three plants of each variety, except for var. *motleyana*, which made a total of 19 accessions of *F. deltoidea*, were used for anatomical study. The samples containing leaf tissues were fixed in formalin-acetic acid-alcohol solution for 2 days (Metcalfe, 1960). After removing the fixative by distilled water, they were dehydrated with ethyl alcohol solutions of 30% and 50%. After that, dehydrated specimens were washed with tert-butyl alcohol of increasing dilution series of 60%, 70%, 85%, 95%, and 100% before being embedded into paraffin and sectioned by using a rotary microtome. The sections were stained in a Safranin O/Fast Green combination. The anatomical characters studied were the structures of the lamina, leaf epidermis, and midrib.

3. Results and discussion

3.1. Leaf morphology

The variations in leaf morphology of 7 *F. deltoidea* varieties are shown in Figure 2. All varieties studied showed an alternate leaf arrangement with numerous golden dots on the upper surface of the lamina. The number of waxy glands beneath the lamina was equal to or more than 3. Almost all varieties have a forked midrib, except for var. *intermedia*, which has a mixture of a forked and unforked midrib, and var. *motleyana*, where the midrib was not forked. This explained the exclusion of var. *intermedia* in previous classifications where this variety was transferred

to *F. oleifolia* King subsp. *intermedia* (Corner) C.C.Berg (Berg, 2003; Berg and Corner, 2005). Although there was no concrete morphological evidence to support the relationship between var. *intermedia* and var. *motleyana* (Fatihah et al., 2012), the position of var. *intermedia* as a member of the *F. deltoidea* varieties, however, was strongly supported by internal transcribed spacer DNA (Nor-Zuhailah et al., 2010). Further combinations of morphological and molecular study should be employed to confirm the position of this variety.

For var. *bilobata*, var. *trengganuensis*, var. *angustifolia*, and var. *intermedia*, the midrib forked less than 45°, while for var. *deltoidea* and var. *kunstleri*, the midrib forked more than 45°. The leaf apex ranged from rounded in var. *kunstleri*, var. *angustifolia*, and var. *deltoidea* to minutely truncate in var. *trengganuensis*, bilobed in var. *bilobata*, and acuminate in var. *intermedia* and var. *motleyana*. Although these 7 varieties had been previously recorded with a cuneate leaf base (Kochummen and Rusea, 2000; Nashriyah et al., 2012), we found that var. *angustifolia*, var. *intermedia*, and var. *motleyana* showed an acute leaf base while the rest showed an obtuse leaf base. The leaves were generally obovate in shape. However, they were obcordate in var. *bilobata*, spathulate in var. *angustifolia*, and oblanceolate in var. *intermedia* and var. *motleyana*.

The longest leaves were those of var. motleyana (11.5-17.0 cm) and the shortest were those of var. deltoidea (3.0-3.6 cm). The widest leaves belong to var. kunstleri (6.5-8.0 cm) and the narrowest leaves belong to var. angustifolia (1.0-2.0 cm). Two general types of leaf margin were observed: wavy in var. kunstleri, var. trengganuensis, and var. bilobata, and entire in var. angustifolia, var. deltoidea, var. intermedia, and var. motleyana. There was no previous record reported and further study is needed to identify the leaf margin. The veins were deeply impressed on the lamina surface of var. kunstleri, and the other varieties showed a plane or slightly impressed veins. The var. angustifolia showed the shortest petiole (0.1–0.4 cm), while the longest petioles belong to var. kunstleri and var. bilobata (up to 3 cm). This result was in agreement with Nashriyah et al. (2012), who grouped var. kunstleri, var. bilobata, and var. trengganuensis into a long-stalked variety based on their petiole length of >1.0 cm. The description of each variety is summarized in Table 2.

3.2. Leaf anatomy

3.2.1. Lamina

Most studied varieties contain a layer of epidermis at both the adaxial and abaxial leaf surfaces, and 1 to 2 layers of hypodermis at the adaxial leaf surface (Figure 3). The epidermis was formed by only one quadrangular or rounded cell layer. In contrast, the occurrence of multiple layers of epidermis in some *Ficus* species, such as *F. abutilifolia* Miq., *F. platyphylla* Delile, *F. trichopoda*

Table 1. List of samples used in the study.

Valuety no. Lokation Continues (m) date PD 018 Jaroba Ronglock, Ajil, Terengganu, Malaysia 4.91/3057; 10.3.549447 113 1.802.2008 PD 019 Jaroba Ronglock, Ajil, Terengganu, Malaysia 4.91/3057; 10.3.555397 11.3 1.802.2008 PD 021 Jaroba Ronglock, Ajil, Terengganu, Malaysia 4.91/3057; 10.3.555397 11.3 1.802.2008 PD 022 Jaroba Ronglock, Ajil, Terengganu, Malaysia 4.91/2179; 10.3.555327 11.3 1.802.2008 PD 023 Siajana, Schil, Terengganu, Malaysia 5.71/2008; 10.2.7454368 6.1 0.2.11.2008 PD 035 Siajana, Schil, Terengganu, Malaysia 5.61/237; 10.2.7454368 6.1 0.2.11.2008 PD 04 Siajana, Schil, Terengganu, Malaysia 5.61/237; 10.2.7454368 6.1 0.2.11.2008 PD 04 Siajana, Schil, Terengganu, Malaysia 5.61/237; 10.2.745436 6.1 0.2.1.12008 PD 04 Siajana, Schil, Terengganu, Malaysia 5.61/457; 10.2.746497 6.5 0.2.1.12008 PD 04 Siajana, Schil, Terengganu, Malaysia 5.61/457; 10.2.756479 2.4.7 0.607.2005	Vanista	Accession	Leastin	Coordinates	Altitude	Collection
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PD 049 Inaba Bongkok, Ajii, Terenggan, Malaysia 4.918057, 103.355597 11.3 1.80.22008 PD 050 Jamba Tongkok, Ajii, Terenggan, Malaysia 4.918057, 103.355597 11.3 1.80.22008 PD 021 Jamba Tongkok, Ajii, Terenggan, Malaysia 4.911457 1.5355187 11.3 1.80.22008 PD 022 Jamba Tongkok, Ajii, Terenggan, Malaysia 4.912171 1.03.255227 11.3 1.80.22008 PD 023 Jamba Tongkok, Ajii, Terenggan, Malaysia 5.7420678, 102.066653 11.9 2.0.7208 PD 039 Sanjana, Seiti, Terenggan, Malaysia 5.961257, 11, 02.46607 6.1 0.2.11.2008 PD 049 Sanjana, Seiti, Terenggan, Malaysia 5.961257, 10.2983147 1.0 0.2.11.2008 PD 041 Sanjana, Seiti, Terenggan, Malaysia 5.591457, 10.2983147 1.0 0.2.11.2008 PD 145 Lembah Biodong, Rbn Tapi, Seitin, Terenggan, Malaysia 5.591457, 10.2983147 1.0 0.2.12.2008 PD 151 Lembah Biodong, Rbn Tapi, Seitin, Terenggan, Malaysia 5.284127, 10.2.267897 5.3 1.1.0.6.2008 Auratori PD 051 Bakii Tiperak, Malaysia		FD 018	Jambu Bongkok, Aiil, Terengganu, Malaysia	4.912658°, 103.354994°	11.3	18.02.2008
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1003 auguni, Muin, Yangan, Setu, Terenggani, Malaysia 5.05237, 10.02280003 6.1 02.11.2008 FD 041 Suijani, Setu, Terenggani, Malaysia 5.859257, 10.0228007 6.1 02.11.2008 FD 042 Suijani, Setu, Terenggani, Malaysia 5.858437, 10.228007 6.1 02.11.2008 FD 145 Lembah Bidong, Rhi Tapai, Setu, Terenggani, Malaysia 5.501456°, 102.989856° 10.7 22.122008 FD 145 Lembah Bidong, Rhi Tapai, Setu, Terenggani, Malaysia 5.254217°, 102.249789° 23.7 06.07.2009 FD 031 Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia 5.254217°, 102.249789° 3.3 11.062008 FD 043 Laloh, Gua Musang, Kelantan, Malaysia 5.254217°, 102.249789° 3.3.3 11.062008 Karntheri FD 074 Guntong, Setu, Terenggani, Malaysia 5.264217°, 102.249789° 3.8.1 12.03.2009 FD 074 Guntong, Setu, Terenggani, Malaysia 5.604547', 102.256037 16.5 16.11.2008 angustifolia FD 075 Guntong, Setu, Terenggani, Malaysia 5.604547', 102.726604° 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia		FD 030	Saujana, Setiu, Terengganu, Malaysia	5.521550 , 102.7 15150 5.592591° 102.664803°	6.1	02.11.2008
1000 auguna, Attu, Terenggana, Malaysia 5007121, 10220000 6.1 02.11.2008 PD 042 Suguna, Setta, Terenggana, Malaysia 5.99257, 102.293047 6.1 02.11.2008 PD 151 Lembab Bidong, Rhu Tayasia, Terenggana, Malaysia 5.591897, 102.293847 10.7 22.12.2008 PD 145 Lembab Bidong, Rhu Tayasi, Settu, Terenggana, Malaysia 5.501897, 102.2978829 24.7 0607.2009 FD 031 Bukit Prang, Laloh, Gua Musang, Kelantan, Malaysia 5.2482177, 102.247384 24.7 0607.2009 Kuratleri FD 034 Laloh, Gua Musang, Kelantan, Malaysia 5.2482177, 102.247389 53.3 11.062.008 Kuratleri FD 044 Laloh, Gua Musang, Kelantan, Malaysia 5.2482177, 102.247384 54.17 55.07.2008 FD 074 Guntong, Setu, Terengganu, Malaysia 5.6045447, 102.745603* 16.5 16.11.2008 angextifolia FD 076 Guntong, Setu, Terengganu, Malaysia 5.6045447, 102.726503* 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia 4.61427, 100.774503* 15.5 12.03.2009 FD 152 Bukit 11, Perak, Malaysia		FD 039	Saujana, Setiu, Terengganu, Malaysia	5.592391, 102.004805 5.617231° 102.728033°	6.1	02.11.2000
1001 Suijana, Suitu, Terengganu, Malaysia 5.07/21, 10.273600 6.1 02.11.2008 FD 042 Suijana, Suitu, Terengganu, Malaysia 5.01456; 10.273647 6.1 02.112.008 FD 145 Lembab Bidong, Rhu Tapai, Setiu, Terengganu, Malaysia 5.01456; 10.279847 10.7 22.12.2008 FD 141 Lembab Bidong, Rhu Tapai, Setiu, Terengganu, Malaysia 5.284217*, 102.249789* 24.7 06.672089 FD 031 Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia 5.284217*, 102.249789* 53.3 11.06.2008 kurstleri FD 044 Laloh, Gua Musang, Kelantan, Malaysia 5.284217*, 102.249789* 53.3 11.06.2008 FD 074 Guntong, Setiu, Terengganu, Malaysia 3.563256; 10.0225603* 16.5 16.11.2008 angustijólia FD 076 Guntong, Setiu, Terengganu, Malaysia 5.609917; 10.2.04959* 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia 4.4631847; 10.0724503* 16.5 16.11.2008 FD 152 Bukit 11, Perak, Malaysia 4.4631847; 10.0724503* 15.5 12.03.2009 FD 152 Bukit 11, Perak, Malaysia 4.4631847; 10.074505		FD 040	Saujana, Setiu, Terengganu, Malaysia	5.017251, 102.728055	6.1	02.11.2008
PD 02 Sutjini, Schu, Hernggin, Malaysia 5.58485, 10:258457, 10:288148 10.7 22.12.2008 FD 151 Lembah Bidong, Rhu Tpad, Stein, Terengganu, Malaysia 5.5061897, 10:2898856 10.7 22.12.2008 FD 181 Tapak Semaian, Jabatan Perhutanan, Setin, Terengganu, Malaysia 5.5061897, 10:2898857 10.7 22.12.2008 FD 031 Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia 5.2481277, 10:2213587 53.3 11.06 2008 FD 041 Laloh, Gau Musang, Kelantan, Malaysia 5.2481277, 10:2213587 57.5 57.507208 FD 154 Bukit 11, Perak, Malaysia 4.4513227, 100.973306° 38.1 12.03.2009 FD 074 Guntong, Settin, Terengganu, Malaysia 5.6045471, 10:2765037 16.5 16.11.2008 argustifolia FD 075 Guntong, Settin, Terengganu, Malaysia 5.6045471, 10:27265037 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia 4.60456°, 100.7020427 9.1 12.03.2009 argustifolia FD 152 Bukit 11, Perak, Malaysia 4.461427, 100.745037 15.5 12.03.2009 FD 152 Bukit 11, Perak, Malaysia 4.4614		FD 041	Saujana, Setiu, Terengganu, Malausia	5.597925, 102.755800 5.595492°, 102.755800	6.1	02.11.2008
PD 153 Lembah Buoling, Rui Tapia, Stelin, Terenggani, Malaysia 5.50189', 102.99856' 10.7 2.21.22086 FD 181 Tapak Semaian, Jabatan Perhutanan, Setiu, Terenggani, Malaysia 5.50189', 102.99856' 10.7 2.21.22086 FD 031 Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia 5.249217', 102.249789' 5.3.3 11.06.2008 kunstleri FD 034 Laloh, Gua Musang, Kelantan, Malaysia 5.25756', 103.268492'' 9.1 27.052009 FD 170 Pelaan, Phahang, Malaysia 3.563256', 103.368492'' 9.1 27.052009 argustifolia FD 074 Guntong, Setiu, Terengganu, Malaysia 5.604544'', 102.726503'' 16.5 16.11.2008 FD 075 Guntong, Setiu, Terengganu, Malaysia 5.604544'', 102.726503'' 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia 4.461842', 100.774503'' 15.5 12.03.2009 argustifolia FD 152 Bukit 11, Perak, Malaysia 4.461842', 100.774503'' 15.5 12.03.2009 FD 153 Bukit 11, Perak, Malaysia 4.461842', 100.774503'' 15.5 12.03.2009 FD 153 Bukit 11, Perak, Malaysi		FD 042	Jaulana, Setiu, Terengganu, Malaysia	5.505405, 102.755047	10.7	22.12.2008
PD 145 Lemman maning, Jabatan Perhutanan, Setiu, Terengganu, Malaysia 5,303197, 102,299839 24,7 6607,2009 FD 181 Tapak Semaian, Jabatan Perhutanan, Setiu, Terengganu, Malaysia 5,481178, 102,299839 24,7 6607,2009 kunstlerit FD 031 Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia 5,284127, 102,249789 23,3 11.06,2008 FD 034 Laloh, Gua Musang, Kelantan, Malaysia 5,24217, 102,249789 33,3 11.06,2008 FD 154 Bakit 11, Perak, Malaysia 5,604547, 102,249789 38,1 12,032009 FD 170 Pekan, Pahang, Malaysia 5,604547, 102,726503* 16,5 16,11,2008 arguestifolia FD 075 Guntong, Setiu, Terengganu, Malaysia 5,6099197, 102,226464* 16,5 16,11,2008 FD 151 Bukit 11, Perak, Malaysia 4,461842*, 100,774503* 15,5 12,03,2009 FD 152 Bukit 11, Perak, Malaysia 4,461842*, 100,774503* 15,5 12,03,2009 FD 153 Bukit 11, Perak, Malaysia 4,451325*, 102,47650* 29,6 07,10,2009 FD 153 Bukit 11, Perak, Malaysia 4,51255*, 102,37162*		FD 135	Lembah Bidong, Khu Tapai, Setiu, Terenggahu, Malaysia	5.510456, 102.985144	10.7	22.12.2008
FD 161 Tipke Semiain, Jaoun Permutani, Setu, Terenggani, Manya 5.4617.8 ; 0.0279859 24.7 0.807.000 Renstleri FD 031 Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia 5.284217; 102.2349789* 53.3 11.06.2008 FD 154 Bukit I. Perak, Malaysia 5.277501; 102.25136* 47.5 25.07.2008 FD 170 Pekan, Pahang, Malaysia 5.604544*; 102.726503* 16.5 16.11.2008 argustifolia FD 074 Guntong, Settu, Terengganu, Malaysia 5.604544*; 102.726503* 16.5 16.11.2008 argustifolia FD 075 Guntong, Settu, Terengganu, Malaysia 5.604544*; 102.726503* 16.5 16.11.2008 argustifolia FD 075 Guntong, Settu, Terengganu, Malaysia 4.46345*; 100.774503* 15.5 12.03.2009 argustifolia FD 152 Bukit 11, Perak, Malaysia 4.46345*; 100.774503* 15.5 12.03.2009 FD 153 Bukit 11, Perak, Malaysia 4.46345*; 100.774503* 15.5 12.03.2009 FD 154 FD 157 Bukit 11, Perak, Malaysia 5.59175*; 102.479172* 1322.8 27.05.2009 FD 157		FD 145	Temban bidong, Khu Tapai, Setiu, Terengganu, Malaysia	5.505189, 102.989850	10.7	22.12.2008
FD 031 Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia 5.284217', 102.249789' 53.3 11.06.2008 kunstleri FD 034 Laloh, Gua Musang, Kelantan, Malaysia 5.275761', 102.25136' 47.5 5.207.2008 FD 154 Bukit 11, Perak, Malaysia 3.63256', 100.973306' 38.1 12.03.2009 angustifolia FD 074 Guntong, Setiu, Terengganu, Malaysia 5.604544', 102.726503'' 16.5 16.11.2008 angustifolia FD 076 Guntong, Setiu, Terengganu, Malaysia 5.598237', 102.726646'' 16.5 16.11.2008 PD 076 Guntong, Setiu, Terengganu, Malaysia 4.461422', 100.774503'' 15.5 12.03.2009 angustifolia FD 151 Bukit 11, Perak, Malaysia 4.461422', 100.774503'' 15.5 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.461422'', 100.774503'' 15.5 12.03.2009 FD 153 Bukit 11, Perak, Malaysia 4.46142'', 100.774503'' 15.5 12.03.2009 FD 159 Hutan Lipur Lat Tembakah, Besut, Terengganu, Malaysia 5.591758'', 102.47650'' 29.6 07.10.2009 FD 159		FD 181	lapak Semaian, Jabatan Perhutanan, Setiu, Terengganu, Malaysia	5.4811/8*, 102./96839*	24.7	06.07.2009
FD 034 Laloh, Gua Musang, Kelantan, Malaysia. 5.275761'; 102251356' 47.5 25.072008' FD 154 Bukit 11, Perak, Malaysia 4.451322'; 100.973306'' 38.1 1203.2009 angustifolia FD 074 Guntong, Setiu, Terengganu, Malaysia 5.604544''; 102.726503'' 16.5 16.11.2008 angustifolia FD 076 Guntong, Setiu, Terengganu, Malaysia 5.609454''; 102.726646'' 16.5 16.11.2008 FD 076 Guntong, Setiu, Terengganu, Malaysia 4.63456'; 100.702042'' 9.1 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.463456''; 100.7764836'' 15.5 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.429733''; 100.764836'' 15.5 12.03.2009 FD 153 Bukit 11, Perak, Malaysia 4.512255'; 101.47912'' 132.28 27.05.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758''; 102.49705'' 29.6 07.10.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758''; 102.497050'' 29.6 07.10.2009 FD 190 Hut		FD 031	Bukit Pinang, Laloh, Gua Musang, Kelantan, Malaysia	5.284217°, 102.249789°	53.3	11.06.2008
FD 154 Bukit 11, Perak, Malaysia 4.451322", 100.973306" 38.1 1.2.03.2009 FD 170 Pekan, Pahang, Malaysia 3.563256", 103.368492" 9.1 27.052009 angustifolia FD 074 Guntong, Setiu, Terengganu, Malaysia 5.604544", 102.725613" 16.5 16.11.2008 FD 075 Guntong, Setiu, Terengganu, Malaysia 5.609919", 102.694539" 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia 4.63456", 100.702042" 9.1 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.461842", 100.774503" 15.5 12.03.2009 FD 153 Bukit 11, Perak, Malaysia 4.461842", 100.774503" 15.5 12.03.2009 FD 171 Cameron Highlands, Pahang, Malaysia 4.512525", 101.479172" 132.2.8 27.05.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.88386", 102.4747056" 29.6 07.10.2009 FD 180 Pair Puteh, Kelantan, Malaysia 5.89888", 102.4747056" 29.6 07.10.2009 FD 153 Jerantut, Pahang, Malaysia 3.939024", 102.3807806" 70.7 09.04.20		FD 034	Laloh, Gua Musang, Kelantan, Malaysia.	5.275761°, 102.251356°	47.5	25.07.2008
FD 170 Pekan, Pahang, Malaysia 3.563256°, 103.368492° 9.1 27.05.2009 angustifolia FD 074 Guntong, Setiu, Terengganu, Malaysia 5.604544°, 102.726503° 16.5 16.11.2008 FD 075 Guntong, Setiu, Terengganu, Malaysia 5.598237°, 102.726464° 16.5 16.11.2008 FD 076 Guntong, Setiu, Terengganu, Malaysia 4.463456°, 100.702042° 9.1 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.463456°, 100.776403° 15.5 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.4212733°, 100.764836° 15.5 12.03.2009 FD 171 Cameron Highlands, Palang, Malaysia 4.4212733°, 100.764836° 15.5 12.03.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758°, 102.47650° 29.6 07.10.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.843469°, 102.297717° 6.1 21.02.2009 FD 157 Jerantut, Pahang, Malaysia 5.843469°, 102.378026° 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.94831	kunstleri	FD 154	Bukit 11, Perak, Malaysia	4.451322°, 100.973306°	38.1	12.03.2009
FD 074 Guntong, Setiu, Terengganu, Malaysia 5.604544°, 10.2726503° 16.5 16.11.2008 angustifolia FD 075 Guntong, Setiu, Terengganu, Malaysia 5.609919°, 102.694539° 16.5 16.11.2008 FD 076 Guntong, Setiu, Terengganu, Malaysia 5.598237°, 102.726646° 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia 4.463456°, 100.702042° 9.1 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.461842°, 100.774503° 15.5 12.03.2009 angustifolia FD 151 Bukit 11, Perak, Malaysia 4.451842°, 100.774503° 15.5 12.03.2009 angustifolia FD 171 Cameron Highlands, Pahang, Malaysia 4.512252°, 101.479172° 132.2 27.05.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758°, 102.447650° 29.6 07.10.2009 FD 157 Jerantut, Pahang, Malaysia 5.843469°, 102.378026° 70.7 09.04.2009 FD 159 Jerantut, Pahang, Malaysia 3.939024°, 102.378026° 70.7 09.04.2009 FD 159 Jerantut, Pahang, Malaysia 3		FD 170	Pekan, Pahang, Malaysia	3.563256°, 103.368492°	9.1	27.05.2009
argustifolia FD 075 Guntong, Setiu, Terengganu, Malaysia 5.609919°, 102.694539° 16.5 16.11.2008 argustifolia FD 076 Guntong, Setiu, Terengganu, Malaysia 5.598237°, 102.726646° 16.5 16.11.2008 FD 151 Bukt 11, Perak, Malaysia 4.463456°, 100.702042° 9.1 12.03.2009 argustifolia FD 152 Bukt 11, Perak, Malaysia 4.463456°, 100.774503° 15.5 12.03.2009 argustifolia FD 152 Bukt 11, Perak, Malaysia 4.429733°, 100.764836° 15.5 12.03.2009 argustifolia FD 153 Bukt 11, Perak, Malaysia 4.429733°, 100.764836° 15.5 12.03.2009 FD 189 Hutan Lipur Lat Tembakah, Esut, Terengganu, Malaysia 5.591758°, 102.447650° 29.6 07.10.2009 FD 180 Hutan Lipur Lat Tembakah, Besut, Terengganu, Malaysia 5.591758°, 102.37020° 70.7 09.04.2009 FD 157 Jerantut, Pahang, Malaysia 3.939024°, 102.380880° 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.948314°, 102.377205° 70.7 09.04.2009 FD 159 Jerantut, Pahang		FD 074	Guntong, Setiu, Terengganu, Malavsia	5.604544°, 102.726503°	16.5	16.11.2008
argustifiolia FD 076 Guntong, Setiu, Terengganu, Malaysia 5.598237', 102.726646° 16.5 16.11.2008 FD 151 Bukit 11, Perak, Malaysia 4.463456°, 100.702042° 9.1 12.03.2009 angustifiolia FD 152 Bukit 11, Perak, Malaysia 4.461842°, 100.774503° 15.5 12.03.2009 angustifiolia FD 153 Bukit 11, Perak, Malaysia 4.461842°, 100.774503° 15.5 12.03.2009 angustifiolia FD 153 Bukit 11, Perak, Malaysia 4.429733°, 100.764836° 15.5 12.03.2009 FD 158 Bukit 11, Perak, Malaysia 4.512525°, 101.479172° 1322.8 27.05.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758°, 102.447656° 29.6 07.10.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.848469°, 102.39711° 6.1 2.102.2009 FD 158 Jerantur, Pahang, Malaysia 5.848346°, 102.37205° 70.7 09.04.2009 FD 158 Jerantur, Pahang, Malaysia 3.948314°, 102.378026° 70.7 09.04.2009 FD 159 Jerantur, Pahang, Malaysia 3.		FD 075	Guntong, Setiu, Terengganu, Malavsia	5.609919°, 102.694539°	16.5	16.11.2008
FD 151 Bukit 11, Perak, Malaysia 4.463456*, 100.702042* 9.1 12.03.2009 angustifolia FD 152 Bukit 11, Perak, Malaysia 4.463456*, 100.774503* 15.5 12.03.2009 angustifolia FD 153 Bukit 11, Perak, Malaysia 4.463456*, 100.774503* 15.5 12.03.2009 angustifolia FD 153 Bukit 11, Perak, Malaysia 4.429733*, 100.764836* 15.5 12.03.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758*, 102.447650* 29.6 07.10.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.843469*, 102.397717* 6.1 21.02.2009 FD 157 Jerantut, Pahang, Malaysia 5.843469*, 102.397717* 6.1 21.02.2009 FD 158 Jerantut, Pahang, Malaysia 3.939024*, 102.38080* 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.94834*, 102.378026* 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.908555*, 102.372209 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.908555*, 102.372209 70.7	angustifolia	FD 076	Guntong, Setiu, Terengganu, Malaysia	5.598237°, 102.726646°	16.5	16.11.2008
FD 152 Bukit 11, Perak, Malaysia 4.461842°, 100.774503° 15.5 12.03.2009 angustifolia FD 153 Bukit 11, Perak, Malaysia 4.429733°, 100.764836° 15.5 12.03.2009 FD 171 Cameron Highlands, Pahang, Malaysia 4.512525°, 101.479172° 1322.8 27.05.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758°, 102.447650° 29.6 07.10.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.884869°, 102.397717° 6.1 21.02.2009 FD 148 Pasir Putch, Kelantan, Malaysia 5.843469°, 102.397717° 6.1 21.02.2009 FD 157 Jerantut, Pahang, Malaysia 3.939024°, 102.387026° 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.948314°, 102.378026° 70.7 09.04.2009 FD 159 Jerantut, Pahang, Malaysia 3.936327°, 102.397205° 70.7 09.04.2009 FD 160 Jerantut, Pahang, Malaysia 3.993555°, 102.307255° 70.7 09.04.2009 FD 181 Ajil, Terengganu, Malaysia 3.935136°, 102.400584° 4.3 25.01.2009		FD 151	Bukit 11, Perak, Malaysia	4.463456°, 100.702042°	9.1	12.03.2009
HD 123 Dutkt 11, Frank, Malaysia 1.00.1021, 100.74300 15.5 12.03.2009 angustifolia FD 171 Cameron Highlands, Pahang, Malaysia 4.1207337, 100.744330 15.5 12.03.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758°, 102.447650° 29.6 07.10.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.588889°, 102.447036° 29.6 07.10.2009 FD 148 Pasir Putch, Kelantan, Malaysia 5.484469°, 102.397717° 6.1 21.02.2009 FD 157 Jerantut, Pahang, Malaysia 3.939024°, 102.38080° 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.9365327°, 102.397205° 70.7 09.04.2009 FD 160 Jerantut, Pahang, Malaysia 3.908555°, 102.37220° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.908555°, 102.37230° 70.7 09.04.2009 FD 184 Ajil, Terengganu, Malaysia 3.908555°, 102.37286°, 102.40764° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 5.637286°, 102.40764° 70.7 09.04.2009 FD 183 Ajil, Terengganu, Malaysia 5.637286°, 10		ED 152	Rukit 11 Darak Malausia	4 461842° 100 774503°	15.5	12 03 2009
IP 150 Dutk II, PLas, Makyaka IP 150 IP 157 IP 150 IP 150 IP 20.0209 IP 0.0230717° 6.1 IP 0.02009 IP 0.02377 IP 0.02.077 IP 0.04.2009 IP 0.04.2009 IP 0.01 IP 20.024009 IP 0.02377 IP 0.02.07209° IP 0.7 IP 0.04.2009 IP 0.01 IP 20.0240004 IP 0.03 IP 20.0240039		FD 152	Bukit 11, Tetak, Malaysia	4.401042, 100.774505	15.5	12.03.2009
angustionia FD 171 Cameron Highlands, Palangi, Malaysia 4-312.22 , 01.479712 1322.8 27.05.2009 FD 189 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.591758°, 102.447650° 29.6 07.10.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.588889°, 102.397717° 6.1 21.02.2009 FD 148 Pasir Puteh, Kelantan, Malaysia 5.941568°, 102.397717° 6.1 21.02.2009 FD 157 Jerantut, Pahang, Malaysia 3.948314°, 102.378026° 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.948316°, 102.378026° 70.7 09.04.2009 FD 160 Jerantut, Pahang, Malaysia 3.948316°, 102.378026° 70.7 09.04.2009 FD 160 Jerantut, Pahang, Malaysia 3.908555°, 102.37220° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.953136°, 102.361764° 70.7 09.04.2009 FD 183 Ajil, Terengganu, Malaysia 3.953136°, 102.4743681° 6.1 07.10.2009 FD 192 Fikri, Setiu, Terengganu, Malaysia 5.829987°, 102.40584° 4.3 25.01.2008 bilobata FD 013 Pasir Puteh, Kelantan, Malaysia	angustifalia	FD 155	Cameron Highlanda Dahang Malaysia	4.429735, 100.704850	1222.9	27.05.2009
FD 169 Fntuan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.39173s, 102.447650 29.6 07.10.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.588889°, 102.447036° 29.6 07.10.2009 FD 190 Hutan Lipur Lata Tembakah, Besut, Terengganu, Malaysia 5.884869°, 102.447036° 29.6 07.10.2009 editoidea FD 148 Pasir Putch, Kelantan, Malaysia 5.843469°, 102.397717° 6.1 21.02.2009 editoidea FD 157 Jerantut, Pahang, Malaysia 3.939024°, 102.39716° 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.936327°, 102.397205° 70.7 09.04.2009 FD 160 Jerantut, Pahang, Malaysia 3.998556°, 102.372200° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.995136°, 102.361764° 70.7 09.04.2009 FD 183 Ajil, Terengganu, Malaysia 3.953136°, 102.361764° 70.7 09.04.2009 FD 184 Cameron Highlands, Pahang, Malaysia 5.637286°, 102.743681° 6.1 07.10.2009 bilobata FD 013 Pasir Putch, Kelantan, Malaysia 5.8298	ungustijoliu	FD 171	United Lines Lete Terribalish Deput Terrepresente Meleurie	4.512525, 101.479172	1322.0	27.03.2009
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FD 148 Pasir Puteh, Kelantan, Malaysia 5.843469°, 102.397/17° 6.1 21.02.2009 FD 157 Jerantut, Pahang, Malaysia 3.939024°, 102.380880° 70.7 09.04.2009 FD 158 Jerantut, Pahang, Malaysia 3.939024°, 102.380880° 70.7 09.04.2009 FD 159 Jerantut, Pahang, Malaysia 3.936327°, 102.372290° 70.7 09.04.2009 FD 160 Jerantut, Pahang, Malaysia 3.908555°, 102.372290° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.908555°, 102.372290° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.908555°, 102.372290° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.953136°, 102.361764° 70.7 09.04.2009 FD 183 Ajil, Terengganu, Malaysia 3.953136°, 102.372290° 70.7 09.04.2009 FD 192 Fikri, Setiu, Terengganu, Malaysia 5.637286°, 102.743681° 6.1 07.10.2009 bilobata FD 013 Pasir Puteh, Kelantan, Malaysia 5.829987°, 102.40078° 4.3 25.01.2008 FD 175 Cameron Highlands, Pahang, Malaysia 4.512458°, 101.479422° 1322.8 27.06.2		TD 440				
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FD 160 Jerantut, Pahang, Malaysia 3.908555°, 102.372290° 70.7 09.04.2009 FD 161 Jerantut, Pahang, Malaysia 3.953136°, 102.361764° 70.7 09.04.2009 FD 183 Ajil, Terengganu, Malaysia 4.989750°, 103.067556° 25.6 30.07.2009 FD 192 Fikri, Setiu, Terengganu, Malaysia 5.637286°, 102.743681° 6.1 07.10.2009 bilobata FD 013 Pasir Puteh, Kelantan, Malaysia 5.829987°, 102.400584° 4.3 25.01.2008 bilobata FD 014 Pasir Puteh, Kelantan, Malaysia 5.841153°, 102.410078° 4.3 25.01.2008 FD 175 Cameron Highlands, Pahang, Malaysia 4.512142°, 101.479422° 1322.8 27.06.2009 intermedia FD 184 Cameron Highlands, Pahang, Malaysia 4.512658°, 101.47924° 1322.8 02.10.2009 intermedia FD 185 Cameron Highlands, Pahang, Malaysia 4.512425°, 101.479428° 1322.8 02.10.2009 FD 186 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479478° 1322.8 02.10.2009 FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479479* 1322.8 02.10.2009 FD 188 <td>FD 159</td> <td>Jerantut, Pahang, Malaysia</td> <td>3.936327°, 102.397205°</td> <td>70.7</td> <td>09.04.2009</td>		FD 159	Jerantut, Pahang, Malaysia	3.936327°, 102.397205°	70.7	09.04.2009
FD 161 Jerantut, Pahang, Malaysia 3.953136°, 102.361764° 70.7 09.04.2009 FD 183 Ajil, Terengganu, Malaysia 4.989750°, 103.067556° 25.6 30.07.2009 FD 192 Fikri, Setiu, Terengganu, Malaysia 5.637286°, 102.743681° 6.1 07.10.2009 bilobata FD 013 Pasir Puteh, Kelantan, Malaysia 5.829987°, 102.400584° 4.3 25.01.2008 bilobata FD 014 Pasir Puteh, Kelantan, Malaysia 5.841153°, 102.410078° 4.3 25.01.2008 FD 175 Cameron Highlands, Pahang, Malaysia 4.512142°, 101.479422° 1322.8 02.10.2009 intermedia FD 184 Cameron Highlands, Pahang, Malaysia 4.5122658°, 101.479244° 1322.8 02.10.2009 intermedia FD 186 Cameron Highlands, Pahang, Malaysia 4.512245°, 101.479486° 1322.8 02.10.2009 FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512146°, 101.479375° 1322.8 02.10.2009 intermedia FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009		FD 160	Jerantut, Pahang, Malaysia	3.908555°, 102.372290°	70.7	09.04.2009
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FD 175 Cameron Highlands, Pahang, Malaysia 4.512142°, 101.479422° 1322.8 27.06.2009 FD 184 Cameron Highlands, Pahang, Malaysia 4.512658°, 101.479294° 1322.8 02.10.2009 intermedia FD 185 Cameron Highlands, Pahang, Malaysia 4.512658°, 101.479486° 1322.8 02.10.2009 intermedia FD 186 Cameron Highlands, Pahang, Malaysia 4.512425°, 101.479486° 1322.8 02.10.2009 FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512146°, 101.479375° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512136°, 101.479375° 1322.8 02.10.2009		FD 014	Pasir Puteh, Kelantan, Malaysia	5.841153°, 102.410078°	4.3	25.01.2008
FD 184 Cameron Highlands, Pahang, Malaysia 4.512658°, 101.479294° 1322.8 02.10.2009 FD 185 Cameron Highlands, Pahang, Malaysia 4.512389°, 101.479486° 1322.8 02.10.2009 intermedia FD 186 Cameron Highlands, Pahang, Malaysia 4.512425°, 101.479428° 1322.8 02.10.2009 FD 186 Cameron Highlands, Pahang, Malaysia 4.5121425°, 101.479428° 1322.8 02.10.2009 FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512136°, 101.479375° 1322.8 02.10.2009		FD 175	Cameron Highlands, Pahang, Malaysia	4.512142°, 101.479422°	1322.8	27.06.2009
FD 185 Cameron Highlands, Pahang, Malaysia 4.512389°, 101.479486° 1322.8 02.10.2009 intermedia FD 186 Cameron Highlands, Pahang, Malaysia 4.512425°, 101.479428° 1322.8 02.10.2009 FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009 FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512136°, 101.479375° 1322.8 02.10.2009	intermedia	FD 184	Cameron Highlands, Pahang, Malaysia	4.512658°, 101.479294°	1322.8	02.10.2009
intermedia FD 186 Cameron Highlands, Pahang, Malaysia 4.512425°, 101.479428° 1322.8 02.10.2009 FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512136°, 101.479375° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512136°, 101.479375° 1322.8 02.10.2009		FD 185	Cameron Highlands, Pahang, Malavsia	4.512389°, 101.479486°	1322.8	02,10.2009
FD 187 Cameron Highlands, Pahang, Malaysia 4.512144°, 101.479414° 1322.8 02.10.2009 FD 188 Cameron Highlands, Pahang, Malaysia 4.512136°, 101.479375° 1322.8 02.10.2009		FD 186	Cameron Highlands, Pahang, Malaysia	4.512425°, 101.479428°	1322.8	02,10.2009
FD 188 Cameron Highlands, Pahang, Malaysia 4.512136°, 101.479375° 1322.8 02.10.2009		FD 187	Cameron Highlands, Pahang, Malaysia	4.512144°, 101.479414°	1322.8	02,10.2009
		FD 188	Cameron Highlands, Pahang, Malaysia	4.512136°, 101.479375°	1322.8	02.10.2009
<i>motieyana</i> FD 254 Batu 6 Forest Reserve, Kuching, Sarawak, Malaysia 1.57/339°, 110.171856° 14.3 27.01.2011	motleyana	FD 234	Batu 6 Forest Reserve, Kuching, Sarawak, Malaysia	1.577339°, 110.171856°	14.3	27.01.2011



Figure 1. Distribution of the Ficus deltoidea varieties collected in Malaysia.



Figure 2. The matured leaf shapes of *Ficus deltoidea*. Pictures showing the adaxial (upper) followed by abaxial (lower) surfaces. Avar. *kunstleri*, B- var. *trengganuensis*, C- var. *bilobata*, D- var. *angustifolia*, E- var. *deltoidea*, F- var. *intermedia*, G- var. *motleyana*.

H.Lév., and *F. elasticoides* De Wild., was described by Sonibare et al. (2006). Cystolith was only found in the epidermal cell at the abaxial leaf surface of var. *motleyana*. A layer of hypodermal cells of equal length was observed in var. *trengganuensis*, while 2 layers of hypodermal cells were only found in var. *deltoidea* and var. *motleyana*. For var. *deltoidea*, the second layer is always longer than the first layer, while for var. *motleyana*, both layers are in equal length. Spongy mesophyll normally occurs in 2 to 4 layers in species like *F. lutea* Vahl, *F. trichopoda* H.Lév., and *F. elastica* Roxb. (Sonibare et al., 2006); however, they were indistinguishable and loosely arranged in var. *kunstleri*, var. *bilobata*, var. *angustifolia*, var. *deltoidea*, var. *intermedia*, and var. *motleyana*. Only var. *trengganuensis* showed an aligned structure of spongy mesophyll.

3.2.2. Midrib

No midrib protrusion was observed on the adaxial leaf surface (Figure 4), although *F. asperifolia* Hook. ex Miq.,

Table 2. The c	comparison of lea	f morphology in	7 Ficus deltoidea varieties.
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Leaf morphology	Variety								
	kunstleri	trengganuensis	bilobata	angustifolia	deltoidea	intermedia	motleyana		
Arrangement	Alternate	Alternate	Alternate	Alternate	Alternate	Alternate	Alternate		
Midrib	Forked at the lower third of the lamina	Forked at lower third of the lamina	Forked at or below the middle of the lamina	Forked at or above the middle of the lamina	Forked at lower third of the lamina	Forked near the apex and some not forked	Not forked		
Angle of the forked midrib	More than 45°	Less than 45°	Less than 45°	Less than 45°	More than 45°	Less than 45°	Nil		
Apex	Rounded	Truncate	Bilobed	Rounded	Rounded	Acuminate	Acuminate		
Base	Obtuse	Obtuse	Obtuse	Acute	Obtuse	Acute	Acute		
Shape	Obovate	Obovate	Obcordate	Spathulate	Obovate	Oblanceolate	Oblanceolate		
Length (cm)	8.0-10.5	6.0-8.5	3.0-4.5	4.0-5.5	3.0-3.6	6.0-7.0	11.5–17.0		
Width (cm)	6.5-8.0	3.0-5.0	2.5-4.0	1.0-2.0	2.0-3.5	2.0-4.0	3.2-4.5		
Margin	Wavy	Wavy	Wavy	Entire	Entire	Entire	Entire		
Surface	Veins deeply impressed	Plane or slightly impressed	Plane or slightly impressed	Plane or slightly impressed	Plane or slightly impressed	Plane or slightly impressed	Plane or slightly impressed		
Petiole length (cm)	1.5-3.0	1.0-2.0	1.0-3.0	0.1-0.4	0.4-0.7	0.8–0.95	0.4-0.9		

F. exasperata Vahl, F. mucuso Welw. ex Ficalho, and a few other species showed a distinct projection (Sonibare et al., 2006). The adaxial surface was flat to concave in most varieties. However, the abaxial surface was curved to nearly flat in some varieties like var. bilobata, var. deltoidea, var. intermedia, and var. motleyana, while in var. kunstleri, var. trengganuensis, and var. angustifolia, the abaxial surface was arched to V-shaped. Fibers are usually extended as girders to the adaxial leaf epidermis or hypodermis in F. saussureana DC., F. abutilifolia, F. platyphylla, F. sagittifolia Warb. ex Mildbr. & Burret, and F. ovata D.Don, but sometimes formed adaxial caps only in some Ficus species (Sonibare et al., 2006). Interestingly, fiber cells were formed around the vascular bundle in all F. deltoidea varieties under study. The pattern of vascular bundles was used to separate var. motleyana, var. intermedia, var. trengganuensis, and var. bilobata from the remaining varieties by having an open-type and continuous vascular bundle while the other varieties have closed-type and separate vascular bundles. The comparison of each variety is summarized in Table 3.

Several previously published classifications of *F. deltoidea* were based on intuitive morphology. The number of varieties fluctuated based on morphological variation and locality (Kochummen, 1998), such as those of Corner (1960), who divided the Southeast Asian species of *F. deltoidea* into 12 varieties and 4 forma, namely var. *deltoidea*, var. *angustifolia* f. *angustissima*, var. *arenaria*

Corner, var. bilobata, var. borneensis Corner f. subhirsuta Corner, var. intermedia, var. kunstleri, var. lutescens (Desf.) f. longipedunculata Corner, f. subsessilis (Miq.) Corner, var. motleyana, var. oligoneura (Miq.) Corner, var. peltata Corner, and var. trengganuensis. Later on, a new variety, var. kinabaluensis Stapf, which seems to be a synonym of var. intermedia of Borneo with larger peduncle and leaves, was introduced (Corner, 1969). In 1978, Kochummen identified 7 varieties, namely var. deltoidea, var. bilobata, var. angustifolia, var. intermedia, var. kunstleri, var. motleyana, and var. trengganuensis, which are available in the Malay Peninsula of Malaysia, formerly known as Malaya. After that, 2 endemic varieties of Borneo, namely var. recurvata Kochummen with curly margin and var. subhirsuta Kochummen with hairs on the surface of the lamina, were added (Kochummen, 1998). Berg (2003) and Berg and Corner (2005) divided the species of the Malesian region into 2 subsp., labeled as subsp. deltoidea and subsp. motleyana, which seems to be simpler in handling the variation based on the forked and unforked midrib. Recently, Fatihah et al. (2012) supported the later classifications by morphological phylogenetic evidence. Subsp. deltoidea contained var. deltoidea, var. bilobata, var. angustifolia, var. kunstleri, and var. trengganuensis. The second subsp. motleyana contained var. intermedia and var. motleyana. Most authors had their own opinion in discriminating taxa, but the leaf morphology was discussed in almost all reports.

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Figure 3. Transverse sections of lamina of *Ficus deltoidea* varieties. A- var. *kunstleri*, B- var. *trengganuensis*, C- var. *bilobata*, D- var. *angustifolia*, E- var. *deltoidea*, F- var. *intermedia*, G- var. *motleyana*. Ep- epidermis, Hy- hypodermis, Pl- palisade cells, Sm- spongy mesophyll.

Observation indicates the taxonomic importance of leaf morphological and anatomical characters employed in the present study. The leaf morphology showed several variations in leaf shape, size, surface texture, margin, midrib dichotomous, and petiole length that can be used to identify the varieties of *F. deltoidea*. Anatomically, variations occurred in the arrangement of spongy mesophyll, the structure of the abaxial surface



Figure 4. Transverse sections of midrib of *Ficus deltoidea* varieties. A- var. *kunstleri*, B- var. *trengganuensis*, C- var. *bilobata*, D- var. *angustifolia*, E- var. *deltoidea*, F- var. *intermedia*, G- var. *motleyana*. Ep- epidermis, Fb- fibers, Hy-hypodermis, Sm- spongy mesophyll, Vb- vascular bundle.

of midrib, and the pattern of the vascular bundle. These variations were noteworthy and particularly significant to differentiate the varieties of *F. deltoidea*. In addition, there were a few important characters that can be used to

discriminate *F. deltoidea* from other *Ficus* species, such as the occurrence of a forked midrib, a single layer of epidermis, 1 to 2 hypodermal layers, and the formation of fiber cells around the vascular bundle.

Leafanatomy	Variety								
	kunstleri	trengganuensis	bilobata	angustifolia	deltoidea	intermedia	motleyana		
Hypodermis no.	1	1	1	1	2	1	2		
Hypodermis length	Unequal	Equal	Unequal	Unequal	Second layer longer than the first layer	Unequal	Equal		
Spongy mesophyll arrangement	Loosely arranged	Aligned	Loosely arranged	Loosely arranged	Loosely arranged	Loosely arranged	Loosely arranged		
Midrib protrusion	Nil	Nil	Nil	Nil	Nil	Nil	Nil		
Midrib adaxial surface	Flat to concave	Flat to concave	Flat to concav	Flat to concave	Flat to concave	Flat to concave	Flat to concave		
Midrib abaxial surface	Arched to V-shaped	Arched to V-shaped	Curved and nearly flat	Arched to V-shaped	Curved and nearly flat	Curved and nearly flat	Curved and nearly flat		
Pattern of vascular bundle	Closed-type and separated	Open-type and continuous	Open-type and continuous	Closed-type and separated	Closed-type and separated	Open-type and continuous	Open-type and continuous		

Table 3. The comparison of selected leaf anatomical features in 7 Ficus deltoidea varieties.

Many members of the mulberry family (Moraceae) are characterized with the presence of cystolith, such as that found in *F. elastica* (Cutler et al., 2008). The appearance and location of calcium oxalate or calcium carbonate crystals (such as cystolith, a crystal associated with the cell wall) may be specific and useful in plant taxonomic classification (Esau, 1977). In *F. deltoidea* var. *motleyana*, a cystolith was observed (Figure 5) in a cell called a lithocyst (Esau, 1977) in the leaf's lower epidermis. Berg and Corner (2005) reported that cystoliths can only be found on the lower side of leaf lamina in subgen. *Ficus* sect. *Ficus*. That is contrary to recent findings by Awang et al. (2011), who found 5–20 glands or cystoliths on the upper leaf surface of *F. deltoidea* varieties; this was probably due to effects of environment or adaptation to nutrient-poor conditions, as this species is holoepiphytic (Berg and Corner, 2005). Even though *F. deltoidea* produces a white latex, laticifers were not studied in the leaves of *F. deltoidea* varieties because it is doubtful that they have any systematic value (Berg and Corner, 2005). Therefore, issues regarding incomplete sampling (of



Figure 5. Cystolith present in the leaf lower epidermis of *Ficus deltoidea* var. *motleyana*. Ct- cystolith, Lc- lithocyst.

data and/or taxa) should be taken into account as this can cloud the interpretation of each *F. deltoidea* variety.

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