Taxonomic Revision and Molecular Studies of *Garcinia* Section *Garcinia* (Guttiferae)

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Declaration

I hereby declare that this thesis has been composed and the work contained within, unless otherwise acknowledged and cited, is my own.

Abstract

Garcinia section *Garcinia* is one of 14 sections of the species-rich pantropical genus *Garcinia* (Guttiferae/Clusiaceae). In its most recent circumscription the section comprised 43 species, mostly of rain forest understorey trees, distributed from eastern India to Fiji, and in Madagascar (Jones, 1980: unpublished Phd. Thesis, University of Leicester). Its most famous member is the fruit tree, mangosteen (*G. mangostana*).

Taxonomic revision of section *Garcinia* reduces the number of species from 43 to 16 with five varieties, with distribution from eastern India to Malesia. A total of nine species are excluded, 19 species are reduced to synonyms and five species are insufficiently known to be classified. Within sect. *Garcinia*, *G. acuticosta, G. discoidea, G. exiguous, G. ochraceus* and *G. sangudsangud* are newly described, *G. diospyrifolia* var. *arborea, G. diospyrifolia* var. *minor* and *G. malaccensis* var. *pseudomangostana* are new varieties, and *G. cataractalis,* previously unassigned to any section by Jones (1980) is newly included. Species limits are defined on the basis of combinations of characters such as shape of stamens and presence of pistillode, fruit type, and leaf characters such as shape, size, venation pattern and type of glandular lines.

A total of 83 accessions representing 42 *Garcinia* species were sequenced for the nuclear ribosomal internal transcribed spacer (ITS) region, while 50 accessions (30 spp.) and 24 accessions (16 spp.) were sequenced for the chloroplast non-coding regions *trn*S-G and *trn*D-T respectively. Of these, 30 accessions or ten spp. (ITS), 23 accessions or nine spp. (*trn*S-G) and 17 accessions or nine spp. (*trn*D-T) belong to sect. *Garcinia.* Parsimony and Bayesian analyses show that the ITS data are more phylogenetically informative and provide better resolution for sectional and species relationships compared to *trn*S-G and *trn*D-T. Most of the sections delimited by Jones (1980) proved to be monophyletic but sect. *Garcinia* is not. *Garcinia maingayi, G. trianii* and *G. costata,* assigned to sect. *Garcinia* by Jones, are in a separate clade that is strongly supported as sister to sect. *Brindonia.* These species have significantly different morphological characters from sect. *Garcinia,* and should be excluded from it.

Characters that are important for sectional delimitation are inflorescences that are simple cymes, stamen bundles that are 4-angled or 4-lobed, and fruits with a smooth surface. Four major clades in sect. *Garcinia* are supported by the shape of the stamen bundles, the shape of the fruit and the stigma, and fruit wall characters. ITS trees are significantly incongruent with plastid trees because of the placement of *G. rigida,* which could reflect a hybrid origin. Another hybrid species, the cultivated mangosteen, could be the product of hybridisation events between varieties of *G. malaccensis* if mangosteen is proven to be an obligate agamosperm. However, if mangosteen is a facultative agamosperm, *G. malaccensis* is likely to be the female parent, but any other *Garcinia* species could be the putative paternal species.

Phylogenetic trees of ITS show that most *Garcinia* species from east of Wallace's Line are nested within species from the west. This might reflect dispersal of species across this biogeographic division from west to east when the Sahul and Sunda shelves converged (c. 20 MY).This hypothesis is supported by the estimated divergence of accessions of *G. rigida* from the east of Wallace's Line, from their most recent common ancestor to the west of the line, not later than 21.58+/-2.90 MY.

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CHAPTER 1
INTRODUCTION

1.1 General Background

Garcinia L. is one of the biggest genera in Guttiferae (Clusiaceae) comprising an estimated 200 species (Stevens, 2001 onwards). The species are small to large trees or occasionally shrubs found in the tropical rain forest. In Asia, its distribution is centralised in the Malesian region, with some species reaching India and the Micronesian islands, but it is also found in tropical Africa and the Neotropics. The trees are characterised by their monopodial form and yellow, white or cream exudates produced from cut boles and twigs (Figure 1.1), and are well known as fruit trees because most species have edible arillate fruits. One of the most famous tropical fruits from South East Asia, mangosteen (*G. mangostana* L.), which is sometimes dubbed as the “Queen of Fruit”, is the most widely known and cultivated species.

Figure 1.1 Exudates from *Garcinia* trees. A: *G. penangiana* Pierre; B: *G. discoidea* Nazre

Many taxonomic works on *Garcinia* are confined to restricted geographic areas, for example Peninsular Malaysia (Whitmore, 1973) or tropical Africa (Robson, 1961; Bamps et al., 1978). The last world-wide monograph is much older (Engler, 1893, 1925), and based upon other 19th century works (Pierre, 1882-1885; Vesque, 1893). Engler's monograph deals with a total of 95 species of *Garcinia* in 34 sections. The number of species since this account was published has increased nearly fourfold, to about 400 species as estimated by Whitmore (1973). However, I would estimate the number of species in *Garcinia* should be around 250 species considering the numerous names in the literature and new species yet to be described.

An unpublished PhD thesis by Jones (1980) proposed a new classification of the sections in *Garcinia*, and suggested that the genus should be divided into 14 sections based mainly on male flower characters. The incorporation of phylogenetic methodology and DNA sequence data in systematic studies allows the evaluation of taxonomic classifications using new methods and data. In *Garcinia*, preliminary molecular phylogenetic work has been started by Rismita-Sari (2000) to test Jones (1980) classifications, and these studies are extended in this thesis, with special emphasis on its main subject, the section *Garcinia.*

In Jones's (1980) classification, sect. *Garcinia* consisted of 43 species distributed in Madagascar, and India to Fiji. However, she stressed the need for a monographic revision of this section because of the poorly defined delimitation of some species. Because of the lack of information for the species on a world wide basis, Whitmore

(1973) left 10 *Garcinia* species unnamed in Peninsular Malaysia despite finding them morphologically different from other Malayan species. He specified that they may have been described elsewhere. Because of this, taxonomic revision in *Garcinia* should be done on a world wide monographic basis to resolve problem of species delimitation.

1.2 Project Aims and Objectives

The core subjects of this project were to evaluate the monophyly of section *Garcinia* sensu Jones (1980) and to prepare a monographic account of section *Garcinia* which will clarify the presently poorly defined species boundaries. Molecular data together with morphological characters will be used to aid the classification and provide a better understanding of the phylogeny and evolution of the section. With this robust phylogeny and comprehensive taxonomic revision, it will be possible to evaluate global patterns and distribution of sect. *Garcinia* with clear concepts of sectional and species limits. It will also allow evaluation of the biogeographical history of sect. *Garcinia* which will contribute to our understanding of the historical construction of South East Asian rain forests.

In summary, the objectives of this study are;

i. to investigate the monophyly of sect. *Garcinia.*

ii. to prepare a taxonomic revision and produce detailed descriptions of morphology, accepted names in use and synonymy, to produce an identification key and geographic distribution for each species in sect. *Garcinia.*

iii. to investigate the relationships, phylogeny and biogeography of the species within sect. *Garcinia*.

1.3 Thesis structure

The thesis starts with a brief introduction and objectives of the study in the **Chapter 1**, while **Chapter 2** and **Chapter 3** will review the taxonomic history and the ecology and biology for sect. *Garcinia* from published literature and my own field observations. The morphological investigation is divided into **Chapter 4**, explaining the significance of morphological characters for sectional and species delimitation and **Chapter 6** will provide the morphological treatment for each species, including the distribution of sect. *Garcinia.* **Chapter 5** will cover the molecular systematic study, and the last chapter, **Chapter 7** will conclude the thesis and give some recommendations for further studies.

CHAPTER 2
TAXONOMIC HISTORY

2.1 Introduction

This chapter will review the taxonomic history of the classifications of the genus *Garcinia* and its sections.

2.2 The Genus *Garcinia*

Garcinia honours Laurentius Garcin (1683-1752) who was a Dutch army doctor and naturalist in the Dutch Indies (Indonesia) between the years 1720-1729. During his voyage to the Moluccas (Maluku islands, Indonesia), he examined the fruit bearing tree which the locals called 'mangoustan' (mangosteen) and gave a description of the fruiting female specimen (Garcin, 1733). The species was named *Garcinia mangostana* by Linnaeus (1753), which became the type species for the genus. Mangosteen may be one of the earliest *Garcinia* species to be recorded by Europeans because the name 'mangostan' had been used by the Portuguese in India as mentioned in Garcia da Orta's book whose title translated as “Colloquies on the Simples, Drugs and Meteria Medica of India and some of the fruits found there” published in 1563 (Burkill, 1935). It was thought that the fruit was native in the Moluccas (Garcin, 1733) or Indonesia and Peninsular Malaysia (Garcin, 1733; Rumphius, 1741) but many suggested (e.g.

Whitmore, 1973; Richards, 1990c) that since mangosteen has never been found in the wild, it indicated that this is a hybrid species. The place of origin for mangosteen was suggested as Peninsular Malaysia because closely related species, *G. malaccensis* Hook f. and *G. celebica* L. (syn. *G. hombroniana* Pierre) are found there (Richards, 1990c). Mangosteen is believed to have been cultivated for hundreds of years in the South East Asia region (Ramage et al., 2004).

The family for *Garcinia,* Guttiferae, was created by Jussieu (1789) based on the presence of the exudates secreted from cut stems and leaves. However, Adanson (1763) was the first to correctly group *Garcinia* with the other guttiferous genera (*Calophyllum* L., *Cambogia* L., *Mesua* L. and *Mammea* L.) without providing a name. In addition, he also included the unrelated genera of *Fraxinus* L. (Oleaceae) and *Lawsonia* L. (Lythraceae).

Several years after Linnaeus' monumental work "Species Plantarum" where *Garcinia* had only one species, *G. mangostana*, two more species were added, each by Stickman (Linnaeus, 1754) and Murray (Linnaeus, 1774) specifically distinguished by shape of leaves and the inflorescences but sharing similar fruit characters, i.e. four sepals and petals, eight seeds and a peltate stigma. The number of species then gradually increased during the 19th century and some improvements were made to the definition of the genus by adding more characters, particularly from the flower, and also by the discovery of more new species, especially from the Far East. Examples are the works of Planchon & Triana (1860) who included characters from the embryo and seeds and

Bentham (1862) who added some characters from the inflorescence. Anderson (1874) introduced the inclusion of pentamerous flowers species as shown in *G. xanthochymus* although most *Garcinia* are tetramerous flower, and Baillon (1877) was the first to suggest the importance of separating the male and female characters.

Since then, species delimitation in *Garcinia* has always incorporated characters available from fruits, flowers or both. When Pierre (1882-1885) published his 'Forest Flora of Cochinchine' the species delimitation used many characters which included flowers (male and female), fruits and the latex colour. His species delimitation had a narrow concept with regard to the geographic distribution. For example, *G. celebica* (a name currently accepted in this study) was previously known by many synonyms created by Pierre such as *G. jawoera* (Java), *G. rumphii* (Bangka Is.), *G. hombroniana* (Peninsular Malaysia), *G. krawang* (Borneo), *G. kurzii* (Andaman) and *G. benthami* (Indo-china). The most important characters considered by Pierre (1882-1885) were the inflorescences, stamens and fruit characters. However, fruit characters together with some vegetative characters could also be used to recognise species, for example in *G. mangostana*. Pierre's species concept proved stable and was followed by subsequent monographic works such as Vesque (1893) and Engler (1893, 1925). Since Pierre, the importance of using both male and female (or fruit) characters has been consistently acknowledged. However, finding both male and female specimens of the same species is problematic. One solution, as adopted by Whitmore (1973), used species recognition from vegetative (leaf) characters and specific ecological distribution (e.g. montane or lowland). In the latest sectional revision by Jones (1980), no new characters or criteria for species delimitation were suggested. In this thesis, the characters used for species delimitation are outlined in Chapter 4.

The International Plant Name Index (IPNI; http://www.ipni.org) has a total of 652 specific and subspecific names in *Garcinia* but the total number of accepted species for *Garcinia* is not entirely known. The latest estimation of 200 species was by Stevens (2001 onwards) which is smaller than the earlier estimates of 400 species by Whitmore (1973) or Jones (1980). These conflicting numbers reflect problems of poorly understood species in *Garcinia.* Many new species have been created since the last revision by Engler (1893, 1925) mainly from the publication of local geographic floras. These floras have contributed new knowledge on the species diversity of *Garcinia*, but because of their restricted geographic focus, may have resulted in the superfluous description of species that are not globally distinct. Examples of such floristic revisions of *Garcinia* are: Africa (Oliver, 1868; Robson, 1961; Bamps et al., 1978); India (Anderson, 1874; Hooker, 1875; Maheshwari, 1960); Myanmar (Kurz, 1877); Indo-china (Pierre, 1882-1885; Pitard, 1910; Pham-Hoang, 1991); Thailand (Craib, 1931); Peninsular Malaysia (King, 1891; Ridley, 1922; Whitmore, 1973); Indonesia (Miquel, 1859, 1860; Koorders & Valeton, 1903; Backer & Bakhuizen, 1963) and the Philippines (Merrill, 1908; 1923).

2.2.1 Generic Limits

During Linnaean time, many genera presently considered synonymous with *Garcinia* were described separately. Murray (Linnaeus, 1774) for instance, separated *Cambogia* by its short stamen filaments and fewer stigma rays, but it was later sunk into *Garcinia* by Choisy (1823).

When erecting the family Guttiferae, Jussieu (1789) divided it into three unnamed groups, and *Garcinia* was placed with *Cambogia, Clusia, Tovomita, Quapoya* and *Grias* into Group I, defined by lack of a style. Because of the dependence on fruit characters in *Garcinia* (rather than the flowers) for generic delimitation in the early years, several authors afterward erected many other genera in the family Guttiferae which they considered possibly related to *Garcinia.* The genera include *Stalagmitis* Murray (1789), *Oxycarpus* Loureiro (1890), *Brindonia* Thouars (1805), *Xanthochymus* Roxburgh (1798) *Hebradendron* Graham (1837) and *Discostigma* Hasskarl (1844). As commented by Jones (1980), during the period from 1789 to 1859, the relationship among these genera could not be established because use of the male flower was overshadowed by the ovary and fruit characters in suprageneric classifications.

Stalagmitis was recognised until 1861 when Planchon & Triana found that there were similarities of flowers with the specimens treated by Murray (1789) as *Garcinia* L. and *Xanthochymus* Roxb. However, Kurz (1870), when he observed *X. pinctoria* as having both pentamerous and tetramerous flowers suggested that *Xanthochymus* was no different from other *Garcinia.* It was not until 1875 that Hooker (1875) who agreed with Kurz, sank *Xanthochymus* into *Garcinia.*

As for *Oxycarpus* Lour. and *Brindonia* Thouars, both were sunk into *Garcinia* by Choisy in 1824 under his section *Brindonia*. *Hebradendron cambogiodes* was the only species described by Graham (1837) when he erected this genus but it was reduced to a synonym of *G. morella* Desr. by Planchon & Triana (1860) who retained *Hebradendron* as the name for their new section.

Warburg (1891) erected *Pentaphalangium* based on having five stamen bundles (usually four in *Garcinia*) adnate to the petals, but it was sunk by Kostermans (1976). He considered the different numbers of stamen bundles in *Pentaphalangium* were part of the natural variation observed in *G. warenii.* A recent classification by Stevens (in Gustafsson et al., 2002) also included *Pentaphalangium* along with *Rheedia* and *Tripetalum* into *Garcinia*.

Rheedia created by Linnaeus (1753) is, however, not considered part of *Garcinia* by some authors, for example Berg (1979). This reflects its distribution, restricted to Africa and South America, and morphology, the filaments of the stamens being free rather than united as in *Garcinia*. Robson (1958) who did not agree with the stamen character argument, created new *Garcinia* species in Africa. This was also followed by Adams (1970), Borhidi (1980), Liogier (1986), Hammel (1989) and Zappi (1993) although much earlier Vesque (1893) had already sunk a few *Rheedia* species from Madagascar into *Garcinia*.

Tripetalum was created by Schumann & Hollrung (1889) with only two species, one in Africa and another in New Guinea. Turner & Stevens (1999) proposed to transfer *Tripetalum cymosum*, a species found in New Guinea to *Garcinia*. Jones (1980), who revised the sectional classifications and generic limits in *Garcinia*, proposed several changes. She considered that *Garcinia* should include, 1) seven species of *Ochrocarpus* because of their 2-thecous globose anthers, 2) a monospecific *Septogarcinia* Kostermans (1962) which only differs by dehiscent and ribbed fruit, and 3) all species in *Rheedia* by sharing a similar pollen type and free stamens as in *Garcinia*. Jones's suggestion was tested by nuclear ribosomal internal transcribed spacer (ITS) sequence data by Rismita-Sari (2000) which mostly agreed with the unification of the genera mentioned but she further proposed to elevate several sections into four subgenera. As neither work has been published these names changes remain invalid. Jones's sectional classification is being reviewed by Patrick Sweeney (Missouri Botanical Gardens) using morphological and molecular data (pers. comm.) Recent work, including data taken from molecular analysis (Gustafsson et al., 2002), also shows *Garcinia* together with *Pentaphalangium, Rheedia* and *Tripetalum* are members of the same monophyletic clade.

2.2.2 Infrageneric Classification of Garcinia

In the early period of infrageneric classification in *Garcinia,* several disagreements arose because of lack of materials and difficulties in communication. The first effort to establish an infrageneric classification in *Garcinia* was made by Choisy (1823 & 1824), who established two sections, *Mangostana* and *Brindonia,* based on stamen and flower characters (Table 2.1) to account for the nine species then known. However, when more species were found (30 species, Choisy 1851) he then changed this classification by dividing the species into two subgenera where most of the species he had described earlier were grouped together into subgenus I while the rest were placed in subgenus II.

By contrast, Blume (1825) put six species of *Garcinia* found in the Dutch East Indies (Indonesia) into two sections, *Cladogynos* and an unnamed section (*G. mangostana* and related species), based on characters of the stigma on the fruits. Wight (1840), on the other hand, suggested that Indian *Garcinia* should be divided into two subgenera, *Mangostana* and *Oxycarpus* and then further separated into sections by the characters of the anthers. He could not, however, place some of the species he took from Roxburgh's Hortus Bengalensis (1814) and Wallich's catalogue (1828-1849).

Planchon & Triana (1860) then published their own classification based on characters of male flowers and supported by the female and fruit characters. *Garcinia* was divided into six sections and many problematic species were resolved. Lanessan (1872) did not agree with Planchon & Triana, claiming they used too many characters for infrageneric classification. He created five unnamed subgenera based on the characters of the anthers. Only subgenus I was divided into four other sections (Table 2.1).

In his work ‘Forest Flora of Cochinchine’, Pierre (1882-1885) described 149 *Garcinia* species, many of which were new, and placed these species within 38 sections based mainly on characters of the inflorescences and the anthers. His treatment, however, covered the species not only found in the Indo-china region but also as far as from Africa and New Caledonia, and provided the basis for the next works in the classification of *Garcinia*. He divided the sections into six groups based on the characters of the anthers but did not formally give any taxonomic ranks to these groups.

Vesque's (1893) work is considered to be the first monograph for *Garcinia.* It did not entirely agree with Pierre’s sectional classification but concurred on many of Pierre’s species. It divided *Garcinia* into three subgenera and nine sections based on flower characters and, in addition, he included stomatal anatomy to justify his classification based upon his anatomical studies (Vesque, 1889) on family Guttiferae. However, the most significant classification for *Garcinia* was by Engler (1893), in which he retained most of Pierre's sectional classification. In Engler’s final account (Engler, 1925), *Garcinia* was divided into 34 sections based mainly on characters of the anthers and stamens (Table 2.3).

No major taxonomic work was published after Engler's treatment except for the floristic accounts mentioned above. The most recent revision of *Garcinia* was by Jones (1980) who incorporated a greater range of characters from the inflorescences, flowers, pistillode, fruit and vegetative features. As a result, she divided *Garcinia* into 14 sections (see table 2.2). The important characters were from the male flowers, i.e. the arrangement of the stamens bundles and the presence of the pistillode.

Table 2.1. Historical events in the infrageneric classification of genus *Garcinia.*

Author	**Infrageneric**	**Characters used**
Choisy (1823 & 1824)	1. Sect. *Mangostana* 2. Sect. *Brindonia*	Flowers monoecious or hermaphrodite & stamens
Blume (1825)	Sect. I. (Unnamed) Sect. II. *Cladogynos*	Stigma
Wight (1840)	1. Subgenera *Mangostana* 2. Subgenera *Oxycarpus*	Anthers
Choisy (1851)	1. Subgenus Primum 2. Subgenus Secundum	Inflorescences: position & flower numbers
Planchon & Triana (1860)	I. Sect. *Mangostana* II. Sect. *Peltostigma* III. Sect. *Cambogia* IV. Sect. *Trachycarpus* V. Sect. *Comarostigma* VI. Sect. *Hebradendron*	Stamen, anther, fruit, stigma, staminodes, ovary
Lanessan (1872)	Subgenera 1 I. Sect. *Mangostana* II. Sect. *Peltostigma* III. Sect. *Echinocarpa* IV. Sect. *Cyclandreae* V. Sect. *Synadelphandreae* Subgenera 2 Subgenera 3 Subgenera 4 Subgenera 5	Male: stamens, pistillode, anther; female: stigma, ovary
Hook f. (1875)	Subgenus I. *Garcinia* Subgenus II. *Xanthochymus*	Number of sepals & petals

Author	Infrageneric	Characters used
Pierre (1882-1885)	Group 1 – Sects.: I. *Teracentrum* II. *Rheediopsis* III. *Xanthochymus* IV. *Discostigma* V. *Dicrananthera* VI. *Plinthostigma* VII. *Mucestigma* Group 2 – Sects.: VIII. *Depastigma* IX. *Echinostigma* X. *Peltostigma* XI. *Gamodesmis* XII. *Conocentrum* XIII. *Sphaerocentrum* XIV. *Mangostana* XV. *Gynegonia* XVI. *Kiras* XVII. *Tagmanthera* XVIII. *Collanthera* XIX. *Stemmandra* XX. *Simosanthera* XXI. *Brindonia* XXII. *Tetradium* XXIII. *Pachyphyllum* XXIV. *Papilla* XXV. *Cambogia* XXVI. *Echinocarpa* XXVII. *Cladogynos* XXVIII. *Anisostigma* XXIX. *Olostigma* Group 3 – Sects.: XXX. *Comarostigma* XXXI. *Didymadenia* XXXII. *Rhinostigma* XXXIII. *Tetraclinia* XXXIV. *Oxycarpus* Group 4 – Sect.: XXXV. *Hebradendron* Group 5 – Sect.: XXXVI. *Ripidionanthera* Group 6 – Sect.: XXXVII. *Daedalanthera* XXXVIII. *Campylanthera*	Inflorescences, anther
Vesque (1893)	1. Subgenus *Xanthochymus* 1. Sect. *Xanthochymus* 2. Subgenus *Rheediopsis*	Inflorescences, sepals and petals, stamen, anther, pistillode, ovary, stigma,

Author	Infrageneric	Characters used
	2. Sect. *Rheediopsis* 3. Sect. *Teracentrum* Subgenus *Eugarcinia* 4. Sect. *Mangostana* 5. Sect. *Cambogia* 6. Sect. *Oxycarpus* 7. Sect. *Rhinostigma* 8. Sect. *Hebradendron* 9. Sect. *Paragarcinia*	stomata
King (1891)	Subgenus 1 *Garcinia* Sect. 1 Sect. 2 Sect. 3 Sect. 4 Sect. 5 Subgenus 2 *Xanthochymus*	Sepals & petals; stamen, anther, pistillode

Jones grouped her sections into three (groups 1 to 3) based on the types of the anthers but did not give any ranks to these groups (Table 2.2). The groups are (1) two thecous anthers, ellipsoid, recurved with a central connective: sect. I, II, III, IV, V, VI and VII, (2) four thecous anthers: sect. VIII, IX and X, (3) two thecous anthers, globose and apical slit: sect. XI, XII, XIII, XIV. Within group 1, three subgroups were created (A-C) and within group 3, two more subgroups were created (A and B) based on floral and fruit characters. She also did not give any ranks for subgroups because she believed that the purpose of classification is practical to identify the species, and these groups, are difficult to recognise using herbarium specimens, especially when sterile. Jones's approach of creating the groups with numerical numbers for the sections were influenced by the work of Whitmore (1973) although she felt that relationships could be expressed at several levels and the characters could be used both for herbarium and living material.

Table 2.2. Groups, subgroups and sections established by Jones (1980).

SECTION	***CHARACTERS***
Group 1	
A. I. *Garcinia*	Inflorescences various; flower tetramerous (rarely pentamerous); stamens numerous in 4-bundles or in annular mass; anthers 2-thecous, ellipsoid; pistillode present or absent; fasciclodes present or absent; staminodes present or absent; ovary 2-10 locules; stigma entire or lobed; fruit various, sometimes with woody wall.
B. II. *Rheediopsis* III. *Teracentrum* IV. *Rheedia*	Inflorescences of cauline axillary glomerules; flower tetramerous except in *Rheedia*; stamens fewer than 50, partially united in 4-bundles or free; anthers 2-thecous, ellipsoid; fasciclodes present; pistillode absent; ovary 2-4 locules; stigma entire or weakly lobed; fruit skin thin, smooth.
C. V. *Macrostigma* VI. *Tetraphalangium* VII. *Tripetalum*	Inflorescences terminal; flower pentamerous, tetramerous or trimerous; stamens numerous in bundles adnate to the petals; anthers 2-thecous, ellipsoid; fasciclodes present or absent; pistillode present or absent; ovary 3-5 locules; stigma lobed; fruit skin thin, smooth.
Group 2 VIII. *Brindonia* IX. *Mungotia* X. *Hebradendron*	Inflorescences axillary or terminal or both; flower tetramerous; stamens in a single mass; anthers 4 or 2-thecous, erect or peltate; fasciclodes absent; ovary 2-15 locules; stigma in rays, glandular; fruit skin thin, smooth, warty or echinate, sometimes grooved.
Group 3	
A. XI. *Xanthochymus* XII. *Paragarcinia*	Inflorescences axillary or terminal or both; flower pentamerous or tetramerous except calyx undivided before anthesis in *Paragarcinia*; stamens partially united in bundles; anthers 2-thecous, globose; fasciclodes present; pistillode absent; ovary 4-5 locules; stigma lobed, smooth; fruit skin thin or with slightly woody wall, smooth or rough
B. XIII. *Discostigma* XIV. *Tagmanthera*	Inflorescences axillary or terminal or both; flower tetramerous; stamens united in 4, rarely 2, strap-shaped bundles; anthers 2-thecous, globose; fasciclodes absent; pistillode present; ovary 1-4 locules; stigma entire, smooth; fruit skin thin or with slightly woody wall, smooth.

Table 2.3. Comparison of the section names used by Jones, Engler & Pierre.

<table>
<tr><th>Jones (1980)</th><th>Engler (1925)</th><th>Pierre (1882-1885)</th></tr>
<tr><td rowspan="11">I – <i>Garcinia</i></td><td colspan="2"><i>Mangostana</i> p.p.</td></tr>
<tr><td></td><td><i>Kiras</i></td></tr>
<tr><td colspan="2"><i>Peltostigma</i></td></tr>
<tr><td colspan="2"><i>Anisostigma</i> p.p.</td></tr>
<tr><td colspan="2"><i>Conocentrum</i></td></tr>
<tr><td colspan="2"><i>Daedalanthera</i> p.p.</td></tr>
<tr><td colspan="2"><i>Echinostigma</i> p.p.</td></tr>
<tr><td colspan="2"><i>Gamodesmis</i></td></tr>
<tr><td colspan="2"><i>Simosanthera</i></td></tr>
<tr><td></td><td><i>Sphaerocentrum</i></td></tr>
<tr><td colspan="2"><i>Stemandra</i></td></tr>
<tr><td>II – <i>Rheediopsis</i></td><td colspan="2"><i>Rheediopsis</i></td></tr>
<tr><td>III – <i>Teracentrum</i></td><td colspan="2"><i>Teracentrum</i></td></tr>
<tr><td>IV – <i>Rheedia</i></td><td colspan="2">-</td></tr>
<tr><td>V – <i>Macrostigma</i></td><td></td><td><i>Macrostigma</i></td></tr>
<tr><td>VI – <i>Tetraphalangium</i></td><td><i>Tetraphalangium</i></td><td></td></tr>
<tr><td>VI - <i>Tripetalum</i></td><td colspan="2">-</td></tr>
<tr><td rowspan="14">VIII – <i>Brindonia</i></td><td colspan="2"><i>Cambogia</i></td></tr>
<tr><td></td><td><i>Brindonia</i></td></tr>
<tr><td></td><td><i>Tetradium</i></td></tr>
<tr><td></td><td><i>Papilla</i></td></tr>
<tr><td></td><td><i>Cladogynos</i></td></tr>
<tr><td colspan="2"><i>Comarostigma</i></td></tr>
<tr><td colspan="2"><i>Echinocarpa</i></td></tr>
<tr><td colspan="2">[<i>Anisostigma</i> p.p.]</td></tr>
<tr><td colspan="2"><i>Didymadenia</i></td></tr>
<tr><td colspan="2"><i>Holostigma</i></td></tr>
<tr><td colspan="2"><i>Depastigma</i></td></tr>
<tr><td colspan="2"><i>Oxycarpus</i></td></tr>
<tr><td colspan="2"><i>Rhinostigma</i></td></tr>
<tr><td><i>Tetrachoristemon</i></td><td></td></tr>
<tr><td rowspan="6">IX – <i>Mungotia</i></td><td><i>Mungotia</i></td><td></td></tr>
<tr><td colspan="2">[<i>Daedalanthera</i> p.p.]</td></tr>
<tr><td></td><td>[<i>Gynegonia</i> p.p.]</td></tr>
<tr><td></td><td><i>Pachyphyllum</i></td></tr>
<tr><td colspan="2"><i>Tetraclinia</i></td></tr>
<tr><td>[<i>Mangostana</i> p.p.]</td><td></td></tr>
<tr><td rowspan="2">X – <i>Hebradendron</i></td><td colspan="2"><i>Hebradendron</i></td></tr>
<tr><td colspan="2">[<i>Daedalanthera</i> p.p.]</td></tr>
<tr><td rowspan="2">XI – <i>Xanthochymus</i></td><td colspan="2"><i>Xanthochymus</i></td></tr>
<tr><td><i>Xanthochymopsis</i></td><td></td></tr>
<tr><td>XII – <i>Paragarcinia</i></td><td><i>Paragarcinia</i></td><td></td></tr>
<tr><td>XIII – <i>Discostigma</i></td><td colspan="2"><i>Discostigma</i></td></tr>
<tr><td rowspan="2">Subsect. I – <i>Discostigma</i></td><td colspan="2"><i>Campylanthera</i></td></tr>
<tr><td colspan="2"><i>Mucestigma</i></td></tr>
</table>

Jones (1980)	Engler (1925)	Pierre (1882-1885)
	Plinthostigma	
	[*Mangostana* p.p.]	
Subsect. II– *Dicrananthera*	*Dicrananthera*	
XIV – *Tagmanthera*	*Tagmanthera*	
Subsect. I – *Tagmanthera*	*Collanthera*	
Subsect. II - *Bifasciculata*		

2.3 Section *Garcinia* sensu Jones

Section *Garcinia* is among the biggest sections in *Garcinia* with a total of 43 species (Appendix I), and is typified by *G. mangostana* L. Jones considered sect. *Garcinia* as the most heterogeneous section of *Garcinia* based on the pollen types, but the key character that united species into this section was the stamens united in four bundles or in an annular mass, usually around the central pistillode. By using this key character, Jones (1980) united 11 sections previously described by Pierre (1882-1885), Vesque (1893) and Engler (1893, 1925) into sect. *Garcinia* (Table 2.3). In sect. *Garcinia,* she stressed the need for taxonomic revision and defining the limits of the species. Apart from revising species in sect. *Garcinia,* this study will also test the sectional circumscription of sect. *Garcinia* as established by Jones.

On the relationships and evolution of sect. *Garcinia,* Jones (1980) was more speculative because not all species had been treated in depth for character variation. By the characters of the 2-thecous, ellipsoid anthers and basic tricolporate pollen, sect. *Garcinia* was said to be closely related with sect. II – VII, but from the vegetative morphology, it resembles members from sect. II, III and IV (Jones, 1980). However, this thesis will not cover morphological evolution and relationship of the sections because it is being studied by Patrick Sweeney (Missouri Botanical Garden).

The distribution of sect. *Garcinia* is centralised in the Malesian region, and goes up to the north-west of Indo-China, Myanmar, eastern India with one species in Madagascar. To the east, with the inclusion of *G. pseudo-guttiferae,* the distribution of sect. *Garcinia* reaches the Fijian and Tonga islands (Table 2.4). In total, there were eight species studied by Jones and in addition, she listed 35 more species (excluding three invalid names) that should be included in sect. *Garcinia* (Appendix I).

Table 2.4. Species number and geographical distribution of 14 sections of *Garcinia* sensu Jones (1980).

Section	**Number of species**	**Distribution**
I. *Garcinia*	43	Madagascar, India, Indo-china, Malesia, New Guinea & Fiji.
II. *Rheediopsis*	20	Tropical Africa.
III. *Teracentrum*	4	Tropical Africa.
IV. *Rheedia*	30	Central & South America, Madagascar.
V. *Macrostigma*	10	Java, Borneo, N. Guinea, Philippines, Caroline Is.
VI *Tetraphalangium*	2	Central & West tropical Africa.
VII. *Tripetalum*	1	New Guinea.
VIII. *Brindonia*	77	India, Sri Lanka, Indo-china, P. Malaysia, New Guinea, Philippines.
IX. *Mungotia*	8	Fiji Is. & New Caledonia.
X. *Hebradendron*	40	India, Indo-china, Thailand, P. Malaysia, Java, Philippines & N. Guinea.
XI. *Xanthochymus*	42	Trop. Africa, Madagascar, India, Nepal, S.E. Asia & N.
XII. *Paragarcinia*	10	Guinea.
XIII. *Discostigma*	54	Madagascar.
XIV. *Tagmanthera*	18	Tropical Africa, India, S.E. Asia, Fiji & Tonga Is. & Taiwan

CHAPTER 3
THE ECOLOGY AND BIOLOGY OF SECTION *GARCINIA*

3.1 Introduction

Information on the ecology and biology of *Garcinia* is scarce as only a few species have been studied. The cultivated species *G. mangostana* (mangosteen) is an exception, as it has been extensively studied for a long time because of the economic importance of the fruit. The biology of mangosteen has been investigated since the early 20th century (e.g. Treub, 1911; Sprecher, 1919; Hume & Cobin, 1946) with much recent work (e.g. Lim, 1984; Verheij, 1991; Normah, 2000; Cruz, 2001). This chapter will, however, try to place more emphasis on species from the wild. Scientific names follow the taxonomic treatment in chapter 6. This has resulted in some nomenclatural changes in comparison with previously published work. For example, *G. malaccensis* Hook. f. in Pasoh Forest Reserve is a misidentification; the correct name is *G. penangiana* Pierre. However, some old synonymous names are provided when necessary.

3.2 Habit

Members of sect. *Garcinia* are generally small to medium sized trees reaching 10-35 cm diameter at breast height (dbh) and 5-25 m tall when mature, and rarely reaching 50 cm dbh and 30 m tall. This means that most *Garcinia* trees are found in the forest under-storey though a few species can reach the main canopy (Appanah & Weinland, 1993). In the tropical forest, under-storey trees do not generally exceed 20 m tall while main canopy trees do not exceed 30 m tall (Kochummen et al., 1990).

An example of an under-storey tree from sect. *Garcinia* is *G. penangiana,* one of the most common species distributed in Sumatra, Peninsular Malaysia and Borneo. Studies in the 50-ha plot of lowland forest in Pasoh Forest Reserve show that of 899 individuals of *G. penangiana,* only three reached 15-20 cm dbh (Nazre, 2000) . A similar pattern of diameter was observed in the 52-ha plot in Sarawak where only four of 47 trees of *G. penangiana* reached 10-19 cm dbh (Lee et al., 2002).

Nevertheless, a few species of sect. *Garcinia* in Malaysia, for example *G. celebica* L, *G. malaccensis* Hook f. and *G. nitida* Pierre, have been recorded to reach more than 50 cm dbh and may be logged for timber. In Malaysia, timber of *Garcinia* species is classified based on their common names, and is known as ‘Kandis’, a medium hardwood which is said to be moderately durable and difficult to work. Whitmore (1973) claimed that the woods of *Garcinia* are not considered to be of commercial value because of the few species that reach desirable timber size in comparison with other timber groups, e.g. the Dipterocarps. Other species in sect. *Garcinia,* namely *G. harmandii* Pierre, *G. cataractalis* Whitmore and *G. diospyrifolia* var. *minor* Nazre var. nov. are bushy trees with dense crowns and *G. diospyrifolia* var. *diospyrifolia* Nazre var. nov. is small and of slender stature.

The crown of *Garcinia* trees was described by Whitmore (1973) as monopodial, dense and conical (pagoda like). This growth form is quite common in tropical forest, and found in families such as Annonaceae or Myristicaceae, but *Garcinia* can easily be differentiated from these groups by its opposite leaves. Monopodial branching is a growth model in which secondary shoots or branches arise behind the growing point but remain subsidiary to the main stem, which continues to grow indefinitely (Tootil, 1984).

3.3 Distribution and Dispersal

Garcinia trees are almost always confined to the interior of the forest or to the shade (Whitmore, 1973). Even species commonly found in coastal forest such as *G. celebica* are shade tolerant and do not grow in the open sunlight but rather among other species within the coastal forest. Ecologically, most species of sect. *Garcinia,* such as *G. penangiana, G. malaccensis* and *G. diospyrifolia* are found in the lowland or hill forest (less than 900 m altitude) but some other *Garcinia* species, such as *G. clusiaefolia* are restricted to montane areas (Whitmore, 1973). *Garcinia celebica,* the most widely distributed species of sect. *Garcinia,* found from South East Asia to India, can be present in different ecological and altitudinal conditions from lowland to montane forest, though it is found more commonly in coastal forest. Another species in sect. *Garcinia* that is found at higher altitude (to 1200 m) is *G. sangudsangud,* while *G. cataractalis* is the only rheophyte, restricted to wet riverine areas.

In lowland forest of Peninsular Malaysia, studies show that half of the 14 species of *Garcinia* in Pasoh Forest Reserve have a high preference for well-drained alluvial soil on flat land rather than on hillsides (Nazre, 2000). Pasoh forest is classified as mixed Dipterocarp forest with two relatively dry periods each year and annual rainfall is below any other tropical rain forest near the equator (Kochummen et al., 1990; Wolseley et al., 1996). The two common species of sect. *Garcinia* found in Pasoh*, G. penangiana* and *G. diospyrifolia* var. *minor* strongly follow the distribution pattern of preferring well-drained and flat land. It is, however, not fully understood how other factors such as soil nutrients affect the distribution of *Garcinia* species though it is known that the composition of the rain forest flora varies dramatically in relation to soil nutrients (Ashton, 1988c).

Geographically, sect. *Garcinia* is as defined in this thesis distributed in the South East Asian region though it spreads to the east to New Guinea while to the west, it reaches the east of India (Figure 3.1). The number of species shows a significant decline towards the east and west. For example, across Wallace's Line to the east, three species are found (*G. celebica, G. rigida, G. ochraceus*) while to the west of Wallace's Line, a total of 15 species of sect. *Garcinia* are found. Species numbers again decrease as it crosses Indo-china (3 species) towards India (1 species).

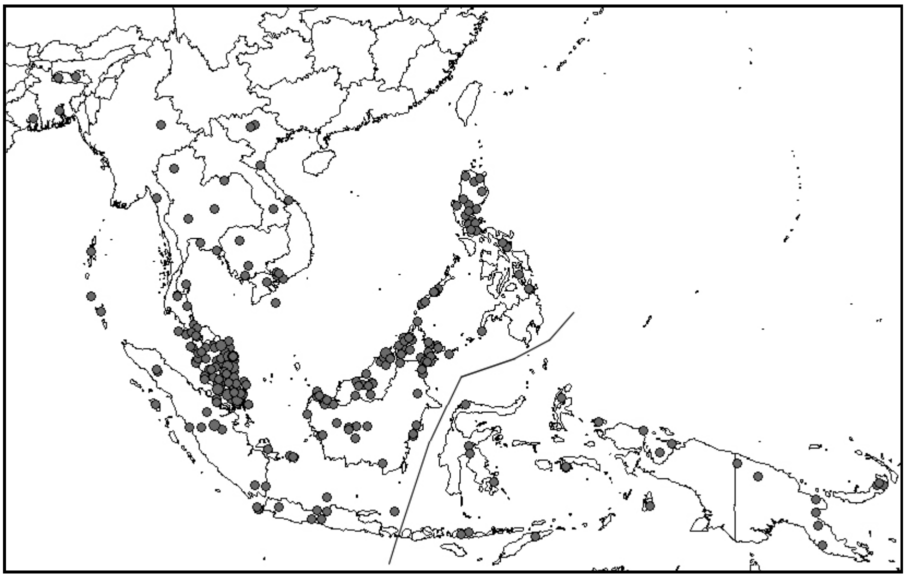


Figure 3.1. Worldwide distribution of sect. *Garcinia*, showing Wallace's Line

3.4 Floral and Fruit Biology

The approximate period of time needed for *Garcinia* trees to reach maturity and first start to produce fruits or flowers is not known except in mangosteen. Based on cultivated trees of mangosteen (Lim, 1984), *Garcinia* species are thought to be slow-growing species and take probably around 10-15 years to start producing flowers.

Each species has a different and irregular flowering pattern. For example, one of the most common *Garcinia* (also sect. *Garcinia*) species in Peninsular Malaysia, *G. penangiana,* flowers only once in a three year period (Ha et al., 1988). This is a perfectly normal pattern for tropical rain forest trees (Whitmore, 1975; Appanah, 1985) and is one reason why *Garcinia* is a difficult subject for study of floral and fruit biology. Richards

(1990b), claimed that *G. celebica* (syn. *G. hombroniana*) is able to flower throughout the year with a peak of flowering from January to June but this observation was based on cultivated trees planted in parks and arboreta where growing conditions differ from natural forest. When comparison was made between cultivated and natural populations of *G. celebica* by Richards (1990b), he found that there were no correlations in flowering time.

During flowering, as observed in *G. celebica* (Richards, 1990b), the anthesis of female flowers occurs when the petals start to reflex and is followed by the loss of the petals. The sepals persist even when the fruit is mature, and the time from flowering to fruit maturation is between 100 and 110 days (Richards, 1990b). For the male flowers, no petals are lost when flowers reach maturity, and the flowering time is much longer than the female (Richards, 1990b). This pattern is typical for most dioecious plants (Bawa, 1980). For many *Garcinia* species, male inflorescences usually contain more flowers than female inflorescences. For example, in *G. celebica* up to 16 flowers are found in male inflorescences but usually solitary, paired or triad flowers in female inflorescences. These factors are considered to increase the chances of sexual pollination. Morphologically, the male flowers are smaller. Thomas (1997) and Ha et al. (1988) found that *G. scortechinii* (non sect. *Garcinia*) has a female based-ratio with only one male tree recorded in Peninsular Malaysia. The same pattern is observed in *G. penangiana* where one population had 31 males compared to 48 females (Thomas, 1997).

The data on pollinators of *Garcinia* is limited but generally for dioecious species, bees are the most common pollinators in tropical rain forest (Renner & Feil, 1993). Bees of the genus *Trigona* may be pollinators as observed in *G. celebica* (Richards, 1990b), attracted to the flowers by their nectar and pollen. The colour of the petals might also help to attract pollinators and in sect. *Garcinia,* species such as *G. diospyrifolia* and *G. malaccensis* have red or pinkish petals. However, in the absence of the pollinators, *Garcinia* may survive and successfully reproduce because of its capacity to produce fertile seed from an asexual breeding system known as agamospermy (see below for more discussion).

Fruits produced in *Garcinia* are edible in almost all of the species. The edible part is the pulp, usually white in colour, surrounding the seeds and protected by an indehiscent fruit wall. In the Indo-Malayan forest, fruit such as this is mostly consumed by primates (Leighton & Leighton, 1983). Some other small mammals might also be attracted to *Garcinia* fruits because the fruits are generally green and yellow at maturity (Corlett, 1993). Fruits eaten largely by mammals and primates are typically duller-coloured than fruits taken mostly by birds (Leighton & Leighton, 1983; Lambert & Marshall, 1991) because mammals and primates have special visual adaptation to make it easier for them to detect fruits against a background of leaves (Osario & Vorobyev, 1996). Some species, however, such as *G. celebica*, *G. diospyrifolia* and *G. nitida*, produce an attractive bright red fruit which might attract large birds such as Bucerotidae (Hornbill). Corlett (1993) also reported that *Garcinia* fruit had been found to be consumed by species of lizards. In general, the dispersal agents for *Garcinia* are most likely primates and other small mammals such as Tupaiideae (tree shrews).

The germination period for different species is variable. From three species of *Garcinia* studied in Pasoh Forest Reserve, Ha et al. (1988) found that the germination of the seed of *Garcinia* was variable and slow, taking from six to eight months and that nearly half of the seeds were sterile. In total, three species from sect. *Garcinia* have been observed; in the well studied *G. mangostana,* germination took 17-64 days; 55-189 days for *G. diospyrifolia;* and 14-35 days for *G. penangiana* (Ng, 1992). Germination is hypogeal where the shoots develop from one end of the seed, and the primary root from the other end, and the primary root is replaced by adventitious roots arising from the base of the shoot (Ng, 1992).

3.5 Agamospermy and *Garcinia*

Agamospermy is a type of apomixis in which seed production is by asexual processes where fertilisation is not required for the normal development of fruit and seed (Gustafson, 1946-1947). Some authors use the term apomixis instead of agamospermy as they consider both synonymous (Richards, 1983), while others use apomixis to describe all forms of asexual reproduction in plants.

Apomixis is considered as a strategy for plant evolutionary success and survival because it maintains genetic heterozygosity inherited from ancestral outcrossers (Allem, 2004). There are two types of agamospermy, obligate and facultative. Obligate agamospermy is rare (Asker & Jerling, 1992), suc as in subarctic Poaceae and Cyperaceae (Richards, 2003), perhaps because species capable of facultative agamospermy can increase their heterozygosity by sexual outbreeding. In angiosperms, the change to apomixis is probably influenced by genetics, physiological and environment factors (Clausen, 1954; Allem, 2004).

In theory, agamospermous progenies will have similar morphology to their mother trees and can be regarded as ‘seed clones’ (Richards, 2003). If one (or more) siblings reproduce sexually, the progeny will show some variation via increased heterozygosity. The role of agamospermy in *Garcinia* is not fully understood as breeding and cytology have been studied in insufficient species. In *G. celebica,* Richards (1990b) observed that two populations, coastal and montane, varied in the size of the pollen, with the coastal populations having a smaller size pollen grain. It is unclear whether this variation reflects agamospermy or environmental factors.

In temperate regions, agamospermy is a common and well-studied phenomenon, for example in *Hieracium, Taraxacum* and *Rubus* (Richards, 2003) . In contrast, it is poorly studied in tropical forest tree species. Agamospermy has been long known in the tropics, but the first observations were on fruit trees such as mangosteen (e.g. Treub, 1911). Kaur et al. (1978) postulated that agamospermy might be widespread in the tropical rain forest based on findings in Dipterocarp species. Carman (1978) recorded 33 agamospermous angiosperm families and Allem (2004) increased this number to 86. Richards (1983) estimated about 330 plant genera are agamospermous. Few data are available for tree genera in Asian tropical rain forest that are capable of agamospermy, but confirmed agamosperms include *Garcinia* and *Calophyllum* (Guttiferae), *Lansium* (Meliaceae), *Syzygium* (Myrtaceae), *Diospyros* (Ebenaceae), *Memecylon* (Melastomataceae), *Mangifera* (Anacardiaceae), and *Shorea* and *Hopea* (Dipterocarpaceae) (Ashton, 1988b; Richards, 1990a; Lughadha & Proenca, 1996; Allem, 2004).

Garcinia is the only agamospermous genus in which both sporophytic agamospermy (adventitious embryony) and gametophytic agamospermy (probably a mitotic diplospory) coexist, having evolved independently within the same genus (Ha et al., 1988). In the presence of male plants, a substantial proportion of sexual seed formation will occur in most species (facultative agamospermy) and only in *G. mangostana* has it been suggested that there is obligate agamospermy where males are always absent (Richards, 1990a). In order to test the occurrence of agamospermy in *Garcinia*, simple experiments have been done by bagging the flower buds at a similar stage of development either with the anthers (if present) removed or not (Lim, 1984). Another method involves monitoring the embryological development when no viable pollen is produced and the embryo is non-zygotic (Ha et al., 1988; Soepadmo, 1989).

However, for *Garcinia,* Richards (1990a) outlined five criteria to determine presence of agamospermy; a) the occurrence of germinable seed in the absence of pollen or after bagging flowers; b) the precocious development of the embryo, i.e. before anthesis; c) the occurrence of adventitious proembryos, budding vegetatively from nucellar or integumental tissues; d) multiple seedling production from a single seed; e) a rarity or absence of males. Following these indications, Richards (1990a) listed 10 species of *Garcinia* that he considered agamospermous by possessing either one or more of these criteria. Of these, three species are in sect. *Garcinia* and their embryology has been studied: *G. mangostana* (Lim, 1984; Richards, 1990a)*, G. penangiana* (mistakenly identified as *G. malaccensis;* Ha *et al.*, 1988) and *G. celebica* (Richards 1990a; 1990b).

Using Richard's final criterion, Thomas (1997) suggested that in *Garcinia*, if a species shows a female biased sex ratio, it is probably a facultative agamosperm. If this assumption is a good indication of the presence of agamospermy, then nearly all species in sect. *Garcinia* may be agamospermous. This is based on the observation of the herbarium specimens in this study which shows female-biased ratios for example in *G. malaccensis* (4 male out of 30 collections)*, G. diospyrifolia* (3 male out of 33 collections) and *G. nitida* (2 male out of 13 collections). However, Richards (1990a) stressed that more information needs to be gathered to discover whether low male ratios are truly clear indications of facultative agamospermy.

To conclude, more study, especially of embryology, will be needed to confirm the presence or type of agamospermy in *Garcinia* and it would be premature to claim the whole genus is agamospermous. The situation may be similar to *Shorea* (Dipterocarpaceae; Kaur et al., 1978; Chan, 1981; Bawa, 1998; Ng et al., 2004) where only some species are agamospermous.

3.6 Chromosome numbers

Basic cytological information is fundamental to the understanding of genetic variation and breeding systems of plant species (Soepadmo, 1989) but *Garcinia* species have been poorly studied, the latest papers being by Richards (1990b). Table 3.1 summarises the diploid numbers of chromosomes that have been reported in sect. *Garcinia.* The exact ploidy level of *Garcinia* is uncertain but Richards (1990c) claimed that *G. mangostana* is probably allopolyploid with respect to its related taxa *G. hombroniana* (=*G. celebica*) and *G. malaccensis* (misidentification of *G. penangiana*). It is, however, sufficient to say that *Garcinia* in general contains complex polyploid series.

Garcinia species have very small chromosomes and most studies have been based on male meiosis (except *G. mangostana*). Because of the small size of the chromosomes, variable numbers have been reported possibly due to inaccurate counts (Richards, 1990c). Even in the widely studied *G. mangostana,* the diploid number ranges from 56 to 96. If the data presented are correct, chromosomal instability may occur and directly contribute to morphological variation within the same species (Ramage et al., 2004). However, more data will be needed to verify this claim especially in relation to morphological change.

Table 3.1. Chromosomes numbers of some *Garcinia* species.

Species	**2n**	**Source**
1. *G. celebica*		
As *G. benthami*	48	Tixier (1990b; 1990c; 1990a)
As *G. hombroniana*	48	Richards (1990b)
As *G. speciosa*	c. 55	Krishnaswamy & Raman (1949)
2. *G. penangiana*	42-43	Ha et al. (1988)
3. *G. mangostana*	c. 76	Krishnaswamy & Raman (1949)
	96	Tixier (1960)
	88-90	Ha et al. (1988)
	60	Kaur et. al (1978)
	56-76	Soepadmo (1989)
4. *G. diospyrifolia*	68	Soepadmo (1989)

3.7 Ethnobotanical Uses

In Asia, *Garcinia* species are widely known as fruit trees and in sect. *Garcinia,* the most widely cultivated species is *G. mangostana*, in which the fleshy portion of the aril that is eaten is estimated to be about 25-30% of the fruit weight (Cruz, 2001). It can be eaten fresh or boiled together with the seeds and sugar added, or the pulp can be made into juice, syrup or jam. Other than mangosteen, some people in Peninsular Malaysia also plant *G. celebica* for its fruits (Burkill, 1935; Whitmore, 1973).

Some other wild *Garcinia* might have potential as fruit trees (Whitmore, 1973) but this is quite difficult to assess given the lack of published studies. Notes on herbarium specimens provide some information on the taste of the fruits. For instance, *G. cataractalis, G. malaccensis, G. nitida* and *G. diospyrifolia* have been recorded as having a sweet and sour taste similar to mangosteen. *Garcinia* also has horticultural potential, for example *G. celebica* is now planted in Malaysia as a roadside plant or in gardens for its beautiful crown shape and colour. *G. diospyrifolia* might have potential for the same purpose and has attractive reddish flowers and fruits.

As a medium hardwood, *Garcinia* wood is suitable for poles, building bridges, flooring and pallets. It is, however, not known which species are used for construction but Watt (1890) and Burkill (1935) claimed that species that reached large size for example, *G. malaccensis* and *G. celebica* were used to build houses and fences in India and Peninsular Malaysia. Whitmore (1973) stated that the wood of *Garcinia* is not generally suitable for timber although some species can be made into poles or smaller items such as instruments.

The most significant ethnobotanical use of *Garcinia*, other than as fruit, is as traditional medicine. In Peninsular Malaysia, Burkill (1935) documented the use of some *Garcinia* species such as *G. celebica* and *G. mangostana* where parts of the trees including bark, roots and leaves were made into a decoction to cure menstrual problems, as medicines after childbirth, for relieving dysentery, fever, itchiness and wounds. Other minor uses include gum-resin (gamboge), tannin and dye.

3.8 Natural Products and Pharmacological Potential

Over the years, research to find natural products in the species of sect. *Garcinia* has increased. Between the years 2000 and 2006, 13 publications of natural product research were published compared to seven before the year 2000. Natural products are chemical compounds, usually secondary metabolites, found in plants with a variety of functions, such as defence against fungi and bacteria, deterrence of herbivores, or attracting pollinators.

The number of species in sect. *Garcinia* that has been studied is still relatively small. The only three species examined are *G. celebica, G. mangostana* and *G. diospyrifolia*. The main compounds found are xanthone or triterpene-derived compounds, as summarised in Table 3.2.

Table 3.2. Some natural products extracted from species of sect. *Garcinia.*

Species	**Chemical content**
G. celebica	1. Friedolanostanes and Lanostanes Rukachaisirikul et al. (2000, 2005); Vieira et al. (2004). 2. Protostane triterpenes Rukachaisirikul et al. (2003).
G. mangostana	1. Xanthone Jung et al. (2006); Nilar & Harrison (2002); Suksamrarn et al. (2002); Huang et al, (2001); Gopalakrishnan & Balaganesan (2000); Gopalakrishnan et al. (1997); Ahluwalia & Tehim (1984); Parveen & Khan (1988); K-Sen et al. (1980); Asai et al. (1995); Nilar et al. (2005); Govindachari et al. (1971). 2. Benzophenone Nilar et al. (2005); Huang et al. (2001). 3. Triterpene Parveen et al., (1991).
G. diospyrifolia	1. Xanthone Goh et al. (1992).

Some of these compounds have been tested for their potential in pharmacology, for example as anti-HIV, anti-fungal or bacterial, anti-cancer agents, and as anti-histamines. Table 3.3 lists species with pharmacological potential in sect. *Garcinia.*

Table 3.3. Species with pharmacological uses in sect. *Garcinia.*

Species	Pharmacological Potential
G. celebica	1. Anti-HIV Rukachaisirikul et al. (2003).
G. mangostana	1. Anti-bacteria/Anti-fungal Chomnawang et al. (2005); Voravuthikunchai & Kitpipit (2005); Sakagami et al. (2005); Suksamrarn et al. (2003); Iinuma et al. (1996); Sundaram et al. (1983). 2. Anti-cancer Nabandith et al. (2004); Moongkarndi et al. (2004a); Matsumoto et al. (2003); Ho et al. (2002). 3.Anti-histamine Nakatani et al. (2002); Chairungsrilerd et al. (1996). 4. Anti-HIV Chen et al. (1996). 5. Anti-oxidation Jung et al. (2006); Moongkarndi et al. (2004b); Williams et al., (1995). 6. Anti-Inflammatory Gopalakrishnan et al. (1980); Shankaranarayan et al. (1979).

CHAPTER 4
MORPHOLOGICAL CHARACTERS

4.1 Introduction

This chapter will provide a discussion of the morphological characters of the species within sect. *Garcinia*. There are two important groups of character. Firstly, the one that defines the sectional classification and the grouping of the species, where characters chosen are fairly constant for whole groups of species, but vary across the genus. These characters are mostly taken from the male flowers and fruits with some additional characters from the leaves. The significance of these characters is also demonstrated by the monophyly of the sections and groups from the molecular analysis (Chapter 5). Secondly, for species delimitation, characters are chosen which are constant or continuously variable within local populations of the same species, but show clear gaps in variation between putative species. These characters come from both vegetative and reproductive features.

4.2 Materials and Methods

The morphological characters are described from herbarium specimens and also from my own observations during field work in Malaysia and Indonesia. Herbarium materials were from herbaria of the Royal Botanic Garden Edinburgh (**E**) with additional specimens loaned from the Royal Botanic Gardens Kew (**K**), Leiden (**L**), Natural History

Museum Paris (**P**), Singapore Botanic Garden (**SING**), Arnold Arboretum (**A**), University of California (**UC**) and Forestry Department Sarawak (**SAR**). Apart from that, herbaria were personally visited during the field work, those of herbarium Kebun Raya Bogor (**BO**), Forest Research Centre Sabah (**SAN**), Forest Research Centre Sarawak (**SAR**) and Forest Research Institute Malaysia (**KEP**).

Information on the label of the herbarium sheets were stored in the PADME database system, developed at RBGE. Amongst the information included were scientific and local names, collector, date collected, locality or any notes written by the collectors. Geographical co-ordinates of the specimens were found on the GEOnet Names Server (http://earth- info.nga.mil/gns/html/index.html) and the co-ordinates were exported from PADME to DIVA-GIS (Hijmans et al., 2001) to map distributions.

Morphological characters were examined by careful observation of herbarium specimens with the help of a hand-lens or stereo microscope. To study the characters of flowers, specimens were first re-hydrated by boiling in water for 10-15 minutes before dissection. Measurements of the leaves are taken from the leaves presumed to be mature and the terminology for leaf morphology follows Hickey's (1979) classification. Detailed information on the field characters of the trees, for example the height or the colour of the bark, were taken either from my own observations, published floristic accounts or from the collectors' notes on the herbarium specimens.

4.3 Vegetative Characters

4.3.1 Leaves

As in the entire genus, leaves in sect. *Garcinia* are simple and oppositely arranged while the margin is always entire and finely revolute towards the lower part of the leaves when dry. Whitmore's (1973) work demonstrated that some *Garcinia* species could be identified to species level by using leaf characters alone. Jones (1980), using radiography techniques, demonstrated that there is large amount of variation in leaf characters, such as the patterns of glandular lines and secondary venation that could be used for species recognition in *Garcinia.*

However, the use of leaf characters in isolation should be treated with caution throughout the whole genus. This is because convergence of vegetative characters means that they do not indicate higher level relationship accurately in all cases. For instance, *G. vidua* (previously included in sect. *Garcinia* by Jones (1980) and *G. nitida* have similar venation that is brochidodromous, with similar glandular line patterns. However, *G. vidua* is not related to *G. nitida* as indicated by its axillary and sessile inflorescences. Whitmore (1973) also found that there were many *Garcinia* species in Peninsular Malaysia (in different sections) with very similar leaf shape and secondary venation but that have different flower and fruit characters. Despite these problems of using vegetative characters at higher taxonomic level within sect. *Garcinia*, some species can be identified by using single 'spot' characters from the leaves or with combinations of characters (see below).

4.3.1.1 Colour

Most of the leaves in *Garcinia* turn brownish when dry but for recent specimens less than five years old, the lamina usually is tinged greenish or yellowish in colour. However, the leaves of *G. penangiana* are a bright reddish colour when dry, making it easy to identify when compared with all other *Garcinia* species.

4.3.1.2 The shape and size

The shape and sizes of the leaves varies greatly even within the same species (Whitmore, 1973) and this is clearly seen in widely distributed species such as *G. celebica,* found from eastern India to Papua, which has elliptic, widely elliptic, lanceolate, sub-orbiculate or round shaped leaves, with size ranging from 3.3-17.5 cm long and 1.7-11.0 cm wide. In general the leaves of sect. *Garcinia* are elliptic derivatives (very narrow elliptic, narrow elliptic, elliptic, wide elliptic, suborbiculate or orbiculate) or sometimes ovate or broadly ovate, and the sizes vary from the smallest of 0.8 cm (e.g. *G. exiguus;* Figure 4.1a) to the biggest of 25.5 cm long (e.g. *G. mangostana;* Figure 4.1b).

Nevertheless, some species have a distinct shape and size which can be used as a spot character. For instance, *G. harmandii* is the only species in the section with leaves of oblanceolate or spathulate shape (Figure 4.1c), *G. cataractalis* has small leaves (to 2.1 cm long) that are very narrow elliptic or lanceolate in shape (Figure 4.1d), and *G. exiguus* has small leaves (less than 2 cm long) that are broadly elliptic in shape (Figure 4.1a).

The drip tips formed by the elongation of the leaf apex are a common feature among *Garcinia* species and are ecologically associated with understorey trees in tropical rainforest. They retard the growth of epiphylls and reduce the loss of soluble nutrients from leaching by hastening the drainage of water films (Whitmore, 1988). For example, drip tips are found in *G. sangudsangud* or *G. diospyrifolia* var. *minor* (Figure 4.1e) which can sometimes reach 1.5 cm long.

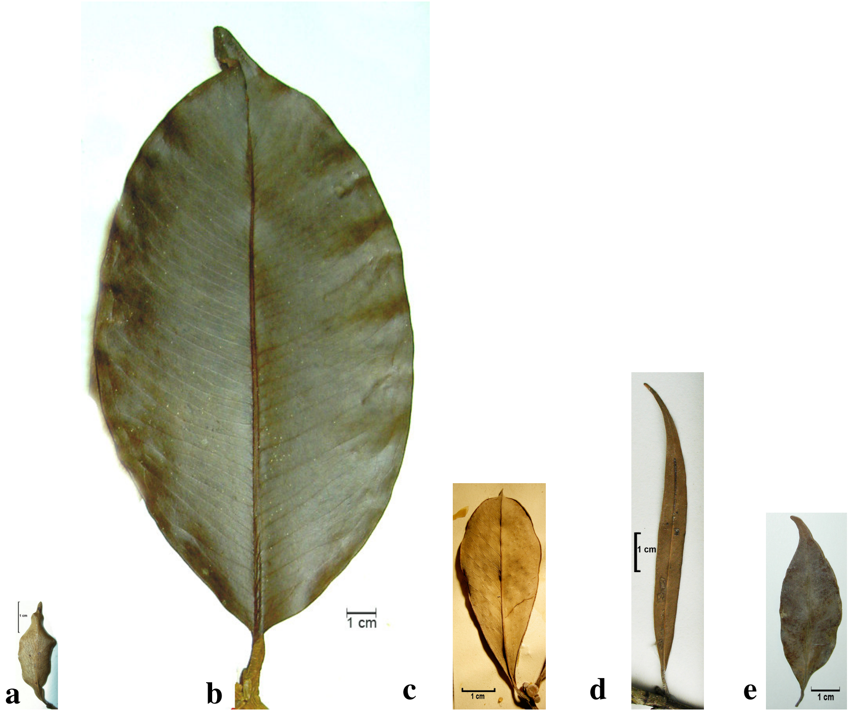


Figure 4.1.Leaf shape and size. — **a**. *Garcinia exiguus* Nazre (*Coode et al. 7886*, A), scale bar = 1 cm; **b**. *G. mangostana* L (*Salma & Sohaime 787,* MARDI); **c**. *G. harmandii* Pierre (*Thorel 1018.,* K); **d**. *G. cataractalis* Whitmore (*Whitmore FRI20350,* K); **e**. *G. diospyrifolia* var. *minor* Ng ex Nazre (*Wong 32216,* A).

4.3.1.3 Petiole

In the forest, *Garcinia* can be identified by their petioles that clasp the twigs in a way that is similar to the unrelated *Fagraea* (Loganiaceae), a genus that does not produce the yellow or white exudate of Guttiferae (Whitmore, 1973). The lower part at the base where the petiole is clasping the twigs is sometimes excavated and enlarged to produce a small ligule-like organ as in *G. venulosa* (Figure 4.2a). The petiole when dry has fine, very closely arranged, horizontal striae that are obvious in most species of *Garcinia* (Figure 4.2b). The upper surface of the petioles is usually sunken or channelled.

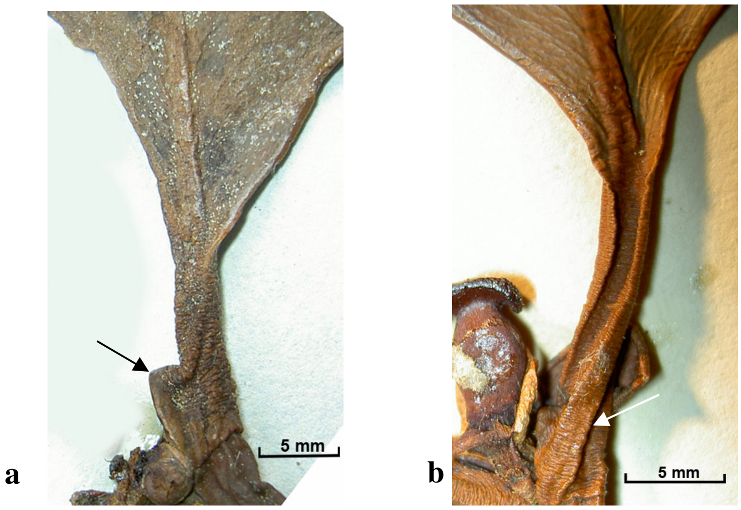


Figure 4.2 Petiole and ligule . — **a**. *G. venulosa* (Blanco) Choisy (*Cumming 2114*, K) showing ligule (arrow); **b**. *Garcinia celebica* L. (*Anon 115,* K) showing striae (arrow).

4.3.1.4 Midrib

Descriptions of the midribs were taken from the dried leaves, with the characters derived from the upper side of the leaf, usually near the middle of the lamina. Three different orientations of midribs are observed: 1) a raised midrib with a square-shaped cross section and flattened upper surface (Figure 4.3a); 2) a raised midrib with a convex-shaped cross section and weakly flattened, pointed or concave upper surface (Figure 4.3b); and 3) the midrib sunken or flattened to the same level as the lamina (Figure 4.3c). In sect. *Garcinia,* the first type of midrib is restricted to *G. diospyrifolia, G. ochraceus, G. penangiana* and *G. nitida.* While the second type of the midrib is commoner in *G. celebica, G. malaccensis*, *G. venulosa* and *G. rigida,* the last type of sunken or flattened midribs is distinct in *G. moselleyana* and *G. harmandii.*

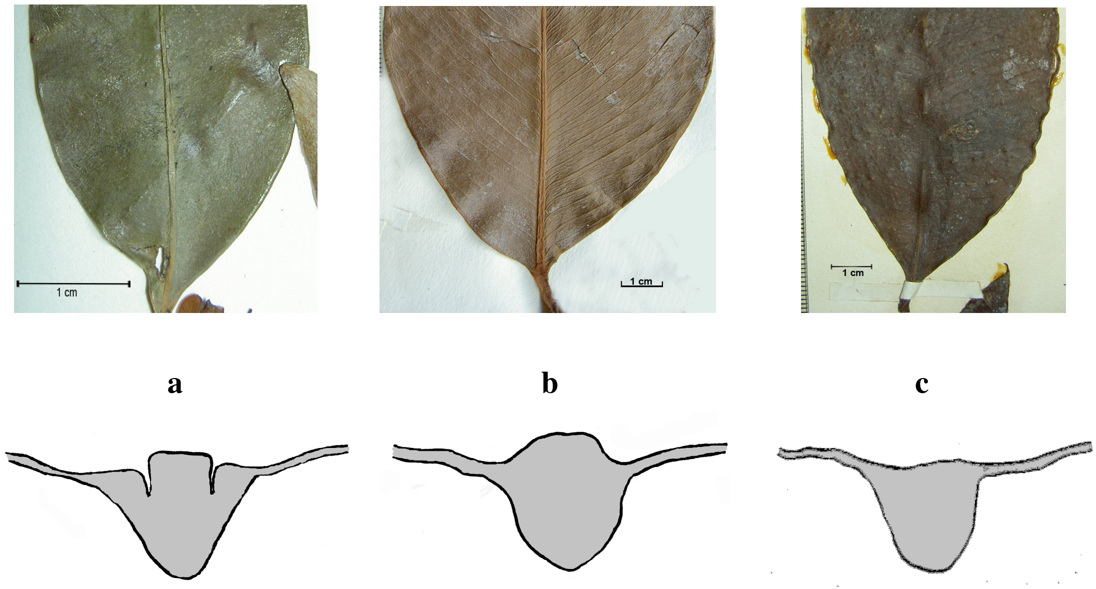


Figure 4.3. Abaxial surfaces of the midribs (above) and cross sections (below). — **a**. *Garcinia nitida* Pierre (*Argent 9318,* E); **b**. *G. celebica* L. (*Harreveld s.n.,* L); **c**. *G. moselleyana* Pierre (*Moseley s.n.,* K).

On the lower (adaxial) surface of the leaves, the midrib in sect. *Garcinia* is always raised and prominent, but sometimes shrinks and becomes more pointed or angular (in cross section), for example in *G. acuticosta* or *G. discoidea.*

4.3.1.5 Secondary veins

Secondary venation in sect. *Garcinia* is mostly uniform, fine but clearly visible on the adaxial surface, and brochidodromous where the veins become united behind the margin to form intramarginal veins. For a few species that have big, thick leathery leaves such as *G. mangostana, G. malaccensis* and *G. venulosa,* a second intramarginal vein is present and located closer to the margin, which becomes a good spot character for these species (Figure 4.4a). However, the second intramarginal vein is only distinct in the female specimens and very faint or not present in the male. Inter-secondary veins are also a common feature, e.g. in *G. penangiana* (Figure 4.4b).

Cladodromous venation, where secondary and tertiary veins form tree like branches is exclusively found in sect. *Garcinia* in *G. moselleyana* and *G. harmandii.* The veins end without touching the margin or at the intramarginal vein (Figure 4.4c & 4.4d).

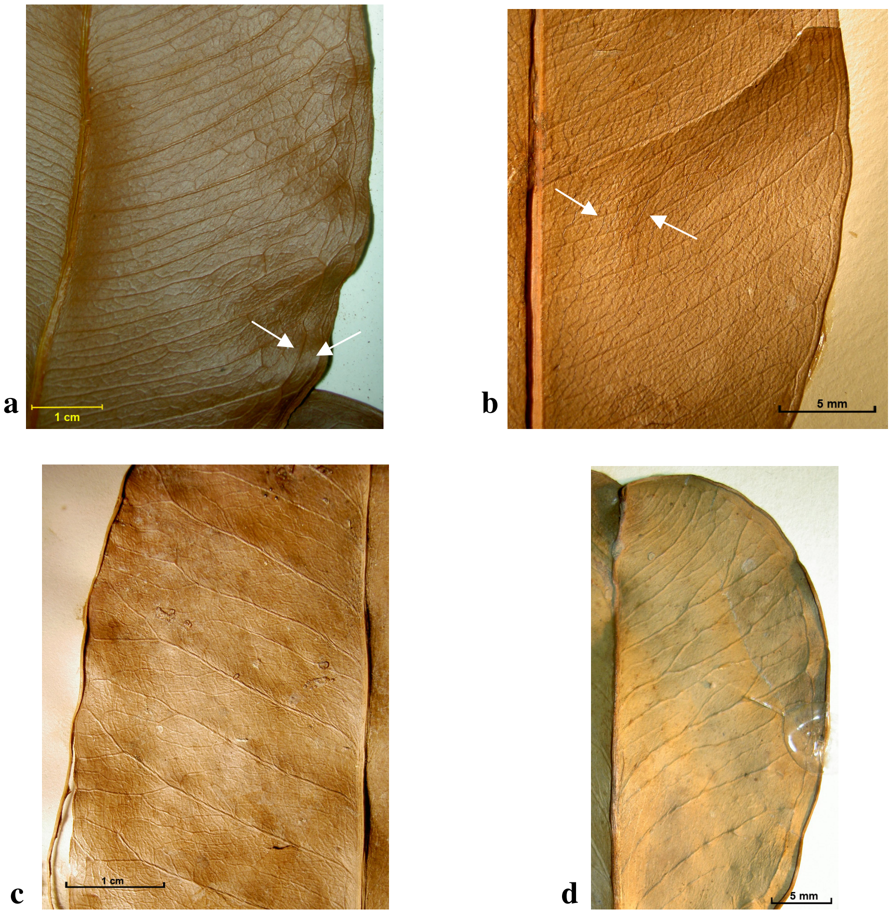


Figure 4.4. Secondary venation; a – b: brochidodromous, c-d: cladodromous. — **a**. *Garcinia mangostana* L. (*Shamsudin s.n.,* MARDI), arrows highlight two intramarginal veins; **b**. *G. penangiana* Pierre (*Henderson 21689,* K), arrows highlight inter-secondary veins; **c**. *G. moselleyana* Pierre (*Wenzel 3036,* K); **d**. *G. harmandii* Pierre (*Thorel 1018,* K).

4.3.1.6 Glandular Lines

Jones (1980) suggested that glandular lines might provide useful characters for species delimitation, but would not be not very useful for infra-generic treatments. There are two different systems of glandular lines between the upper and lower layers of the leaf. Sprecher (1919; in Jones 1980) was the first to realise this and found that the glandular lines on the lower surface are situated in the lower parenchyma and those on the upper surface under the palisade layer. Anatomically, glandular lines are canaliform in the mesophyll and differ from the mesophyll cells by the surrounded rings of 5-7 bordered cells (Jones, 1980).

The pattern of glandular lines from the lower (abaxial) part of the leaves is quite useful in species delimitation and identification of species of sect. *Garcinia,* but only when used in conjunction with other leaf characters. For most species, the glandular lines are fine wavy lines of a thumb-print pattern, which only run in one direction, from the midrib to the margin, across the secondary veins, in blackish, greyish, brownish or dark green colours. However, in a few species such as *G. ochraceus, G. discoidea* and *G. moselleyana,* the glandular lines are not visible or very faint. Sometimes, in old herbarium specimens collected in the 19th century, the colour of the glandular lines is faded and obscure.

Three main variations of glandular line pattern are found in sect. *Garcinia.* The first is the most common where the lamina is dominated by long wavy lines of differing lengths, and occasionally shorter lines are present alongside the longer lines (Figure 4.5a & b). This type is found in *G. acuticosta, G. cataractalis, G. celebica, G. exiguus, G. malaccensis, G. mangostana, G. rigida, G. venulosa, G. harmandii* and *G. penangiana*. Sometimes the distance between the lines can differentiate two species. For example, the lines in *G. celebica* are much closer than to those of *G. rigida.* In few species, such as *G. penangiana* (Figure 4.5a) and *G. cataractalis*, the glandular lines are sometimes mistaken as secondary venation due to their size and distinctness. In *G. exiguus,* the glandular lines are strongly raised compared to the secondary venation, which make the latter hardly visible on the lower surface of the lamina (Figure 4.5b).

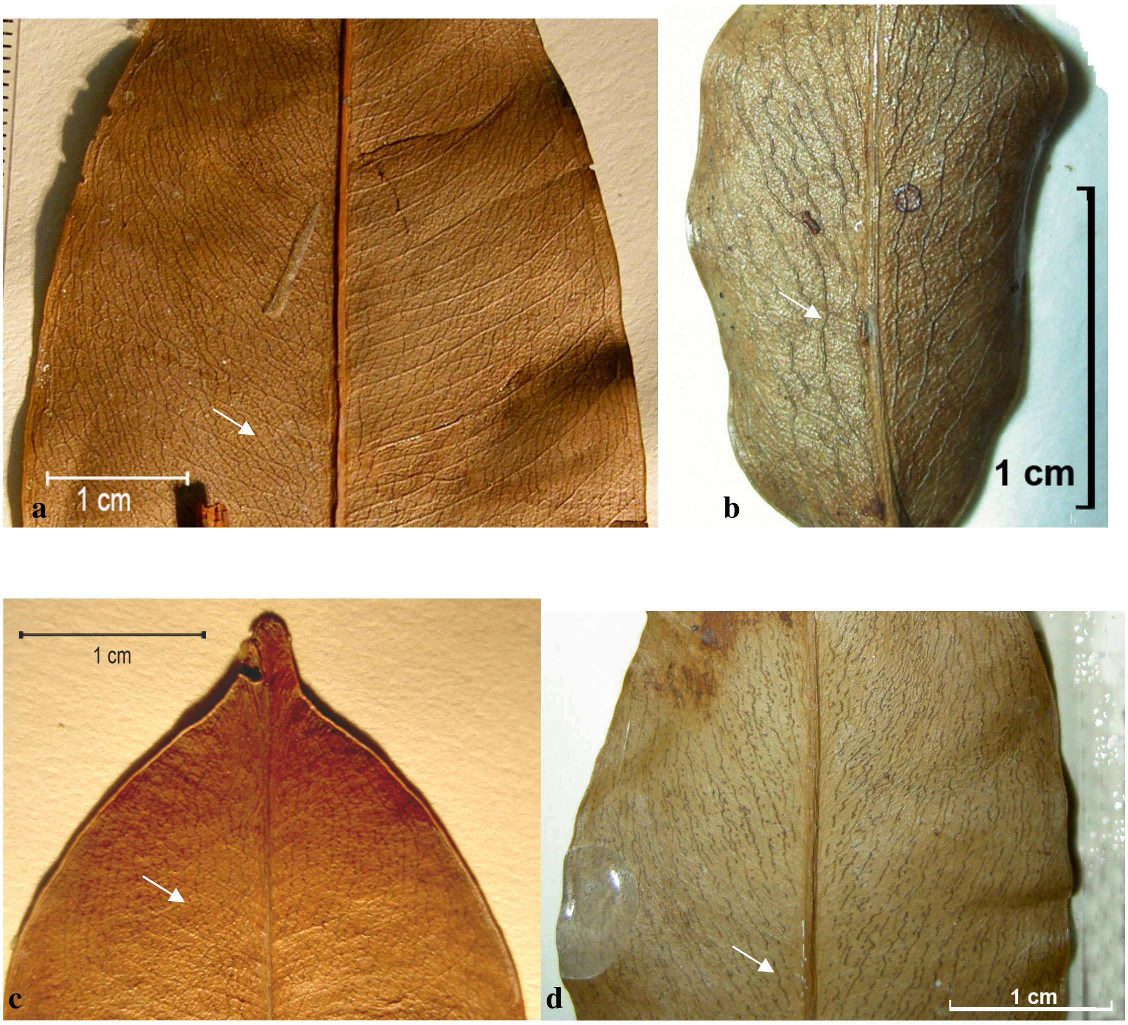


Figure 4.5 Glandular line patterns; arrows highlight glandular lines. — **a**. *Garcinia penangiana* Pierre (*Henderson 21689,* K); **b.** *G. exiguus* Nazre (*Coode 7886,* A); **c**. *G. nitida* Pierre (*Haviland 2339,* K); **d**. *G. sangudsangud* Nazre (*Aban SAN32977,* L).

In the second type, the lamina is dominated by long wavy lines but there are much shorter lines and dashes in between these long lines. Species with this characteristic pattern are *G. nitida* (Figure 4.5c) and *G. diospyrifolia*. The third pattern is found exclusively in *G. sangudsangud* which has long wavy lines that are nearly equal number to the short lines and dashes, and in addition there are many dots alongside the short lines and dashes (Figure 4.5d).

4.4 Floral Characters

4.4.1 The Inflorescence

The basic type of inflorescence in sect. *Garcinia* is a simple cyme (Figure 4.6a, b) in which few flowers (2 to 16) are clustered together and arranged mostly in terminal branches except in *G. moselleyana,* which has both axillary and terminal inflorescences. In this study, the term cluster as used by Whitmore (1973) is preferred for use in species descriptions because ‘cyme’ is defined as a flat-topped or round-topped determinate paniculate inflorescence, in which the terminal flowers bloom first (Harris & Harris, 2004). Species of sect. *Garcinia* are dioecious and there are two obvious differences between male and female inflorescences. Firstly, the male flowers are usually greater in number, and secondly the male flowers are slightly smaller in size than the female flowers. The size of the flowers is often not uniform. For example in *G. celebica,* the male flowers range from 10 mm to 25 mm across. For species such as *G. malaccensis* or

G. mangostana, where occasionally the flowers are in triads, the flower in the middle is always largest.

The female flowers are usually solitary in most of the species in sect. *Garcinia* or occasionally in pairs such as in *G. nitida.* Since the female flowers are bigger than the male, the pedicels are stouter in the female compared with more slender, longer pedicels in the male. In general the shape of the pedicel is angular or round and bracts are usually present. Bracts can be persistent or caducous, are small and triangular reaching 1.7 cm long, but are insignificant in species delimitation.

Generally, inflorescence type is a good synapomorphic character for sectional delimitation in *Garcinia.* For instance, species removed from the section in this study, *G. anomala, G. costata, G. maingayi, G. pseudo-guttiferae, G. tonkinensis* and *G. trianii* have thyrsoid inflorescences composed of 3-flowered cymes (Figure 4.6c) whereas species in sect. *Garcinia* have inflorescences arranged in clusters of few to many flowers.

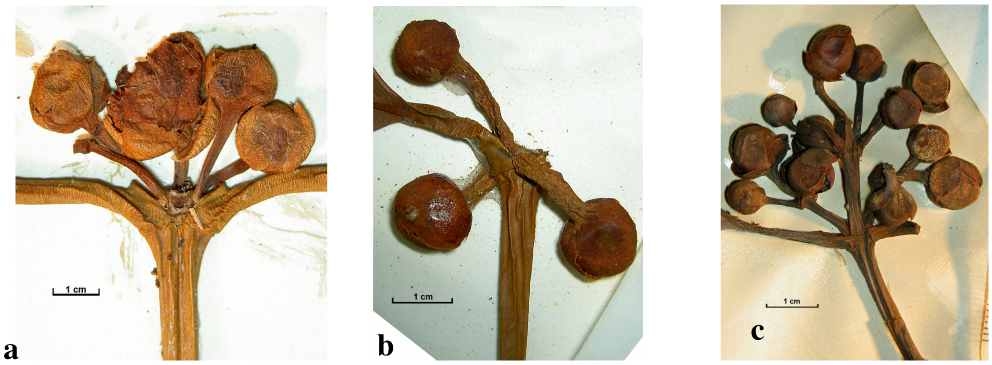


Figure 4.6. Inflorescences in section *Garcinia* (a – b) and omitted species from sect. *Garcinia* (c). — **a**. *Garcinia celebica* L. (*Hamilton 1113,* A); **b**. *G. mangostana* L. (*Shamsudin s.n.,* MARDI); **c**. *G. maingayi* Hk. f. (*Curtis 1610,* K).

4.4.2 Sepals and Petals

The number of sepals and petals in sect. *Garcinia* is always four except in *G. moselleyana* which has five. Pentamerous sepals and petals are not common in *Garcinia* except in sect. *Macrostigma,* though species such as *G.* x*anthochymus* (sect. *Xanthochymus*) have both pentamerous and tetramerous sepals and petals (Jones, 1980). However, *G. moselleyana* is included in the sect. *Garcinia* because the stamens are arranged into 4-lobed bundles and the anthers are 2-thecous. When there are four sepals and petals, they are arranged in pairs (decussate).

The colour of the sepals is usually green or yellowish and the outer part is thicker than the inner, and when compared with the petals, the sepals are usually thicker but smaller. The petals, however, have a brighter colour, from yellow to white, cream, and pink or red. Between the male and female flowers of the same species, petal shape is usually not variable, but between different species, shape varies from ovate to elliptic, or oblanceolate to obovate.

Unlike the petals, the sepals (calyx) on female flowers are persistent and remain on the fruits. Morphologically, the calyx on the fruits is leathery for all species in sect. *Garcinia; G. malaccensis* and *G. mangostana* have a thicker calyx than other species. The shape is variable from ovate to obovate but always concave while the size varies from 1-3 cm long.

4.4.3 Male Flowers

The male flower has been used most extensively in infrageneric classifications by Jones (1980) and species delimitation by Whitmore (1973) who worked on 49 species of *Garcinia* in Peninsular Malaysia. Both authors also used male flower characters to construct artificial groupings without formal taxonomic rank in order to help the identification process. In sect. *Garcinia*, however, using male flower characters alone is not sufficient to construct either higher groups or to use in species delimitation. The taxonomic account (Chapter 6) will mostly use male flower, fruit, and vegetative characters. However, for species where the male flower is absent, DNA sequence data are used to help the placement of the species into the groups.

4.4.3.1 Stamens

The stamens in sect. *Garcinia* are always united in a bundle at the centre of the flower. Based on their shape, stamen bundles can be divided into three types;

1. Distinctly 4-lobed, stamens usually open when mature (e.g. *G. celebica* and *G. discoidea*).
   The stamen bundle is attached at the base of the pistillode above the petals and the lobes are always arranged opposite the petals (Figure 4.7a; 4.8a & 4.9a).
2. Weakly 4-lobed, stamens hardly open when mature (e.g. *G. nitida, G. diospyrifolia, G. sangudsangud,* and *G. ochraceus*).

The attachment and the arrangement of the stamen bundle is similar to the above but the lobes will always enclose the pistillode, even in mature flowers (Figure 4.7b).

3. 4-angled (e.g. *G. penangiana, G. venulosa*. *G. mangostana* and *G. malaccensis*). The stamens, if the pistillode is present, are located at the base of the pistillode, and are usually bigger than the stipe of the pistillode (Figure 4.7c – g; Figure 4.9b - f).

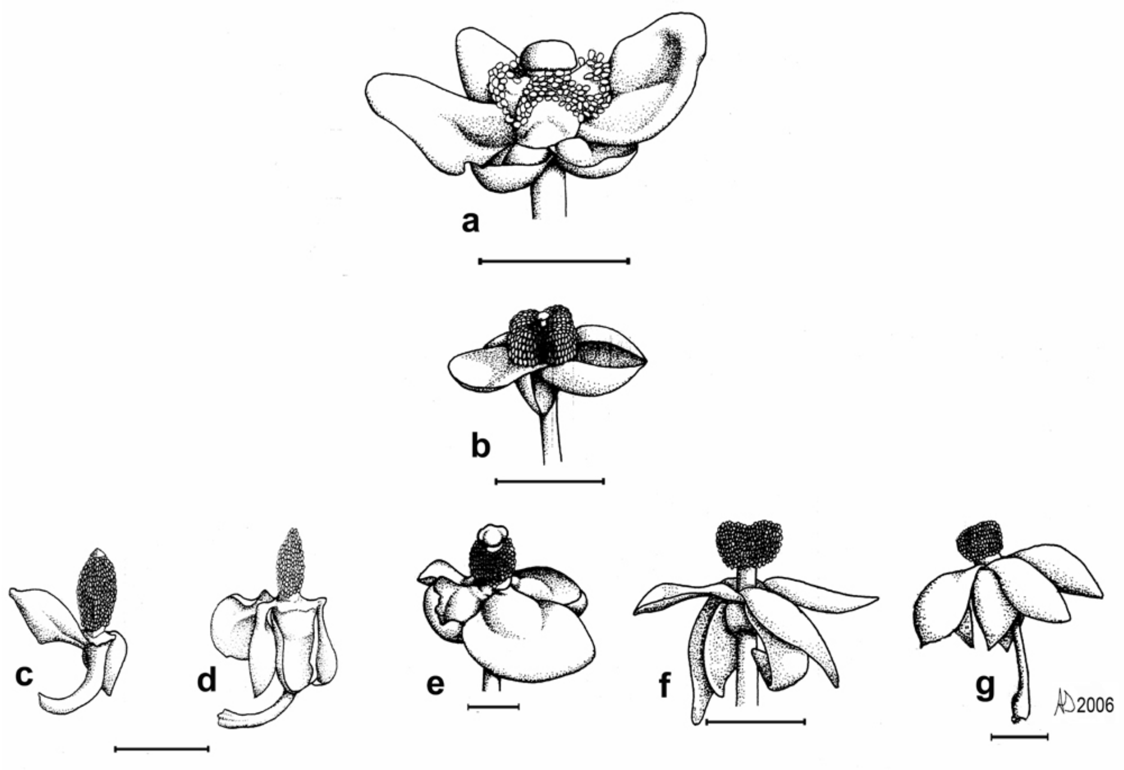


Figure 4.7. Variation of male flowers; Type 1= a, Type 2= b and Type 3= c to g. — **a.** *Garcinia celebica* L. (*Nazre 062,* E); **b.** *G. sangudsangud* Nazre (*Aban* SAN *32914,* L); **c.** & **d.** *G. malaccensis* var. *malaccensis* (c. *Ashton BRUN3392,* SAR; d. *Maingay 149,* K); **e.** *G. mangostana* L. (*Shamsudin s.n.,* MARDI); **f.** *G. penangiana* Pierre (*Whitmore FRI20347,* L); **g.** *Garcinia malaccensis* var. *pseudomangostana* Nazre (*Madani 50574,*L). Scale bar = 1 cm. Drawn by Anna Dorward.

The stamens number c. 100, and the anthers are two thecous, recurved and dehisce by longitudinal slits. These anthers are either with short filaments or completely sessile. Using stamen characters, *G. anomala, G. costata, G. maingayi* and *G. trianii* are omitted from sect. *Garcinia* because their stamens are arranged in an annular mass at the centre, without lobes and encircle the pistillode, compared to 4-angled or 4-lobed stamen bundles in sect. *Garcinia* (Figure 4.8). Another omitted species, *G. vidua* is, however, quite different from other species having very few anthers (c. 10) clustered in the middle of the flower and the pistillode is not present. From these characters it appears closely related to many species from sect. *Brindonia* sensu Jones (1980).

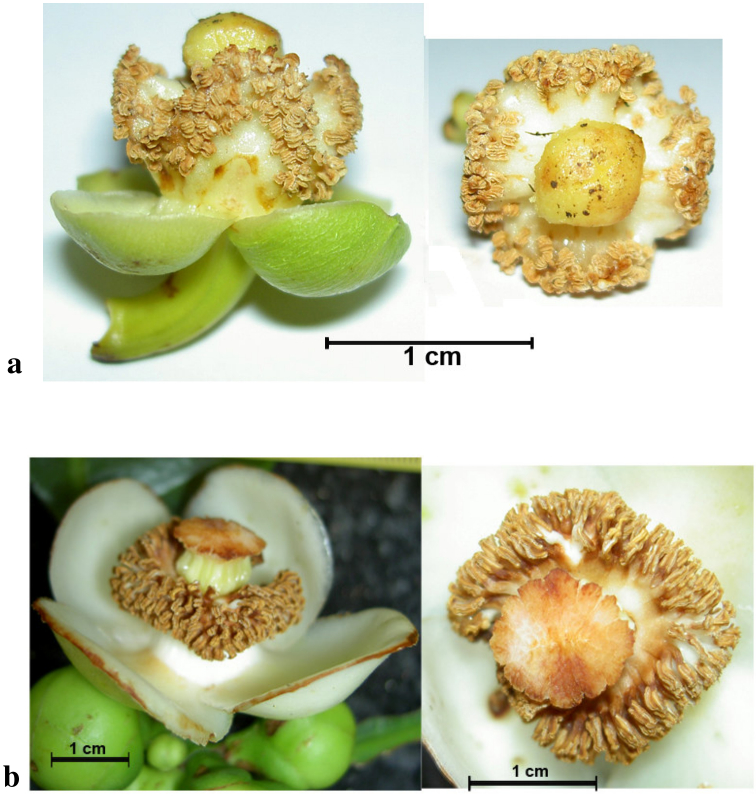


Figure 4.8. Comparison of male flowers in section *Garcinia* (a) and omitted species (b). — **a**. *G. celebica* L.; **b.** *G. costata* Hemsl. ex King

4.4.3.2 Pistillode

The pistillode in the male flower of many *Garcinia* species is homologous with the gynoecium of the female flower (Jones, 1980). Morphologically, pistillodes in sect. *Garcinia* have a fungiform-like shape, consisting of a cap and the shaft (or stipe), which is homologous to the stigma and ovary, respectively (Figure 4.9a & b). The pistillodes are small, from 1 mm long, e.g. *G. malaccensis* var. *malaccensis* (Figure 4.9c & d), to 5 mm long e.g. *G. mangostana* (Figure 4.9b). The stipe can be slender or ovoid and the margin of the cap may be crenate or lobed. However, not all species in sect. *Garcinia* possess a pistillode (Figure 4.9e & f), which is lacking in, for example, *G. penangiana, G. venulosa* and in few individuals of *G. malaccensis.*

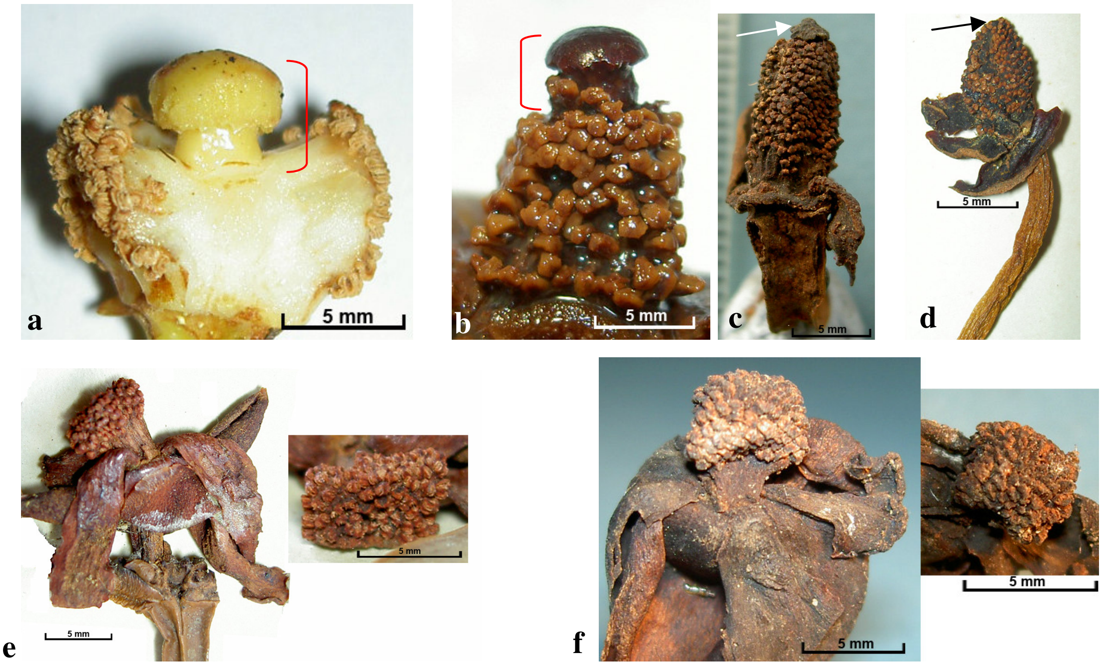


Figure 4.9. Variations of pistillode (a–d), bars and arrows highlight the pistillode; species without a pistillode (e–f.) — **a**. *Garcinia celebica* L. (*Nazre 062*, E); **b.** *G. mangostana* L. (*Shamsudin s.n.*, MARDI); c. & d. *G. malaccensis* var. *malaccensis* (c. *Ashton BRUN3392,* SAR; d. *Cockburn FRI18181,* KEP)*;* **e**. *G. venulosa* (Blanco) Choisy (*Alvarez 18513,* K); **f**. *G. penangiana* Pierre (*Burbridge s.n.,* K).

4.4.4 **Female Flowers**

4.4.4.1 Ovary

For most of the species in sect. *Garcinia* (*G. acuticosta, G. cataractalis, G. discoidea, G. exiguus, G. nitida, G. ochraceus, G. rigida* and *G. venulosa*) the absence of female flowers on herbarium specimens hindered the use of the ovary for comparative studies. In general, the ovary in *Garcinia* is superior and very few species have constant locule numbers (Jones, 1980). In sect. *Garcinia,* most species have 4 or 5 locules as in *G. celebica* and *G. malaccensis*. Two shapes of the ovary are found in sect. *Garcinia;* ovoid (flask-shaped) as in *G. diospyrifolia* and *G. celebica* to broadly ovate (dwarf fungi-form) as in *G. nitida, G. mangostana, G. malaccensis* and *G. sangudsangud* (Figure 4.10a – c)*;* and orbiculate or globose as in *G. harmandii, G. moselleyana* and *G. penangiana* (Figure 4.10d). Because little variation is found in the ovary, it has less taxonomic value and is not really an important character for species circumscription in sect. *Garcinia.*

4.4.4.2 Stigma

The stigma in sect. *Garcinia* crowns the top of the ovary, is blackish in colour, and sessile or raised to 2 mm long. For most of the species, the stigma is usually fungiform cap-shaped or skull-cap shaped (hemispherical), smooth or corrugated, with or without lobes, and the margin is irregularly crenate (Figure 4.10a – d). Stigma characters

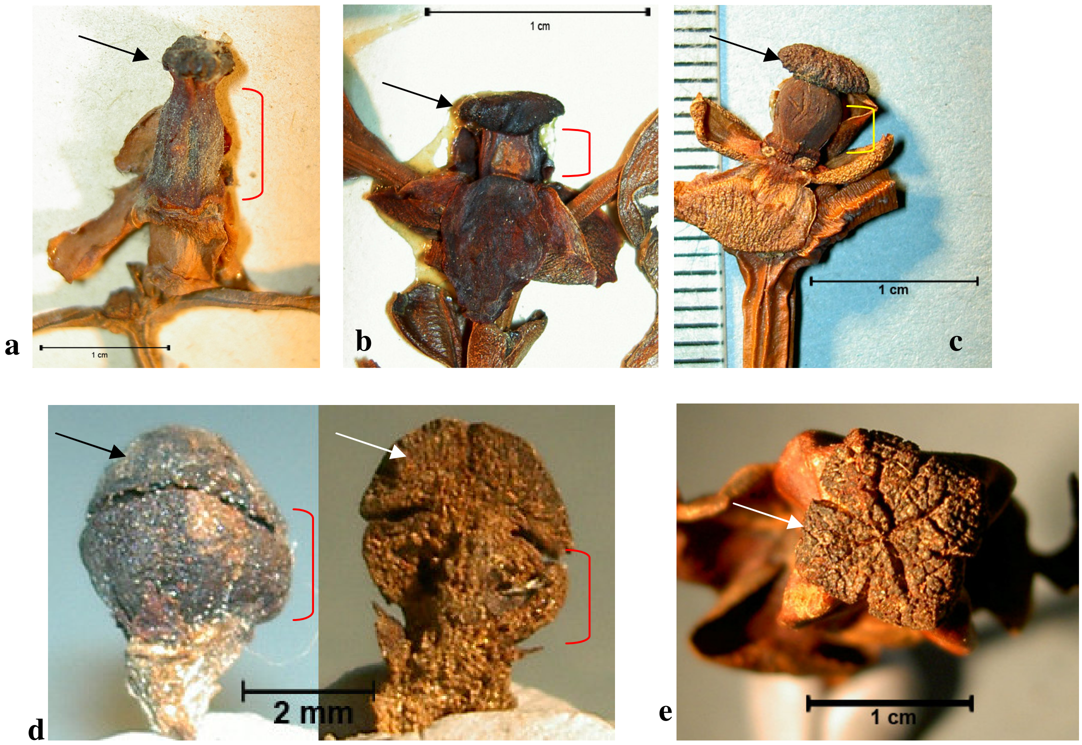


Figure 4.10. Variation in ovaries and stigmas, bars indicate ovary and arrows indicate stigma; a – c: ovoid or broadly ovate ovary with fungiform cap-shaped stigma; d : globose ovary with skull cap-shaped stigma; e: stigma in 4-bundles with corrugated surface. — **a**. *G. diospyrifolia* var. *diospyrifolia* (*Zainal AA914,* A); **b**. *G. nitida* Pierre (*Haviland 2339,* K); **c**. *G. celebica* L. (*Anon 115,*K) **d**. *Garcinia moselleyana* Pierre (*Elmer 7187,* K); **e**. *G. penangiana* Pierre (*Chai S32334,* L).

in the female flowers are not as useful as the stigma characters in the fruits (see below) for species circumscription because with the exception of a few species, less variation is found. For example, *G. moselleyana* has a skull-cap shaped stigma and is distinctly different from other species because the stigma is bigger or nearly the same as its globose ovary (Figure 4.10d). Another example is *G. mangostana* with its skull-cap shaped stigma of 4-5 lobes, and smooth surface, and *G. penangiana* with a skull-cap shaped stigma of 3-4 bundles with rather corrugated surface (Figure 4.10e). These characters are retained on the mature fruit (see stigma on fruit below) making the stigma characters even more useful. However, the use of the stigma to identify other species such as *G. diospyrifolia, G. celebica, G. nitida, G. venulosa* and *G. malaccensis* is difficult because of the similarity of their fungiform cap shaped stigmas (Figure 4.10a – c).

4.4.4.3 Staminodes

Staminodes of the female flower are homologous to the stamens of the male flower and differ from functional stamens by not producing any pollen. In sect. *Garcinia,* the appearance of the staminodes does not reflect the morphology of the stamens in the male flowers. For example, two species in sect. *Garcinia*, *G. malaccensis* and *G. mangostana* (Figure 4.11), have staminodes present as free stamens numbering few to 20, surrounding the ovary. However, the stamens for both species are many (c. 100) arranged in central, 4-angled bundles. The staminodes are usually caducous and are sometimes missing on the herbarium sheets.

Figure 4.11. The position of free staminodes in female flowers of *Garcinia mangostana* L. Arrow highlights staminodes.

4.5 Fruits

Fruits in sect. *Garcinia* are berries with walls that are thick or thin and woody, or occasionally very hard and woody. Whitmore (1973) described the fruit types in *Garcinia* as fleshy to woody berries because some fruits have an edible fleshy fruit wall. In sect. *Garcinia,* however, no species have an edible fruit wall.

In the absence of male flowers, for some species (e.g. *G. acuticosta* and *G. cataractalis*) fruits provide important characters for species recognition. These characters are mainly from the types of fruit wall, i.e. thick or thin, and variation in the shape of the stigma. Combined with other floral and vegetative characters, the fruit characters also provided significant characters for higher taxonomic groupings in the family (Jones, 1980).

4.5.1 Fruit wall

In general there are two types of fruit wall (Figure 4.12). *Garcinia mangostana, G. celebica, G. discoidea, G. venulosa, G. sangudsangud* and *G. discoidea* have thickly woody walls (Figure 4.12a). In contrast, *G. rigida, G. diospyrifolia, G. nitida, G. cataractalis, G. ochraceus* and *G. penangiana* have thin woody walls which rupture easily when dry (except for *G. rigida* and *G. penangiana*) (Figure 4.12b).

The fruit surface is normally smooth but occasionally some fruits in *G. celebica, G. discoidea* and *G. sangudsangud* have small lenticels or dents. Species with thin woody walls such as *G. cataractalis, G. diospyrifolia* and *G. nitida* sometimes have longitudinal glandular lines of dark reddish or maroon to dark brownish colour.

The smooth fruit wall without stripes is a good synapomorphy to define sect. *Garcinia* (Figure 4.13a). For example, species excluded from the section include *G. costata* that has a ribbed or segmented wall (Figure 4.13b). The other excluded species *G. maingayi* and *G. trianii* have a deep green (or blackish when dry) fruit wall striped with pale green or yellow (or brownish colour when dry) (Figure 4.13c).

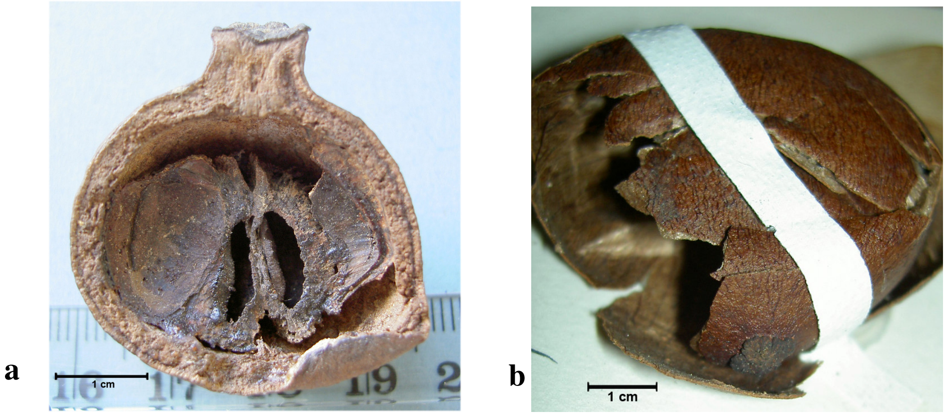


Figure 4.12. Fruit wall type; a. thick and b. thin and easily ruptured. — **a**. *G. celebica* L. (*Blume 2026,* L); **b**. *G. diospyrifolia* var. *minor* Ng ex Nazre (*Wong 32216,* A).

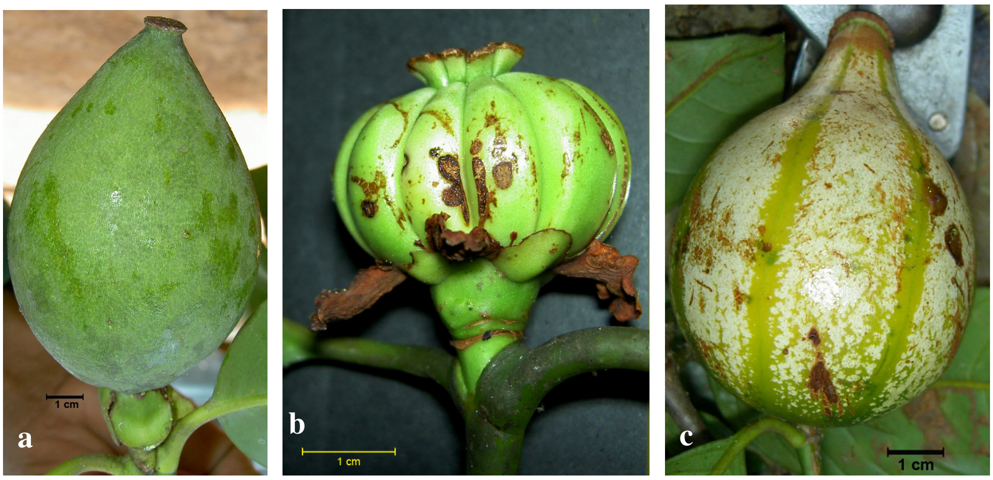


Figure 4.13. Comparison of fruit wall surfaces in section *Garcinia* (a) with omitted species from the section (b, c). — **a**. *Garcinia discoidea* Nazre with smooth wall without stripes; **b**. *G. costata* Hemsl. ex King with ribbed wall; **c**. *G. trianii* Pierre with striped fruit wall.

4.5.2 Colour

The colour of the fruits is normally greenish when young and turning yellowish, reddish or dark purplish when mature. Dried fruit of species such as *G. diospyrifolia, G. nitida, G. ochraceus* and *G. penangiana* retain their reddish colour while the rest of the species turn brownish or blackish.

4.5.3 Shape and size

The shape of the fruits varies from globose, ovoid (flask-shaped) to ellipsoid (Figure 4.14). The elongation of the stigma from the ovary to become a neck-like structure is quite common, for example in *G. celebica, G. diospyrifolia, G. nitida* and *G. malaccensis*, while the elongation of the base is rare and only observed in a few specimens of *G. celebica* and *G. malaccensis* var. *malaccensis.*

Fruit size ranges from very small (less than 1 cm) to large (more than 7 cm) (Figure 4.14). *Garcinia moselleyana, G. harmandii, G. exiguus,* are amongst the species with very small fruit, and *G. cataractalis, G. nitida, G. diospyrifolia* are species with small fruit (less than 7 cm). The largest fruits are found in *G. mangostana*, *G. malaccensis* and *G. discoidea.*

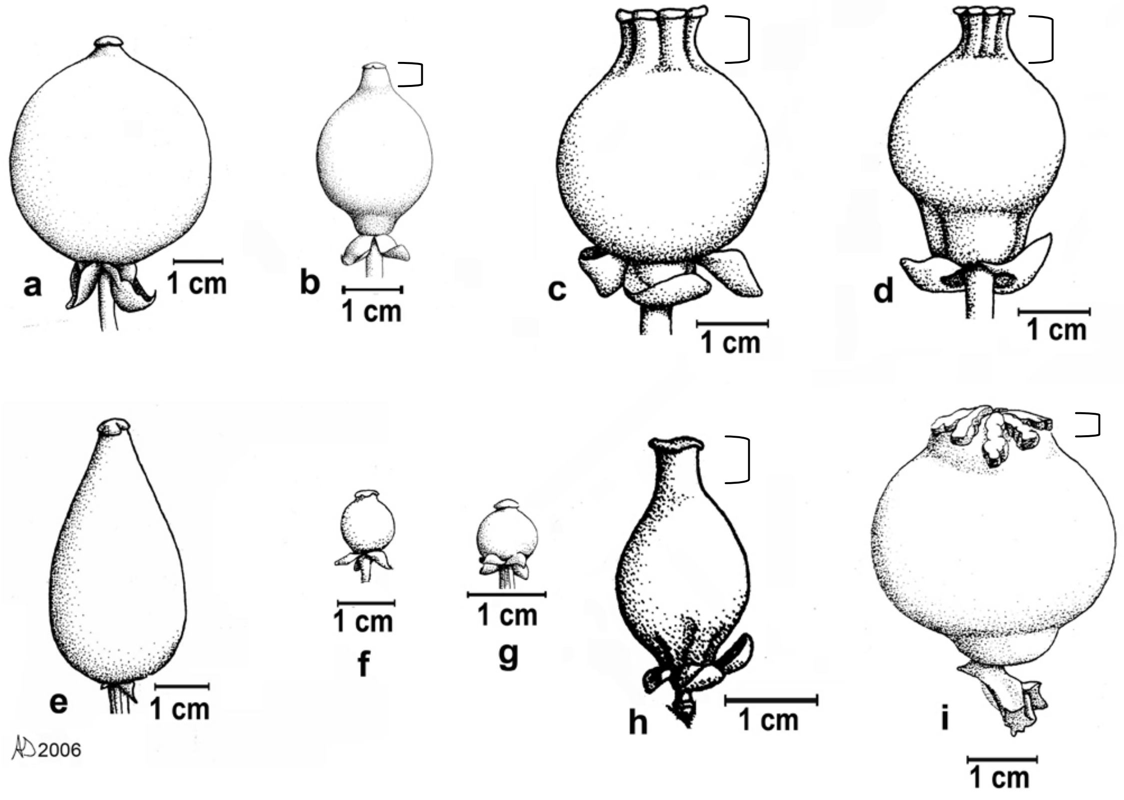


Figure 4.14. Variations of fruit, bars highlight elongation of stigma. — **a**. *Garcinia discoidea* Nazre (*Shamsul SA02-10,* E); **b**. *G. cataractalis* Whitmore (*Whitmore FRI 20350,* K); **c** & **d**. *G. celebica* L.(c: *Burkill HMB259*, SING; *Yahya SFN21419*, SING); **e**. *G. diospyrifolia* var. *diospyrifolia* (*Soegeng 47,* L)*;* **f**. *G. harmandii* Pierre (*Pierre 1371,* K); **g**. *G. exiguus* Nazre (*Chai S31750,* SAR); **h**. *G. nitida* Pierre (*Argent & Amiril 9318,* K); **i**. *G. malaccensis* var. *malaccensis* (*Whitmore FRI 8986,* L). Drawn by Anna Dorward.

4.5.4 Stigma

The persistent stigma of the fruit is an important character for species delimitation but can be used only in mature or nearly mature fruits. For instance, the young fruit of *G. celebica* strikingly resembles *G. sangudsangud* and *G. venulosa* with a fungiform cap shaped stigma. When mature the stigma of *G. celebica* is weakly or strongly raised with convex or concave surface and 4-8 weak lobes compared to the raised, unlobed stigma, with sunken or flattened surface in *G. sangudsangud,* and sessile stigma with 6-12 square shaped lobes in *G. venulosa.*

Whitmore (1973) considered the stigma on the fruit to be the next most important character after the male flowers for distinguishing species. There are three basic types of stigma in sect. *Garcinia*:

1) Distinctly lobed as in *G. mangostana, G. malaccensis, G. penangiana* and *G. venulosa* (Figure 4.15a – c).
2) Weakly lobed as in *G. acuticosta, G. cataractalis, G. celebica, G. diospyrifolia, G. discoidea, G. exiguus, G. moselleyana* and, *G. rigida* (Figure 4.15d – i).
3) Without lobes or with irregular crenate or wavy margin as in *G. harmandii, G. nitida, G. ochraceus* and *G. sangudsangud* (Figure 4.15j – m).

The number of lobes or bundles on the stigma always reflects the number of the locules and seeds. Occasionally the stigma is sessile as in *G. mangostana, G. malaccensis* var. *pseudomangostana* and *G. venulosa,* but it is commonly found raised (with neck) to 3 cm as in *G. celebica, G. cataractalis, G. diospyrifolia, G. malaccensis, G. nitida.* The overall shape of the stigma is either a skull-cap or discoid with flattened, convex or sunken surfaces. The colour of the stigma is always darker on the fruit than in the flower, and turns black when dry.

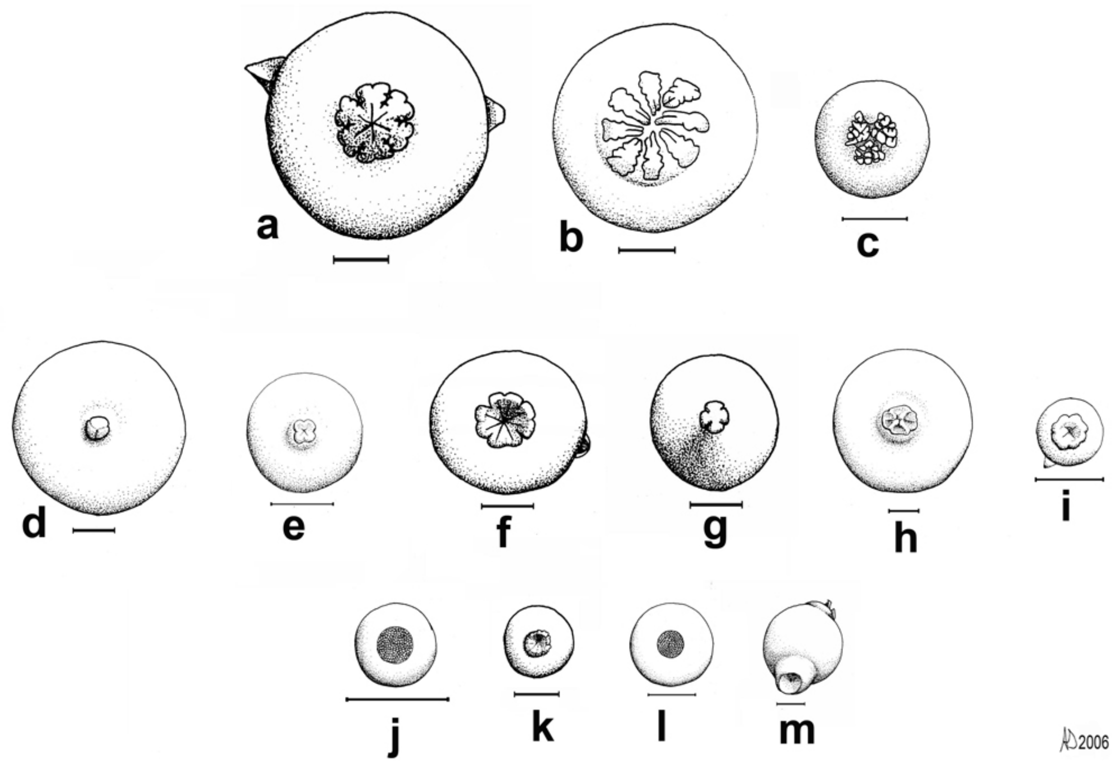


Figure 4.15. Variation of the fruit stigmas; distinctly lobed (a – c); weakly lobed (d – i); and without lobes (j – m). — **a**. *Garcinia mangostana* L. (*Sibat S23041*, L.); **b.** *G. malaccensis* var. *malaccensis* (*Whitmore FRI 8986,* L); **c.** *G. penangiana* Pierre (*Sinclair SFN 40794,* SING); **d.** *G. discoidea* Nazre (*Henderson 19654,* L); **e.** *G. cataractalis* Whitmore (*Whitmore FRI 20350,* K); **f.** *G. celebica* L. (*Burkill HMB259,* SING); **g.** *G. diospyrifolia* var. *diospyrifolia* (*Kochummen 77731,* L); **h.** *G. discoidea* Nazre (*Shamsul SA01-10,* E); **i.** *G. exiguus* Nazre (*Chai S31750,* SAR); **j.** *G. harmandii* Pierre (*Thorel 1018,* K); **k.** *G. nitida* Pierre (*Argent & Amiril 9318,* K); **l.** *G. ochraceus* Nazre (*Streimann & Martin 52890,* E); **m.** *G. sangudsangud* Nazre (*Muin Chai SAN 33449*, L). Scale bar = 1 cm. Drawn by Anna Dorward

4.5.5 Seed

Observation of seeds from herbarium specimens are limited as not all fruits were cut open. Seeds are axile, 2-8 per fruit, and one seed per locule. Each seed is enveloped by fleshy aril or endocarpic pulp (Ng, 1992) and in sect. *Garcinia* the colour of the aril is usually white.

CHAPTER 5
MOLECULAR SYSTEMATICS OF SECTION *GARCINIA*

5.1 Introduction

5.1.1 Classification of Section Garcinia sensu Jones

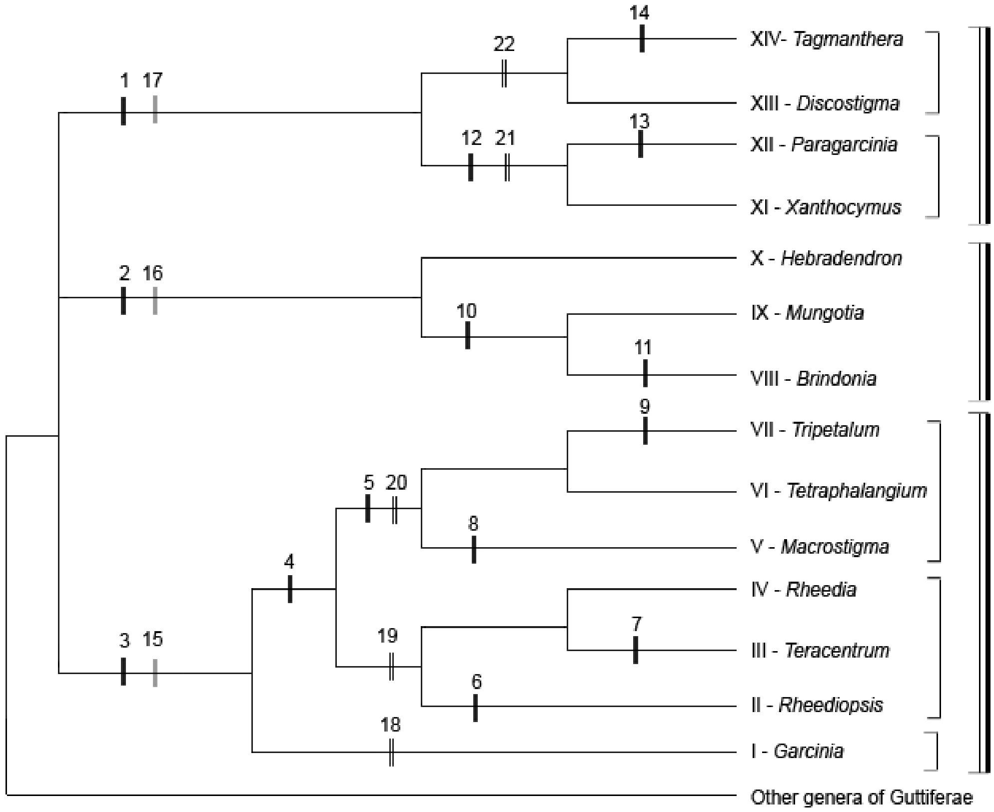
On evaluating the relationships of the sections in *Garcinia*, Jones (1980) proposed a hypothetical relationship based on morphology that is shown here in Figure 5.1, although she did not perform any formal cladistic analysis. Using anther characters, Jones first divided the representative species into three groups and further divided the groups into five subgroups based on stamen characters. These groups and subgroups were merely artificial and helped her to establish a sectional classification and they were not formally named.

The characters used to define the sectional classification are mainly taken from the male flowers. However, the over-reliance on these characters that this system adopted has lead to some complications in the determination of both sectional and species limits within the genus. For example, for sect. *Garcinia* the use of stamen bundles, inserted in the middle of male flowers will lead to the inclusion of more species found on the islands of Madagascar and Fiji but the inflorescence and fruit characters of these species are not consistent with those of other members of the section.

Section *Garcinia* sensu Jones (1980) consists of 43 species that are distributed mainly in Southeast Asia although a few species are found on the Madagascar and Fijian islands, and in the eastern part of India. Morphological characters that united the section were based on the stamens which were described as a central mass either in the form of four connecting bundles or not, surrounding a fungiform pistillode; the anther was 2-thecous (Jones 1980).

The circumscription of sect. *Garcinia* by Jones (1980) contains a large number of species but there are no single characters that are unique to the section and shared by all of the members that could be considered synapomorphies. It is clear that use of either male or female flowers alone does not lead to a satisfactory infra-generic or species-level classification.

Given the problems associated with classification based solely on morphology, it is possible that molecular data may provide the information needed to identify significant morphological characters that could better determine species and sectional limits. Molecular data, in particular, DNA sequences have been used extensively in taxonomic studies to infer phylogenetic relationships or for classification purposes.



| - Characters used for sectional classification

1 - venation: eucamptodromous ➡ reticulodromous
2 - stipule : present ➡ absent
3 - inflorescence : terminal triad ➡ solitary or thyrsoid
4 - sepals : 5 ➡ 4, 2, undivided calyx
5 - petals : 5 ➡ 6-8, 4, 0
6 - stamen : partially united in bundles ➡ completely united in bundles or annular mass, free
7 - stamen : free from petals ➡ adnate to petals
8 - stamen : bundles antepetalous ➡ bundles antesepalous
9 - pollen : colporate ➡ porate
10 - pollen : ornamentation reticulate ➡ ornamentation psilate, more complex
11 - pistillode : present ➡ absent
12 - fasciclodes : present ➡ absent
13 - staminodes : present ➡ absent
14 - ovary : number of locule equal to segment perianth ➡ locules greater, locules fewer

| - Characters used to divide groups

15 - anther : 2-thecous, ellipsoid, recurved, central connective
16 - anther : 4-thecous
17 - anther : 2-thecous, globose

‖ - Characters used to divide sub-groups

18 - stamen : united in 4-bundles or annular mass
19 - stamen : partially united in 4-bundles or free stamens
20 - stamen : united in bundles to the petals
21 - stamen : united in 2,4 strap-shaped bundles
22 - stamen : partially united in bundles

Figure 5.1. Hypothetical relationships of sections in *Garcinia* sensu Jones (1980). Tree originally drawn by Jones with some modification showing characters for her artificial groupings and subgroups. *Garcinia* was firstly divided into informal groups (characters 15-17) and subgroups (characters 18-22) then were divided to form sections (characters 1-14).

5.1.2 Molecular Studies of Garcinia

A key aim of this chapter is to use phylogenetic analysis of DNA sequence data to investigate the monophyly of sect. *Garcinia* and the relationships of its species. The application of molecular data for taxonomic purposes is perhaps best exemplified by the Angiosperm Phylogeny Group (APG, 2003). This group indicated that Guttiferae (Clusiaceae), the family to which *Garcinia* belongs, is placed in the order Malphigiales. Based on a phylogeny using *rbc*L sequences Guttiferae is paraphyletic if *Hypericum* is included (Gustafsson et al., 2002). *Hypericum* plus eight other genera was therefore split into its own family, Hypericaceae. The closest relatives of Guttiferae are the families Bonnetiaceae, Hypericaceae and Podostemaceae (APG, 2003). Plastid *rbc*L sequence data also indicate that the family Guttiferae consists of two subfamilies, Kielmeyeroideae and Clusioideae (Gustafsson et al., 2002). Gustafsson et al. (2002) placed *Garcinia* in the tribe Garcinieae that was placed in subfamily Clusioideae along with tribes Clusieae and Symphonieae.

Garcinia is placed in the tribe Garcinieae, but *Garcinia* is paraphyletic having *Rheedia* nested within it (Gustafsson et al., 2002). Gustafsson et al. (2002) also indicated that *Symphonia, Tripetalum, Pentaphalangium* and *Garcinia* formed a monophyletic group with moderate bootstrap support (67%). Greater sampling than that included in this study will be necessary to determine the monophyly of each of these genera.

Rismita-sari (2000) used internal transcribed spacer of ribosomal DNA (ITS) sequences to show that *Tripetalum, Pentaphalangium, Rheedia* were nested within

Garcinia. In her study, Jones's sectional classification was also evaluated indicating paraphyletic sects. *Brindonia* and *Xanthochymus,* while the rest of the sections including sect. *Garcinia* formed monophyletic groups. However, most of the species used in this study were of Indonesian and Australian origin and global sampling was therefore limited.

A regional approach for studying the phylogeny of *Garcinia* in tropical lowland forest of the Pasoh Forest Reserve and using 15 species sequenced for both the ITS and *trn*L-*trn*F regions indicated that five of Jones's (1980) sections (*Brindonia, Garcinia, Discostigma, Hebradendron* and *Xanthochymus*) formed a monophyletic group (Nazre, 2000). These sections represent the sections that are found in Peninsular Malaysia. Sect. *Garcinia* was shown to be closely related to sect. *Brindonia* while sect. *Xanthochymus* as in Rismita-Sari's (2000) studies is placed as sister to all other sections.

In contrast, ITS sequences of several species from Thailand, Malaysia and Indonesia (Yapwattanaphun et al., 2004) indicated that section *Garcinia* is a paraphyletic group because of the inclusion of *G. rostrata* and *G. sizygiifolia* (sect. *Discostigma* and sect. *Brindonia,* respectively, sensu Jones, 1980). The members of sect. *Garcinia* included by Yapwattanaphun et al. (2004) were *G. mangostana, G. malaccensis, G. speciosa* (a synonym of *G. celebica*) and *G. hombroniana* (also a synonym *G. celebica*). However, I believe that this outcome may be due to a misidentification. The text in this paper states that "the fruit of *G. rostrata* is quite similar to *G. hombroniana* except it is smaller and turns red when ripe" and no descriptions were given for *G. sizygiifolia*.

Morphologically, although the fruit of *G. rostrata* is smaller in size, (*c*. 1 cm across compared to *G. celebica* that is *c*. 4 cm across) the overall morphology for both species is distinctly different. For example the stigma of *G. rostrata* is small and discoid while with *G. celebica,* the stigma is raised or elongated and tipped with wavy lobes (Whitmore, 1973). The specimen identified as *G. rostrata* could therefore be *G. celebica* but no voucher specimens (for all species collected from BO in his study) were made by the authors and it is not possible to verify this. For *G. sizygiifolia,* there is also a possibility that this accession might be a misidentification of *G. rigida* due to the similarity of the sequence produced (98% similarity). Morphologically, *G. sizygiifolia* (sect. *Brindonia* sensu Jones) is distinctly different from *G. rigida* with the fruit nearly sessile, borne in axils, smaller in size at c. 1.5 cm long, and the stigma is sessile. The fruit of *G. rigida,* has a pedicel of 2.0 cm, is borne terminally, is c. 3.0 cm long and has a stigma raised to 3 mm long.

5.1.3 Hybridisation in Garcinia

Some species of *Garcinia* are believed to be of hybrid origin (Whitmore, 1973; Richards, 1990c). Evidence for this includes the capability of some *Garcinia* species to produce seed without fertilisation, a phenomenon defined as agamospermy (Gustafson, 1946-1947). Most agamosperms are highly heterozygous as hybrid species or hybrid derivatives (Grant, 1971), and at least ten wild species of *Garcinia* in Peninsular Malaysia are thought to be facultative agamosperms (Richards, 1990a). The most widely studied of these species is mangosteen, perhaps an obligate agamosperm only found in cultivation (Richards, 1990a). Richards (1990c) suggested that mangosteen was a hybrid between *G. hombroniana* (now reduced to synonymy under *G. celebica*) and *G. malaccensis* based on morphological and cytological evidence. The combination of nuclear and plastid DNA sequences should provide evidence of hybridisation if tree topologies based on sequences from these separate genomes are different. They may also allow us to determine the parents of hybrid species as shown by studies in the family Caricaceae (Kyndt et al., 2005).

5.1.4 Biogeography of Section Garcinia

Historically, the South East Asian (SEA) area was formed by processes beginning in the Palaeozoic and Mesozoic (540-65 million years ago) from assemblages of terranes that originated from the margins of Gondwana (Metcalfe, 1998). These processes culminated in the mid-Miocene collision of the Sunda and Sahul (Australian) shelves. Some authors (e.g. Morley, 2000) have suggested that massive plant dispersal events across the border between these two shelves followed this geological event. Wallace (1863) described a distinct biogeographical discontinuity that more or less matched this line that has become known as Wallace's Line (Figure 5.2). This was subsequently modified by Huxley (1868) . These biogeographical lines are indicated in Figure 5.2. Sect. *Garcinia* sensu Jones (1980) is distributed mainly in the SEA area on the west side of both Wallace's and Huxley's Lines. This is consistent with the section originating in the west. This assumption will be tested using molecular data. If the eastern species are nested within those from the west then this is evidence for origin in the west with recent migration to the east. Dating of the molecular phylogeny will also indicate the timing of dispersal across Wallace‘s line.

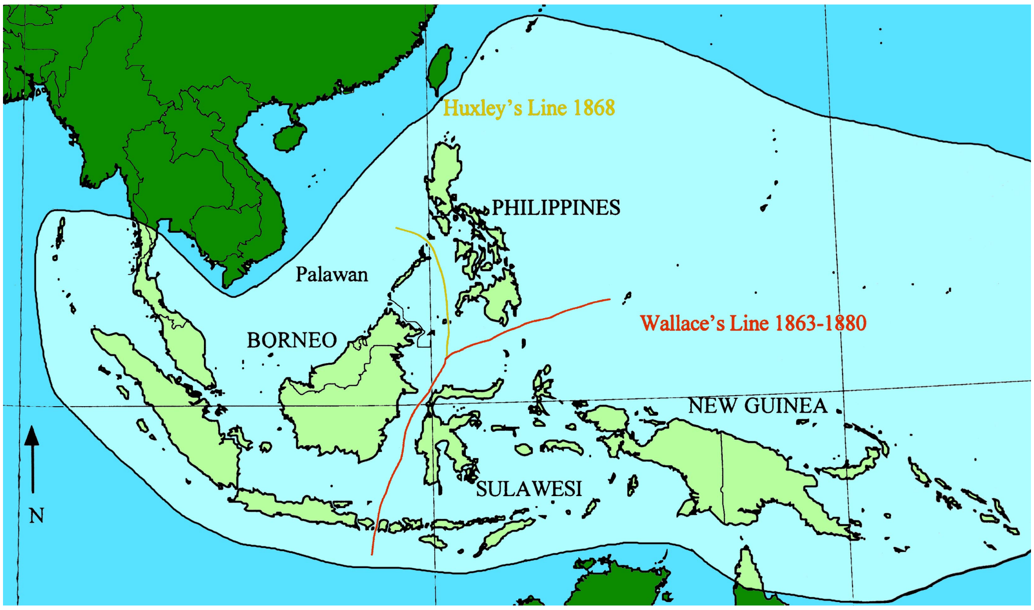


Figure 5.2 The position of Wallace's Line and Huxley's Line.

5.2 Objectives

The first objective of this study is to test the monophyly of section *Garcinia* sensu Jones (1980). For that purpose, any available *Garcinia* species including sequences already submitted to GENBANK will be included in the phylogenetic analysis. Secondly, molecular data will be used to study the relationships of species within sect. *Garcinia*. Thirdly, this study will include multiple accessions of some of the individual species that will allow to test whether the species delimited in previous chapters are distinct taxonomic entities. Finally, the aim of this study is to determine whether any species in section *Garcinia* might be of hybrid origin and elucidate the biogeographic history of the section.

5.3 Materials and Methods

5.3.1. Region Chosen

The internal transcribed spacer of nuclear ribosomal DNA (ITS) is one of the most widely used regions to infer phylogeny at low taxonomic ranks. The two internal transcribed spacers evolve more rapidly than coding regions and were suggested to have great potential for studies among closely related species (Baldwin et al., 1995). This region has been used in previous studies in *Garcinia* (Nazre, 2000; Rismita-Sari, 2000; Yapwattanaphun et al, 2004), that indicated that it was sufficiently variable to resolve relationships amongst species and ITS was therefore chosen for this study. The ITS region consists of two spacers, ITS1 and ITS2 flanked by the coding regions of 18S and 26S, with the 5.8S exon in the middle. The sequenced lengths of ITS regions for *Garcinia* are between 599-630 base pairs (bp) (Nazre, 2000; Rismita-Sari, 2000; Yapwattanaphun et al., 2004).

To corroborate any phylogenetic hypotheses based on a nuclear marker it is necessary to utilise other markers, preferably from another genome. Comparison of trees based on analysis of nuclear and plastid markers should also provide evidence for hybridisation as plastid markers are usually uniparentally inherited. Plastid DNA is maternally inherited, generally evolves at a slower rate compared to nuclear DNA (Palmer et al., 1998; Shaw et al., 2005). Two markers from non-coding regions of chloroplast DNA (cpDNA) were chosen, *trn*S-*trn*G and *trn*D-*trn*T. Both regions occur in the Large Single Copy (LSC) region of the chloroplast genome. Based on the *Nicotiana* chloroplast genome (Wakasugi et al., 1998), the *trn*S-*trn*G region is located within and between the *trnG* and *trnS* exons, and consists of the *trnG* intron and *trnS-trnG* spacer. The *trnG* intron has an average length of 763bp and ranges from 697-1000 bp, while the *trnS-trnG* spacer length averages 763 bp and ranges from 619-1035bp (Shaw et al., 2005). The *trnS-trnG* intergenic spacer was found by (Xu et al., 2000) to be the most informative cpDNA non-coding region within two closely related subgenera of *Glycine.* The *trnS-trnG* regions have been demonstrated to have phylogenetically informative variation even within species in *Corythophora* (Hamilton et al., 2003), *Moringa* (Olson, 2002) and *Lathyrus* (Kenicer et al., 2005). The *trnD-trnT* spacer is less widely used to infer phylogenetic relationships. However, significant variation has been observed in studies of *Allium* (Friesen et al., 2000) and Arecaceae (Hahn, 2002). The average length of the *trnD-trnT* intergenic spacer is 1066 bp, ranging from 578-1403 bp (Shaw et al., 2005).

5.3.2. Taxonomic Sampling

Sources of plant material and voucher information used in this study are listed in Appendix II and a summary of the number of taxa sequenced for each gene is shown in Table 5.1 below. In this study, a total of 83 accessions representing ten species of section *Garcinia* (13 species out of 43 species sensu Jones) were sequenced for ITS, plus 53 accessions representing 32 species of 8 other sections of *Garcinia*. However, the accessions and species numbers sequenced for *trn*S-G and *trn*D-T are fewer compared to the ITS region because of time constraints. A total of 51 and 25 accessions of *trn*S-G and *trn*D-T regions were sequenced, respectively, with nine representatives of sect. *Garcinia* (Table 5.1). In addition, 41 ITS sequences were taken from GenBank (see Appendix III for the complete list of all species) with only five species belong to sect. *Garcinia* from a total of 29 species. These additional GenBank sequences were sampled predominantly from other sections in *Garcinia* in order to test the monophyly of sect. *Garcinia*.

Table 5.1. Summary of the accession and sequence numbers used in this study.

	ITS	***trn*S-*trn*G**	***trn*D-*trn*T**
No. of accessions sequenced	83	50	24
No. of sect. *Garcinia* accessions sequenced	30	23	17
No. of species sequenced	42	30	16
No. of sect. *Garcinia* species sequenced	10	9	9
(species no. sensu Jones, 1980)	(13)	(12)	(9)
No. of accessions from GENBANK	41	-	-
No. of sect. *Garcinia* accessions from GENBANK	26	-	-
No. of species from GENBANK	29	-	-
No. of sect. *Garcinia* species from GENBANK	5	-	-
(species no. sensu Jones, 1980)	(6)		
Total no. of Accessions	124	51	25
Total no. of Species	58	30	17
Total no. of species in Sect. *Garcinia*	10	9	9

5.3.3. Outgroup Taxa

Another advantage of using ITS was the availability of sequences on GenBank that could be incorporated into the analysis and used as outgroups. Species of *Clusia* were used as the outgroup because previous studies indicated that this genus was related to *Garcinia*. The genus *Clusia* is neotropical with about 200 species, and grouped together with *Garcinia* and other genera within the subfamily Clusioideae (Stevens, 2001 onwards). Other close relatives of *Garcinia* such as *Rheedia, Symphonia* and *Tripetalum* were not deemed suitable because previous studies (Rismita-Sari, 2000) indicated that they were nested within *Garcinia*. The lack of availability of material of GenBank *trn*S-G or *trn*D-T sequences for *Clusia* or other close relatives of *Garcinia* meant that alternative outgroups had to be used for the analyses of the chloroplast data sets generated here. In these cases our main focus was to determine the monophyly of section *Garcinia* and we therefore sequenced species of *Garcinia* that were indicated to be basally divergent in the ITS phylogeny and used those as outgroups.

5.3.4. DNA Extraction

Approximately 1.0g of leaf tissue from silica gel dried or herbarium material was extracted using the CTAB (Cetyltriammonium bromide) extraction buffer following the protocol of Doyle & Doyle (1990). However, for herbarium specimens, during the isopropanol step, the precipitation period was increased up to 40 days at -20ºC because this has been shown to increase yield in other studies (e.g. Richardson et al 2000). In some cases, problematic samples with low yield or badly degraded DNA were also extracted using the Dneasy Plant Mini kit (QIAGEN, California USA) following the manufacturers protocol. Detailed steps on the protocol used for DNA extraction are found in Appendix IV. The quality and quantity of the DNA yielded was estimated by running it on a 1% agarose gel and comparing with a 1Kb+ DNA ladder (Invitrogen).

5.3.5. Amplification

PCR was performed either using a Perkin Elmer or MJ Research thermal cycler, with 30-35 amplification cycles (1 min. denaturation at 94^0 C, 1 min. annealing at $48\text{-}66^0$ C, 2 min. of extension at 72^0 C) in 25 µl volumes with the following reaction components: 1-2 µl template DNA (10-100ng), 2.5 µl 10x PCR buffer (Bioline Ltd.), 1.25 µl $MgCl_2$ (50mM), 2.5 µl dNTP 2mM (200 µM each dATP, dTTP, dGtp and dCTP), 1.5 µl primers (10 µM each) and 0.125 µl Taq Polymerase (Biotaq Ltd.). Reaction volume was adjusted to 25 µl by adding deionised water. The primers used to amplify each region are listed in Table 5.2 below.

The PCR products were checked on a 1% agarose gel for quality, while the remainder of the products were purified with either Qiaquick PCR purification kit (Qiagen Ltd.) or GFX PCR purification kit (Amersham Bioscience), following the manufacturer's instructions. To check the quality and quantity of the purified DNA template, a 1% agarose gel electrophoresis was again performed prior to sequencing.

Table 5.2 Primers used for amplification and sequencing.

Primer name	**Sequences**	**Annealing Temperature**
1. *trn*S-*trn*G (Shaw et al., 2005)	*trn*S AGAT AGGG ATTC GAAC CCTC GGT *trn*G GCGG GAAT CGAA CCCG CATC	48^0 - 66^0 C
2. *trn*T-*trn*D (Demesure et al., 1995; Shaw et al., 2005)	*trn*D ACC ATT TGA ACT ACA ATC CC *trn*T CTA CCA CTG AGT TAA AAG GG *trn*E AGG ACA TCT CTC TTT CAA GGA G *trn*Y CCG AGC TGG ATT TGA ACC A	48^0 C-55^0 C
3.ITS (White et al., 1990)	ITS2 GCAT CGAT GAAG AACG TAGC ITS3 GCTA CGTT CTTC ATCG ATGC ITS4 TCCT CCGC TTAT TGAT ATGC ITS5 GGAA GTAA AAGT CGTA ACAA GG	48^0 C

5.3.6. Sequencing

Cycle sequencing was performed with the CEQ™ Dye terminator Cycle Sequencing (DTCS) Quick Start Kit (Beckman Coulter Inc., USA). Each sequence reaction contains 10 µl volume of DTCS Quickstart mix (4 µl), 10pM primer (1 µl), purified DNA template (0.5-5 µl) and deionised water (0.5-5 µl). The thermal cycle parameters were 35 cycles of 96^0C denaturation (20 sec.), 50^0C annealing (20 sec.) and 60^0C extension (4 min.).

The cycle sequencing products were then cleaned using an Ethanol clean up procedure (see Appendix IV) before electrophoresis and analysis on the CEQ™ 8000 Genetic Analysis System (Beckman Coulter Inc., USA).

5.3.7. Sequence Alignment

Raw sequence data were analysed individually by CEQ Sequence Analysis (Beckman Coulter Inc., USA), assembled for both forward and reverse sequences to produce contig files in Sequencher™ (Genecode, USA) that were checked and corrected manually. Sequences were then exported to BIOEDIT Ver. 7.0.2 (Hall, 1999), and aligned using CLUSTAL X (Thompson et al., 1997). Sequence alignments were then refined and checked manually using BIOEDIT.

Gaps in the aligned sequences of cpDNA, were coded using GAPCODER (Young & Healy, 2003) using the simple indel coding method described by Simmons and Ochoterena (2000) in which gaps are coded as present or absent. Complete aligned sequences with indel coded site/regions are presented in Appendix VI and VII. Ambiguous and microsatellite regions which are too difficult to align were excluded from the analysis and are also indicated in Appendix VI and VII. Output of the NEXUS file from GAPCODER was incorporated into the sequence matrices and used for analysis in PAUP and MRBAYES (see below). Three different datasets were prepared for the analyses; 1) ITS, 2) *trn*S-*trn*G, 3) combined *trn*S-G and *trn*D-T (combining the two plastid sequence data sets can be justified because as chloroplast regions they are part of the same non-recombining molecule).

5.3.8. Phylogenetic Analysis

5.3.8.1. Choice of Methods for Phylogenetic Inference

For any given set of aligned DNA sequences there may be a number of possible phylogenetic tree topologies. Optimality criterion approaches put a score on every possible tree, and then select the tree(s) with the best score; the parsimony criterion is based on tree-length (minimizing the total number of substitutions through the tree) and the likelihood criterion is based on a model of DNA sequence evolution. In a parsimony analysis, ideally all possible trees generated from the alignment will be assessed to determine the shortest (most parsimonious) one. However, since the number of trees generated increases exponentially with the addition of each new sequence, a large dataset (c. >20 sequences) will make it computationally impossible to assess every tree. Heuristic search strategies are therefore employed to reduce the number of trees that need to be assessed. The search strategy employed here is described in section 5.2.9.2 below. Parsimony is straightforward to understand and efficient in the sense of computational time. Maximum likelihood is an optimality criterion that determines the likelihood of a data set given a tree and a model of molecular evolution. If given some data, D, and a hypothesis H, the likelihood of that data is given by:

$$\mathrm{L}D = \mathrm{Pr}(D|H)$$

which is the probability of obtaining D, given H. In the context of molecular phylogenetics D is the set of sequences being compared and H is a phylogenetic tree. The idea is not to estimate the phylogeny but to estimate the likelihood of observing the data *D* under certain specified conditions. Those conditions are a particular tree topology and a particular model of character evolution. The tree that makes our data the most probable evolutionary outcome is the maximum likelihood estimate of the phylogeny. Maximum likelihood searches are more complex than parsimony searches as they are model-based and consequently take a great deal more computer time. However alternative model-based approaches can be used to estimate phylogeny, as is done in the analyses presented in this chapter.

Bayes theory determines the probability of an evolutionary tree based on the sequence data. The analysis starts with a loose assumption or prior expectation about the tree topology, branch length and the evolutionary model used to assume the correct tree. By examining the alignment, it then improves the confidence of the tree topology (clades) by calculating the confidence or posterior probabilities using Bayes formula. However, to calculate the probability of every tree topology (clades) with every model is computationally impossible and a sampling method called Metropolis coupled Markov chain Monte Carlo (MCMC) is used where the aim is to efficiently search tree space for the most likely trees. The Markov chain starts the searches at a random tree and evolutionary parameters, and calculates the probability (likelihood). It then proposes a new state with modification of one of the parameters (either topology, branch length or evolutionary model), re-calculates the probability of the new state and either accepts or rejects it. Usually four chains are run at a time. Each chain event is called a generation and several thousands to millions of generations are run. Of the four chains, the chains that sample the trees are called the 'cold' chain and the rest are 'heated' chains. The heated chains more readily allow swapping of states. This strategy increases the chances of finding the globally optimal tree without getting stuck in one particular (locally optimal) tree space area.

An advantage of Bayesian Analysis over maximum likelihood is that it can partition data sets and determine different models of evolution for each one, i.e. data sets that contain two markers that might have different patterns of molecular evolution can be analysed under different models simultaneously. In terms of computing times, Bayesian analyses are also more efficient than a maximum likelihood approach. Other advantages include the fact that the analyses are more explicit by using all available parameters, confidence values of each clade are given with posterior probabilities, and the results are probability values of the sampled trees and evolutionary models (rather than single probability of the evolutionary model as in Maximum Likelihood). For all of these reasons I chose to use Bayesian analyses in addition to the parsimony analyses for this study.

5.3.8.2. Maximum Parsimony

Analyses to find the most parsimonious trees were run using PAUP* Ver. 4.0b10 for Windows using 'Heuristic' methods under the Fitch (1971) parsimony criterion where character state changes were weighted equally and unordered. Character state change is optimised with accelerated transformation (ACCTRAN; (Swofford & Olsen, 1990) where the changes occur as early in relation to the root as possible.

Two rounds of heuristic searches were performed. The first search involves multiple replicates each of which has two stages: (i) the initial tree is obtained by connecting the taxa one at a time using stepwise addition and additional taxa are added in random order; (ii) to search for more parsimonious trees, branches were swapped using tree bisection reconnection (TBR). Only 10 shortest trees per replicate found during the swapping steps were saved to avoid searching for too long on suboptimal islands. All the shortest trees from 10, 000 replicates will be saved and used for a second round of searches. The second round of heuristic search starts with the shortest trees that were obtained from the first search. These trees were branch-swapped to completion or swapped on until 10, 000 trees were produced, at which point the number of trees was limited and these were swapped to completion. To evaluate the confidence values of the clades, ten thousand replicates of the bootstrap (Felsenstein, 1985) were then carried out with simple addition of sequences, TBR branch swapping and holding five trees at each replicate. All trees produced from the parsimony search were visualised using TreeView 1.6.6 (Page, 1996).

5.3.8.3. Bayesian Analysis

Bayesian analyses were performed using MRBAYES ver. 3.1.1 software for Windows (Ronquist & Huelsenbeck, 2003). A prior probability of the simplest model to fit the aligned sequence data was estimated by MrModeltest 2.2 (Nylander, 2004) using the Hierarchical Likelihood Ratio Test (hLRT). Each sample was run for a minimum of three million generations and four Markov chains running simultaneously. Running was stopped as data converged on the stationary distributions, assessed by viewing when the average standard deviation of split frequencies reaches less than 0.01 (Ronquist et al., MrBayes Manual ver. 3.1). The phylogenetic trees produced from Bayesian Inference were summarised by calculating the 50% majority-rule consensus tree after excluding the 'burn-in' trees. The burn-in trees were estimated by plotting (plot command) the 'lnlikelihood' against number of generations. The posterior probabilities produced are used as an estimation of the degree of robustness for the clades. In the combined Bayesian analysis each gene was treated as a separate partition.

5.3.9. Incongruence Length Difference Test

Two plastid DNA datasets (*trn*S-G, combined *trn*S-G and *trn*D-T) were compared against the ITS dataset using the incongruence length difference (ILD) test (Farris et al., 1994) to determine whether these datasets were incongruent. The ILD test compares the number of steps required for minimum-length trees in separate, combined and random partitions of the data (Cunningham, 1997). The ILD test is performed in PAUP Ver. 4.0 (Swofford, 2003) using the Partition Homogeneity Test between 60 accessions of ITS against *trnS-G* sequences, and 32 accessions of ITS and cpDNA (*trnS-G* and *trnD-T*) sequences.

5.3.10. Age Estimation

The ITS sequence data was used to determine age estimates for nodes within the ITS trees. Rate heterogeneity among lineages was first evaluated using the likelihood ratio test, which compares log likelihoods of both constrained and unconstrained hypotheses on one of the trees from the parsimony analysis. The molecular clock was rejected because the constrained and unconstrained analyses were significantly different, so Sanderson's methods of nonparametric rate smoothing (NPRS; Sanderson, 1997) was applied to estimate divergence times using the software package r8s (Sanderson, 2003). The standard deviation for the NPRS derived dates was also estimated by keeping the tree fixed and bootstrapping the data set 100 times using PAUP. The resulting trees were then processed in r8s to calculate the standard deviation of divergence times for selected nodes. A 90 MY fossil, *Paleoclusia,* described by Crepet and Nixon (1998) from the Late Turonian was used to constrain the age of the node representing the split (most recent common ancestor) between *Clusia* and *Garcinia* as it is morphologically similar to both of these genera, and the estimated date for the crown of *Garcinia* and nodes within sect. *Garcinia* were calculated. Of particular interest would be any node representing the most recent common ancestor of species found to the east of Wallace's Line.

An additional, though somewhat crude approach to dating involves application of rates determined from other taxa, an approach used by Richardson et al. (2001a). Using the program DNAsp 4.0 (Rozas & Rozas, 1999), the mean number of substitutions in the ITS tree from tip to root within the *Garcinia* clade were calculated. The mean was divided with the published substitution rates (number of substitution per site per year) cited in Richardson et al. (2001a) to yield estimated dates for the crown node of *Garcinia.*

5.4 Results

5.4.1 ITS data

The aligned ITS sequence data contains 240 (39%) informative characters out of 615 characters used. Only a small number of indels are created to accommodate length differences between taxa. The largest was a nine base pair insertion found in *Symphonia globulifera* at position 470 to 479 (see Appendix V). Table 5.2 summarises sequence information, analysis parameters and tree characteristics from the Maximum Parsimony and Bayesian Inference analyses.

In the maximum parsimony (MP) analysis, the first round of heuristic searches produced 85 most parsimonious trees and the second round resulted in more than 10, 000 most parsimonious trees. Figure 5.3 shows one of 10,000 trees with a tree length of 998 steps, CI=0.50, RI=0.88 and HI=0.51.

The Bayesian inference analysis (BI) of the ITS dataset produced a fifty percent majority rule consensus tree (Figure 5.4) that was almost the same as the strict consensus tree from the parsimony analysis. The main difference is in the placement of clades **D** and **E**, where in MP these form a clade that is the sister group of clade **A**, **B** and **C** but in BI, clade **D** is sister to a clade consisting of clade **A**, **B**, **C**, **F** and **G** while clade **E** is sister to the clade consisting of groups **A**, **B**, **C**, **D**, **F** and **G**. BI also exhibits higher probabilities than the bootstrap support values obtained with MP, a common phenomenon as described by Huelsenbeck et al. (2002). However, these are two entirely different measures of support and are therefore not directly comparable.

Table 5.3. Summary of sequence information, analysis parameters and tree characteristics from Maximum Parsimony and Bayesian Inference analyses. CI = Consistency Index, RC = Rescaled Consistency Index, HI = Homoplasy Index, RI = Retention Index, hLRT = Hierarchical Likelihood Ratio Test, GTR+I+G = General Time Reversible with Invariant sites Estimated and a Gamma distribution of rates, HKY +G= Hasegawa, Kishino & Yano and a Gamma distribution of rates.

	ITS	***trn*S-G**	***trn*D-T**	***trn*S-G + *trn*D-T**
No of Taxa	128	50	24	24
No. of Characters	615	1253	1325	2667
No. of Gap Coded Characters	-	53	30	58
G+C Contents (%)	51.34	23.5	32.75	-
Maximum Parsimony				
No. of Informative Characters	240	109	-	149
Tree Length	998	481	-	491
CI(RC)	0.50(0.44)	0.83(0.79)	-	0.88(0.70)
HI(RI)	0.51(0.88)	0.18 (0.79)	-	0.12(0.80)
Bayesian Analysis				
Prior Prob. of Best Suit Model (hLRTs)	GTR+I+G	HKY+G	HKY+G	-
Gamma Distribution (mean) [alpha]	0.19	0.92	0.43	-
Proportion of Invariable Sites [pinvar]	0.017	0.14	0.63	-
Base State frequency (mean):				-
pi (A)	0.24	0.38	0.34	-
pi (C)	0.23	0.11	0.16	-
pi (G)	0.25	0.14	0.16	-
pi (T)	0.29	0.37	0.35	-
Substitution Rate:				-
R [G-T]	0.07	0.14	0.14	-
R [C-T]	0.38	0.25	0.19	-
R [C-G]	0.06	0.14	0.12	-
R [A-T]	0.09	0.11	0.14	-
R [A-G]	0.28	0.16	0.27	-
R [A-C]	0.11	0.20	0.24	-

Sect. *Garcinia* sensu Jones (1980) is paraphyletic with most of the species in clade **A** and the rest in clade **G**, with 100 and 79 percent bootstraps values (BV), and with 100 and 96 percent posterior probabilities (PP), respectively. In this study, only species in clade **A** are considered to belong to sect. *Garcinia* (more discussion of this clade can be found in section *5.5.3*). In both the MP and Bayesian analyses some moderately to strongly supported monophyletic clades were consistent with Jones's (1980) sectional classification.

Clade **A** is a highly supported group, with 100% bootstrap values (BV) and posterior probabilities (PP). In the parsimony analysis, *G. echinocarpa* is sister to the clade and in the Bayesian analysis it is unresolved in a polytomy with clades **A**, **B** and **C**, **D**, **F** and **G** and its relationship to other clades is therefore not clear. According to Jones (1980), *G. echinocarpa* belongs to sect. *Brindonia* (clade **F**), but she acknowledged the morphological differences from other species of sect. *Brindonia* by its scaly-walled fruits and *G. echinocarpa* is also the only species from sect. *Brindonia* found endemic in Sri Lanka while the rest of the species in sect. *Brindonia,* are found from India to New Guinea.

Clade **B** is moderately supported (75% BV, 95% PP) and consists of *G. urophylla* and related species confirming that Jones (1980) sect. *Hebradendron* is a natural group with distinct free or united stamens in a column. Both analyses of MP and PP show a close relationship (100% supported BV and PP) with clade **C.** Clade **C** resolved by BI is consistent with Jones, (1980) definition of sect. *Macrostigma* and contains two sub-clades. The first sub-clade (76% BV and 99% PP) consists of *G. latissima* and related species from the east of Wallace's lines in Sulawesi, Maluku and Papua, and the second sub-clade (100% BV and PP) contains species (*G. sp. M6*) from the western side of Wallace's line in Peninsular Malaysia. These two sub-clades are not monophyletic in the MP strict consensus tree but BI analysis moderately supported (76%) their unification into sect. *Macrostigma* sensu Jones (1980). However, the inclusion of *G. sp. M6* in sect. *Macrostigma* merits further investigation.

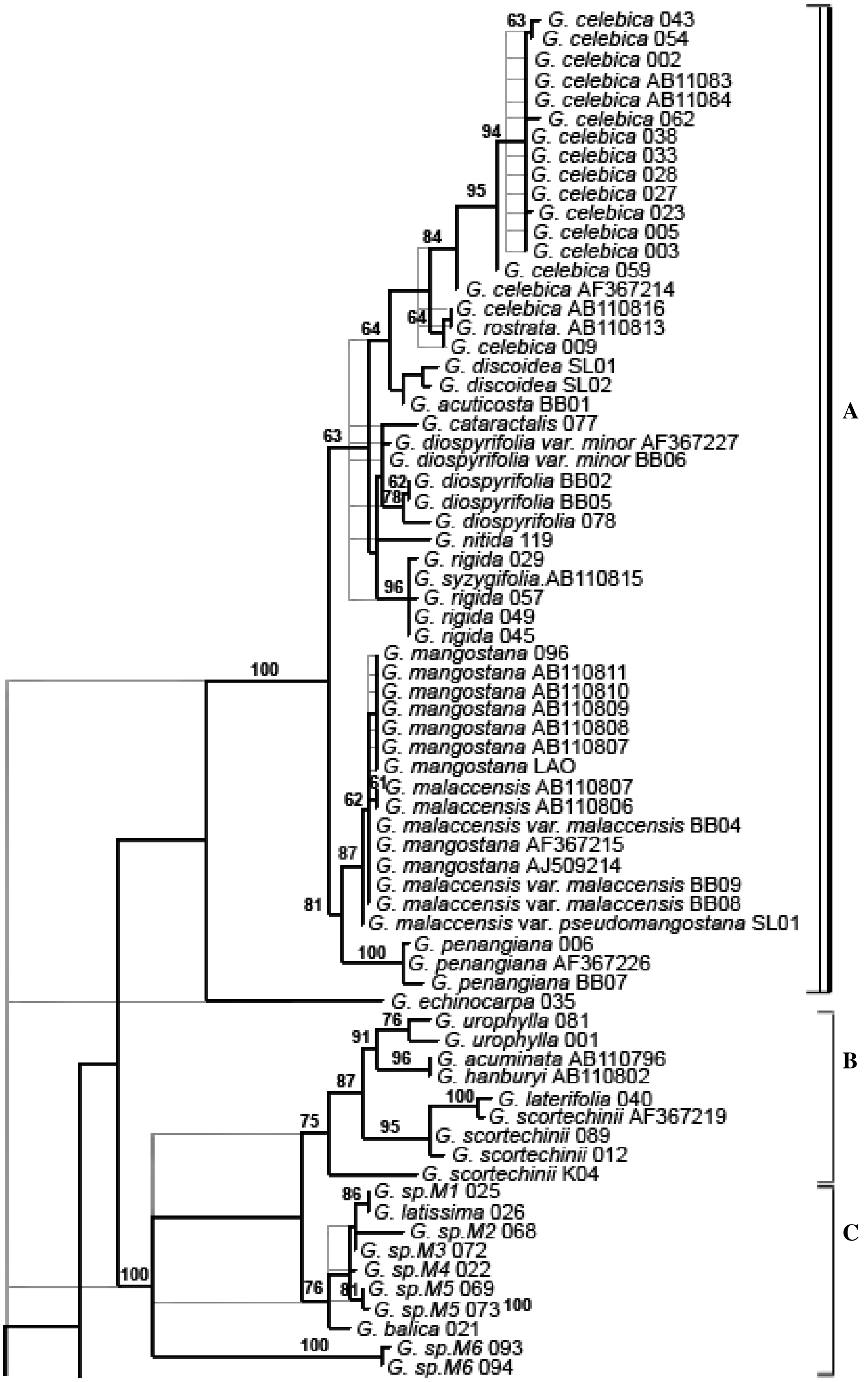
Clade **D** is a monophyletic group corresponding to sect. *Discostigma* sensu Jones (1980), and is highly supported by MP analysis (90% BV) and BI (100% PP). Clade **E** however, consists of species from various sections (sensu Jones) and is only moderately supported (91% PP with less than 60% bootstrap support). Jones (1980) placed *G. cymosa* (*Tripetalum cymosum*) in sect. *Tripetalum, G. prainiana* in sect. *Xanthochymus* and *G. picrorhiza* in sect. *Discostigma.* There is a possibility that there was an error in the last two species identifications as both rely on secondary data and sterile herbarium specimens that are difficult to identify. If these two species are incorrectly identified and omitted from the analysis, this clade would correspond to sect. *Tripetalum* sensu Jones (1980).

Clade **F** is consistent with sect. *Brindonia* sensu Jones (1980), and is significantly supported (93% BV and 100% PP) and is one of the biggest sections in *Garcinia* with 77 species distributed mainly in Southeast Asia. However, within the clade, the identification of *G. porrecta* (GenBank accession AB110812, Yapwattanaphun et al. 2004) is dubious as the name has been used illegitimately for *Garcinia celebica* in Bogor Botanic Garden (BO), Java. This material was collected from the same locality as my own collection (tree number VI.A.4 from BO) but no herbarium voucher is available. The collections from BO have two different species labelled as *G. porrecta* (accession no 062) and *G. porrecta* var. *schizogyna* (accession no 049 and 057) and were identified in this study as *G. celebica* and *G. rigida,* respectively, and both species are placed in clade **A**, i.e. sect. *Garcinia* here.

Clade **G** receives 79% BV and 96% PP and consists of species such as *G. maingayi* which were regarded by Jones (1980) as members of sect. *Garcinia* but are indicated here to be a sister clade of sect. *Brindonia* (clade **F**) with moderate to strong support (66 % BV, 98% PP). Clade **G** and clade **F** **(**sect. *Brindonia*) share similar morphology with segmented fruits.

Clade **H** is a strongly supported group (99% BV, 100% PP) where most of the species belong to sect. *Xanthochymus* sensu Jones (1980). However, as in clade **F**, there are some issues regarding the identification of species whose sequences were obtained from GENBANK. For instance, *G. costata* and *Tripetalum cymosum* (*G. cymosa*) will need verification in order to confirm placement of these two species in this clade. This is because accessions with the same identification were positioned in clades **E** and **G**, respectively. In addition, the placement of accessions of *G. megaphylla* (one in clade **H** and the other in clade **I**) within two different clades also needs to be studied further by verifying the identity of the voucher specimens.

The most basally divergent clade **I**, a highly supported group (100% BV and PP) consists mainly of members of sect. *Rheedia* sensu Jones (1980), represented by mostly South American species. Within this, there is a further possibility of misidentification for *G. latissima* (placed in sect. *Tripetalum* by Jones). Another problematic clade is that of *Symphonia*, here represented by *Symphonia globulifera.* This species is placed as sister to clade **H** in MP (with no support) but in the BI analysis, the clade is indicated, with low PP, as sister to a clade consisting of clades **A** to **G**. The nesting of both *Symphonia globulifera* and *Tripetalum cymosum* within *Garcinia* is well supported in all analyses of ITS data.


G. celebica 043
G. celebica 054
G. celebica 002
G. celebica AB11083
G. celebica AB11084
G. celebica 062
G. celebica 038
G. celebica 033
G. celebica 028
G. celebica 027
G. celebica 023
G. celebica 005
G. celebica 003
G. celebica 059
G. celebica AF367214
G. celebica AB110816
G. rostrata. AB110813
G. celebica 009
G. discoidea SL01
G. discoidea SL02
G. acuticosta BB01
G. cataractalis 077
G. diospyrifolia var. minor AF367227
G. diospyrifolia var. minor BB06
G. diospyrifolia BB02
G. diospyrifolia BB05
G. diospyrifolia 078
G. nitida 119
G. rigida 029
G. syzygifolia.AB110815
G. rigida 057
G. rigida 049
G. rigida 045
G. mangostana 096
G. mangostana AB110811
G. mangostana AB110810
G. mangostana AB110809
G. mangostana AB110808
G. mangostana AB110807
G. mangostana LAO
G. malaccensis AB110807
G. malaccensis AB110806
G. malaccensis var. malaccensis BB04
G. mangostana AF367215
G. mangostana AJ509214
G. malaccensis var. malaccensis BB09
G. malaccensis var. malaccensis BB08
G. malaccensis var. pseudomangostana SL01
G. penangiana 006
G. penangiana AF367226
G. penangiana BB07
G. echinocarpa 035
G. urophylla 081
G. urophylla 001
G. acuminata AB110796
G. hanburyi AB110802
G. laterifolia 040
G. scortechinii AF367219
G. scortechinii 089
G. scortechinii 012
G. scortechinii K04
G. sp.M1 025
G. latissima 026
G. sp.M2 068
G. sp.M3 072
G. sp.M4 022
G. sp.M5 069
G. sp.M5 073
G. balica 021
G. sp.M6 093
G. sp.M6 094
63
94
95
84
64
64
63
62
78
96
100
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76
100
100
A
B
C

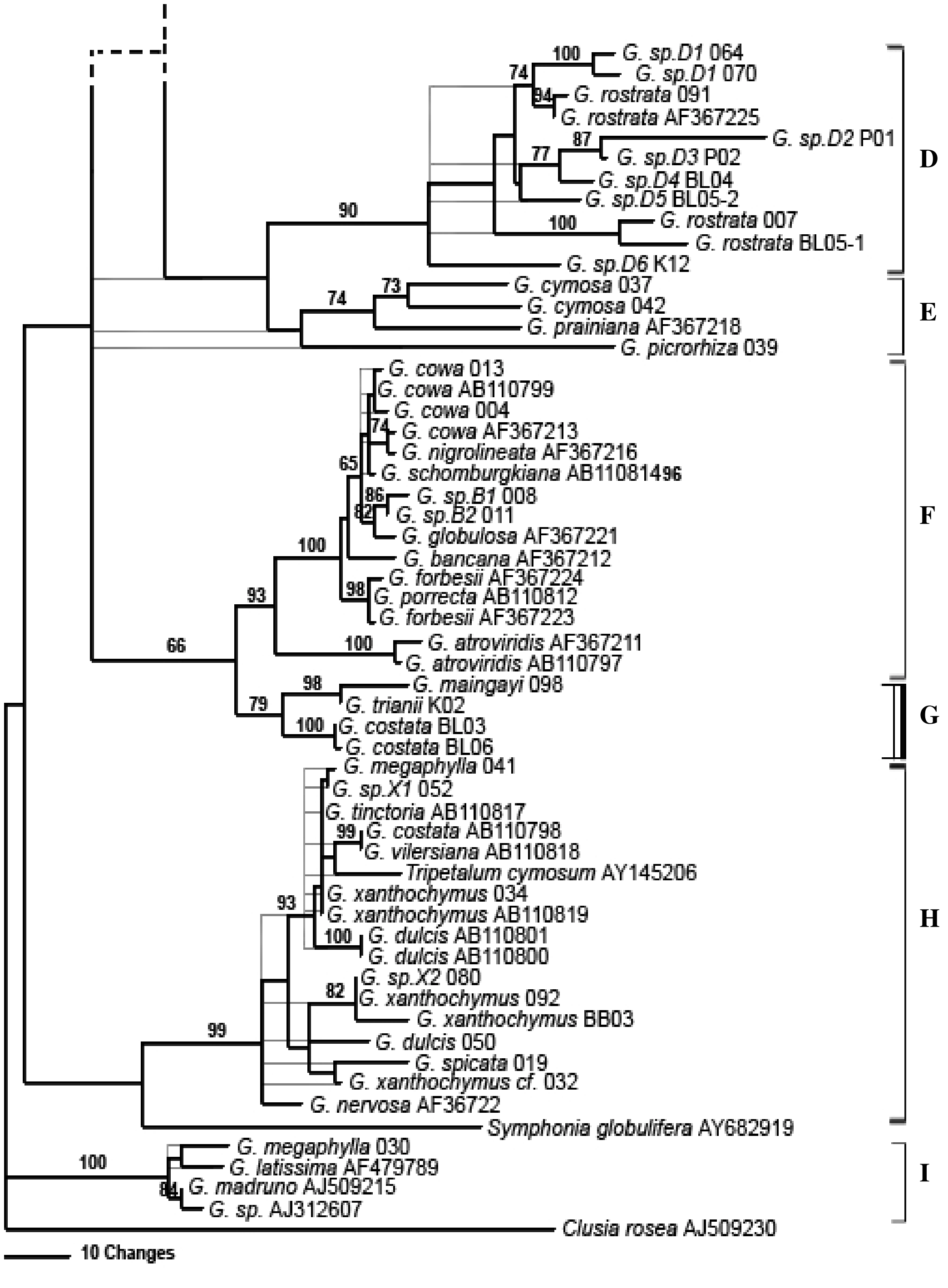
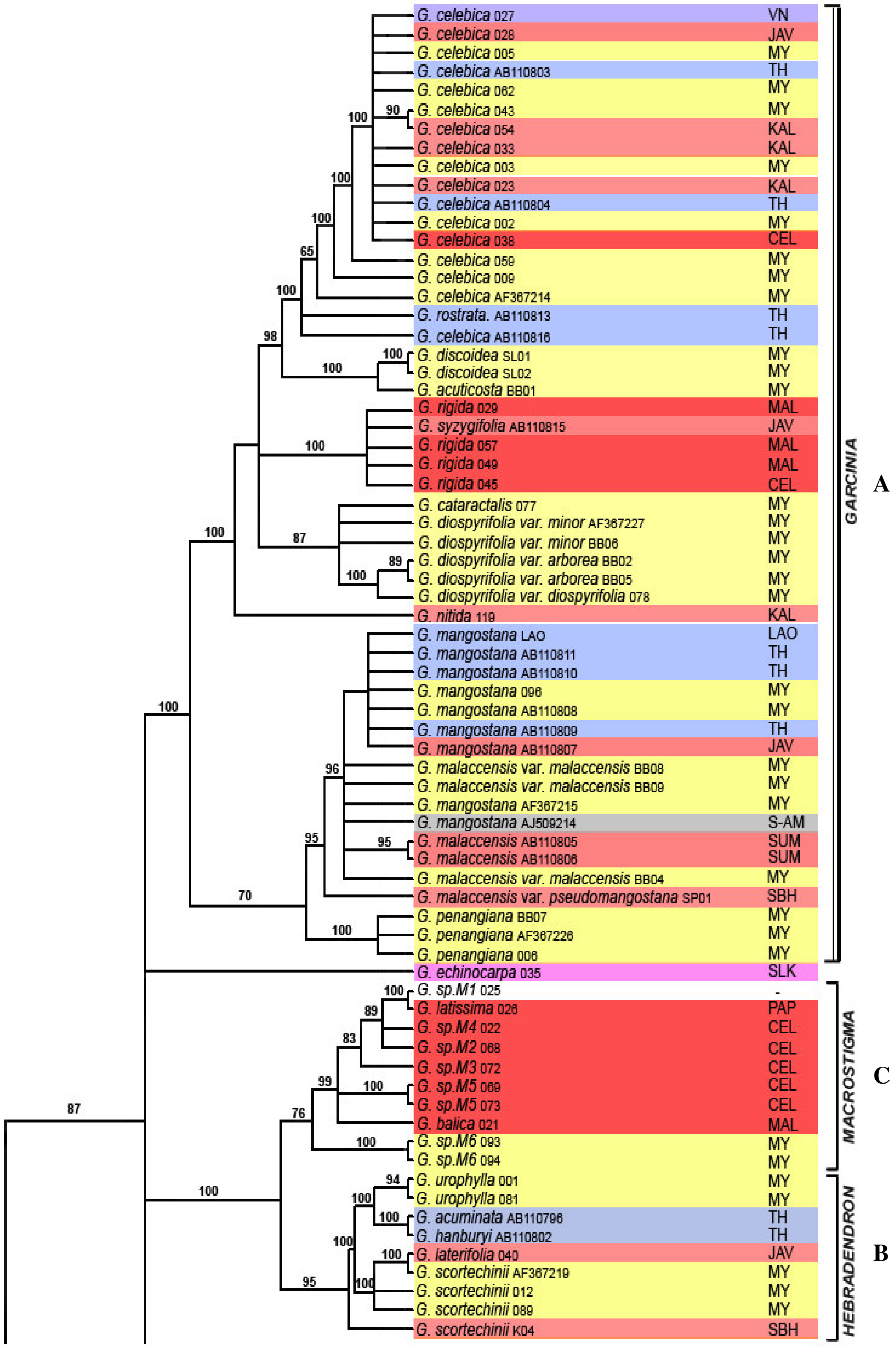


Figure 5.3. One of 10, 000 most parsimonious trees from the analysis of the ITS data. Numbers above branches indicate bootstrap values (shown for values above 60% only). The grey branches indicate the topology of the strict consensus tree. Tree length = 998 steps, CI = 0.50, RI = 0.88 and HI = 0.51. The double lined bars indicate taxa that were placed in section *Garcinia* sensu Jones (1980).


G. celebica 027 VN
G. celebica 028 JAV
G. celebica 005 MY
G. celebica AB110803 TH
G. celebica 062 MY
G. celebica 043 MY
G. celebica 054 KAL
G. celebica 033 KAL
G. celebica 003 MY
G. celebica 023 KAL
G. celebica AB110804 TH
G. celebica 002 MY
G. celebica 038 CEL
G. celebica 059 MY
G. celebica 009 MY
G. celebica AF367214 MY
G. rostrata. AB110813 TH
G. celebica AB110816 TH
G. discoidea SL01 MY
G. discoidea SL02 MY
G. acuticosta BB01 MY
G. rigida 029 MAL
G. syzygifolia AB110815 JAV
G. rigida 057 MAL
G. rigida 049 MAL
G. rigida 045 CEL
G. cataractalis 077 MY
G. diospyrifolia var. minor AF367227 MY
G. diospyrifolia var. minor BB06 MY
G. diospyrifolia var. arborea BB02 MY
G. diospyrifolia var. arborea BB05 MY
G. diospyrifolia var. diospyrifolia 078 MY
G. nitida 119 KAL
G. mangostana LAO LAO
G. mangostana AB110811 TH
G. mangostana AB110810 TH
G. mangostana 096 MY
G. mangostana AB110808 MY
G. mangostana AB110809 TH
G. mangostana AB110807 JAV
G. malaccensis var. malaccensis BB08 MY
G. malaccensis var. malaccensis BB09 MY
G. mangostana AF367215 MY
G. mangostana AJ509214 S-AM
G. malaccensis AB110805 SUM
G. malaccensis AB110806 SUM
G. malaccensis var. malaccensis BB04 MY
G. malaccensis var. pseudomangostana SP01 SBH
G. penangiana BB07 MY
G. penangiana AF367226 MY
G. penangiana 006 MY
G. echinocarpa 035 SLK
G. sp.M1 025 -
G. latissima 026 PAP
G. sp.M4 022 CEL
G. sp.M2 068 CEL
G. sp.M3 072 CEL
G. sp.M5 069 CEL
G. sp.M5 073 CEL
G. balica 021 MAL
G. sp.M6 093 MY
G. sp.M6 094 MY
G. urophylla 001 MY
G. urophylla 081 MY
G. acuminata AB110796 TH
G. hanburyi AB110802 TH
G. laterifolia 040 JAV
G. scortechinii AF367219 MY
G. scortechinii 012 MY
G. scortechinii 089 MY
G. scortechinii K04 SBH
90
100
100
100
65
100
98
100
100
100
100
87
89
100
100
100
96
95
95
70
100
100
89
83
99
100
76
100
100
94
100
100
100
100
100
95
87
GARCINIA
A
MACROSTIGMA
C
HEBRADENDRON
B

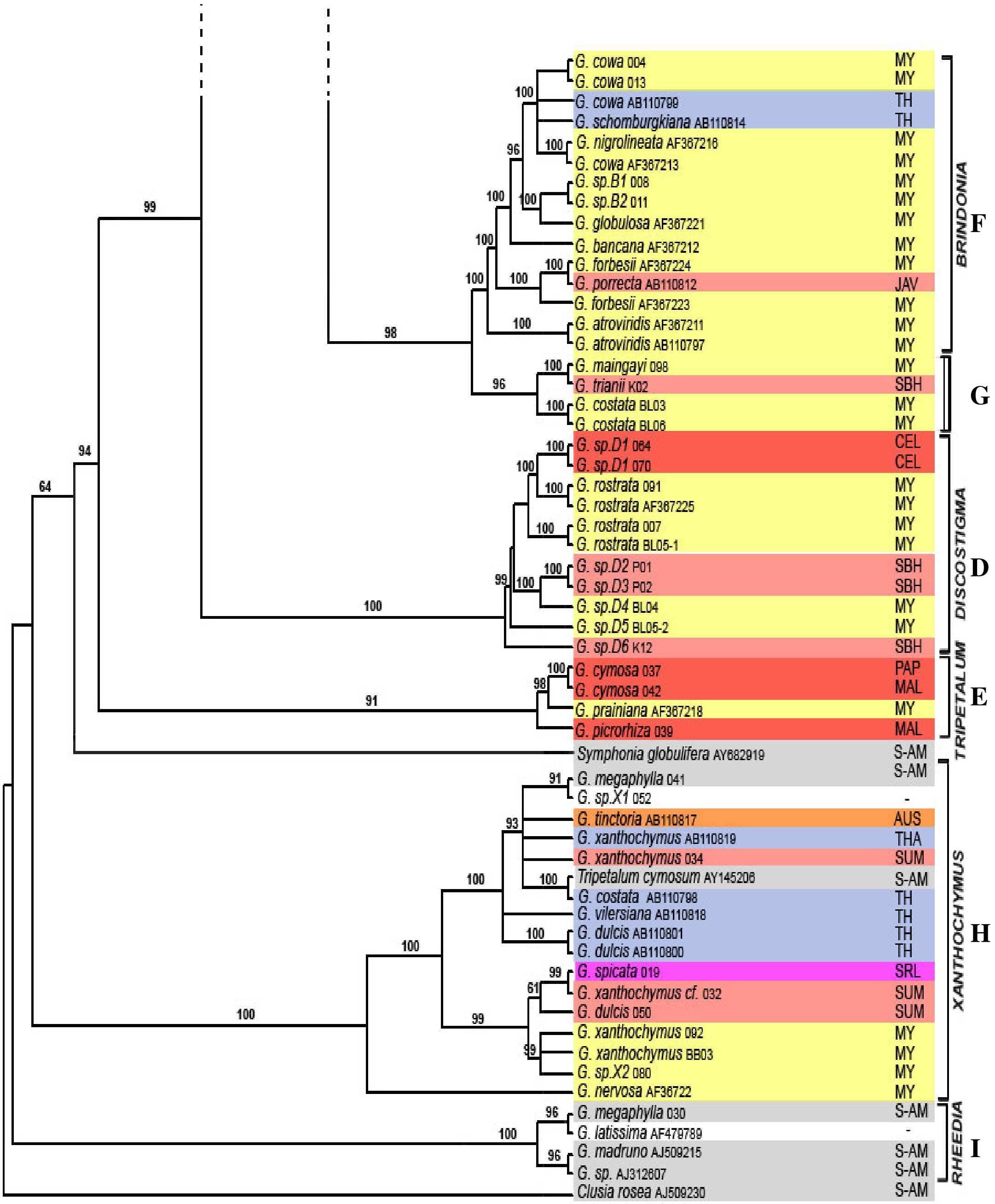


Figure 5.4. Fifty percent Majority Rule consensus tree resulting from the Bayesian analysis of ITS. Numbers above branches indicate posterior probabilities (shown for values above 60% only). The double lined bars indicate taxa that were placed in section *Garcinia* sensu Jones (1980). Origin of samples collected; CEL=Sulawesi, JAV=Java, KAL=Kalimantan, LAO=Laos, MAL=Maluku, MY=Peninsular Malaysia, NWG=New Guinea, S-AM=South America, SBH=Sabah, SRL=Sri Lanka, SUM=Sumatra, TH=Thailand, Vn=Vietnam; Purple=Sri Lanka, Blue=Indochina & Thailand, Yellow=Peninsular Malaysia, Red=Malay Islands, Orange=Australia, Grey=South America and White=unknown origin.

*5.4.2 trn*S-*trn*G

Aligned *trn*S-G sequences resulted in a total of 1253 characters of which 109 (8.70%) were potentially phylogenetically informative. However, there is great variation in the length of the sequences among taxa which resulted in many phylogenetically informative indels being coded from the sequence alignment, such as the large indel (403 bps) found from position 226 to 716 (Appendix VI). In total, 53 indels and 65 informative substitutions were used in the analysis. The first round of heuristic search resulted in a total of 1408 trees and the second round yielded more than 10,000 most parsimonious trees. The tree length was 481 steps and the CI (0.83) was higher than for the ITS region but the RI (0.79) and HI (0.18) were lower compared to ITS.

Because of the decreased taxon sample size and lack of variability, not all clades that were evident in the ITS analysis are evident in the plastid DNA analyses (Figure 5.4 and 5.5). MP and BI analyses show some dissimilarity in the position of infrageneric clades and most clades are not highly supported by BV (less than 90%) but moderately to highly supported by PP. However, the topologies of the MP and BI trees are broadly similar.

As with ITS, sect. *Garcinia* sensu Jones is paraphyletic, with taxa from the section found in clades **A-1** and **G** and also in clade **A-2** (*G. rigida*). Clade **A-1** is largely similar to clade **A** in the ITS trees, but is not strongly supported by the BV (<60%), though moderately supported by PP (93%). *Garcinia celebica* which is monophyletic in ITS trees is paraphyletic in *trn*S-G trees and other clades within **A-1** are collapsed. Interestingly, one clade, **A-2** (consisting of accessions of *G. rigida* with strong support of BV [93%] and PP [99%]) previously nested within clade **A** in the ITS trees is outside this clade.

In the MP analysis, clades **D**, **E** and **F** are strongly supported. BI gives more resolution and higher support values as for clade **H.** The four clades (**D, E, F** and **H**) correspond to the sections *Discostigma, Tripetalum, Brindonia* and *Xanthochymus* sensu Jones (1980), respectively. However, sections *Macrostigma* and *Hebradendron* sensu Jones (1980) are not monophyletic in the *trn*S-G analysis with representatives of each being unresolved with respect to one another in the clade **B/C**. The monophyly of clade **B/C** is not strongly supported by BV (<60%) but strongly supported by PP (97%).

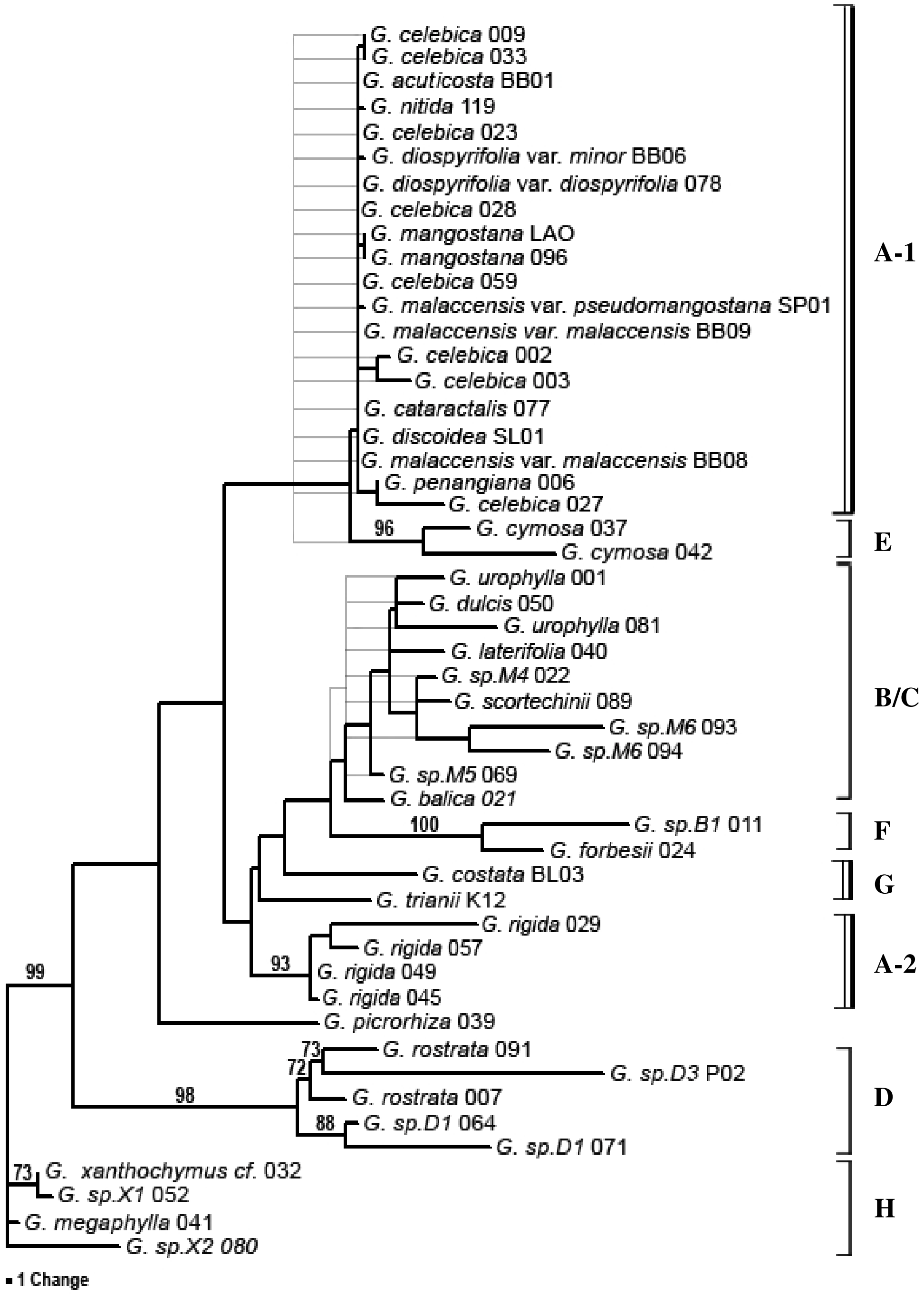


Figure 5.5. One of 10, 000 most parsimonious trees from the analysis of the *trn*S-G region. Numbers above branches indicate bootstrap values (shown for values above 60% only). The grey branches indicate the topology of the strict consensus tree. Tree length=525 steps. CI=0.81, RI=0.76 and HI=0.19. The double lined bars indicate taxa that were placed in section *Garcinia* sensu Jones (1980).

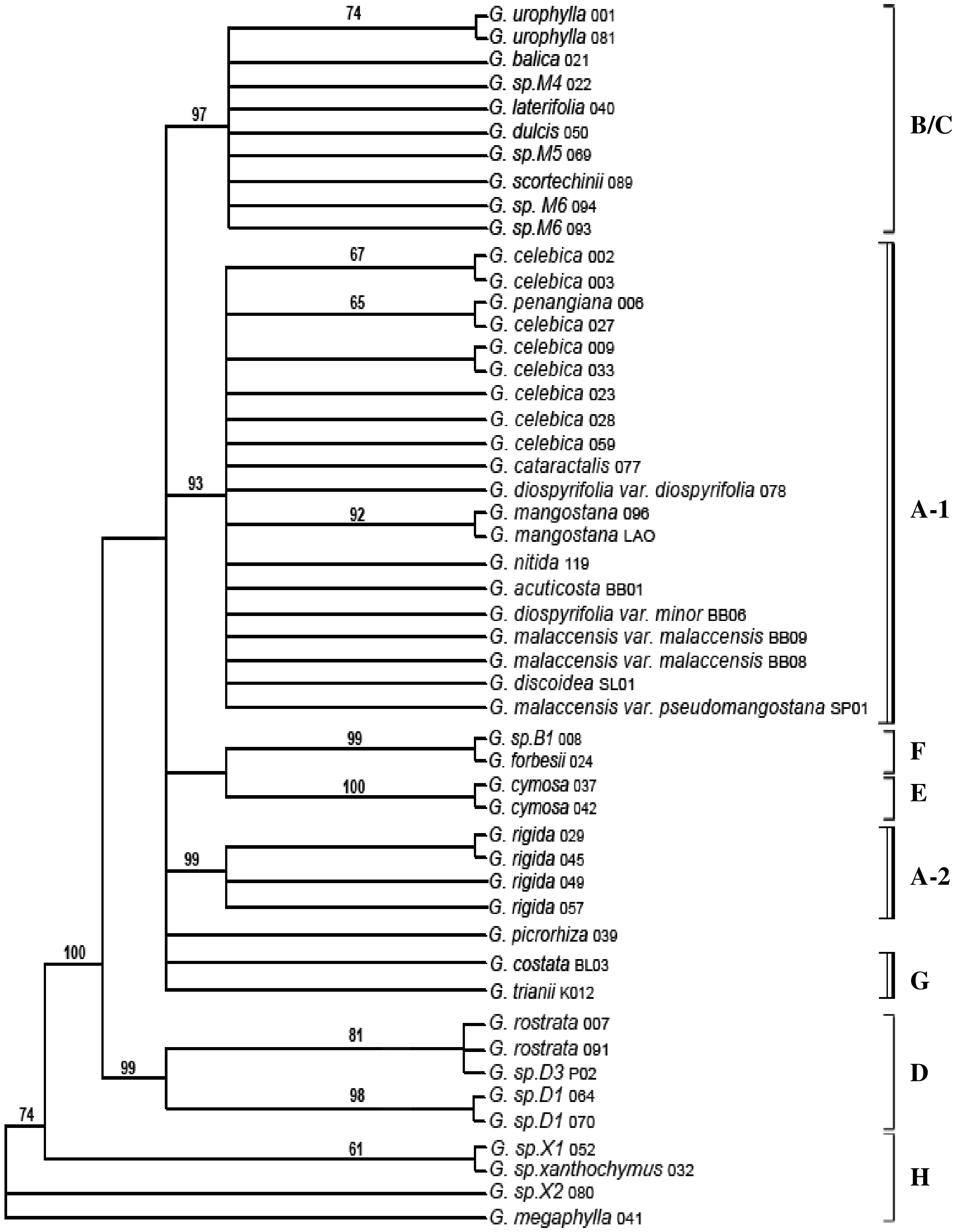


Figure 5.6. Fifty percent Majority Rule consensus tree resulting from Bayesian analysis of the *trn*S-G region. Numbers above branches indicate posterior probabilities (shown for values above 60% only). The double lined bars indicate taxa that were placed in section *Garcinia* sensu Jones (1980).

*5.4.3 Combined trn*S-G *and trn*D-T

The combination of the two cpDNA data matrices resulted in a total of 2499 characters of which a low number (149; 5.96%) were phylogenetically informative. From the 24 accessions of *trn*S-G and *trn*D-T regions, a total of 58 gap characters were used in the analysis. In the MP analysis, more than 10,000 parsimonious trees were produced in both the first and second round of heuristic searches with a tree length of 491 steps. The CI (0.88) and RI (0.80) were higher than for the trn*S-G* region but the HI (0.12) was lower compared to *trn*S-G.

The MP and BI analyses show a similar topology, and some of the clades are more resolved in this combined analysis compared to *trn*S-G trees. For example in Clade **A-1,** *G. celebica* is monophyletic with moderate BV (70%) and PP (74%) support. Another monophyletic clade in clade **A-1**, the group of *G. malaccensis* and *G. mangostana* differs from the ITS trees in the placement of *G. malaccensis* var. *pseudomangostana* which is nested outside the group.

Clade **A-2** is sister to clade **A-1** with low support (60%) in the parsimony analysis**.** However, in the BI analysis *G. rigida* (accession 045) is sister to clade **A1** but with PP less than 60% . This difference with the *trnS-G* analysis may be because of the limited sample of taxa used in this analysis. The paraphyly of sect. *Garcinia* sensu Jones (1980) indicated by ITS and *trn*S-G trees is still evident from the position of clade **E** and **G** in the parsimony and BI analysis. Sequencing of plastid regions from more taxa, particularly from the clades **B**, **C**, and **F** will be necessary to provide further evidence for paraphyly of section *Garcinia*.

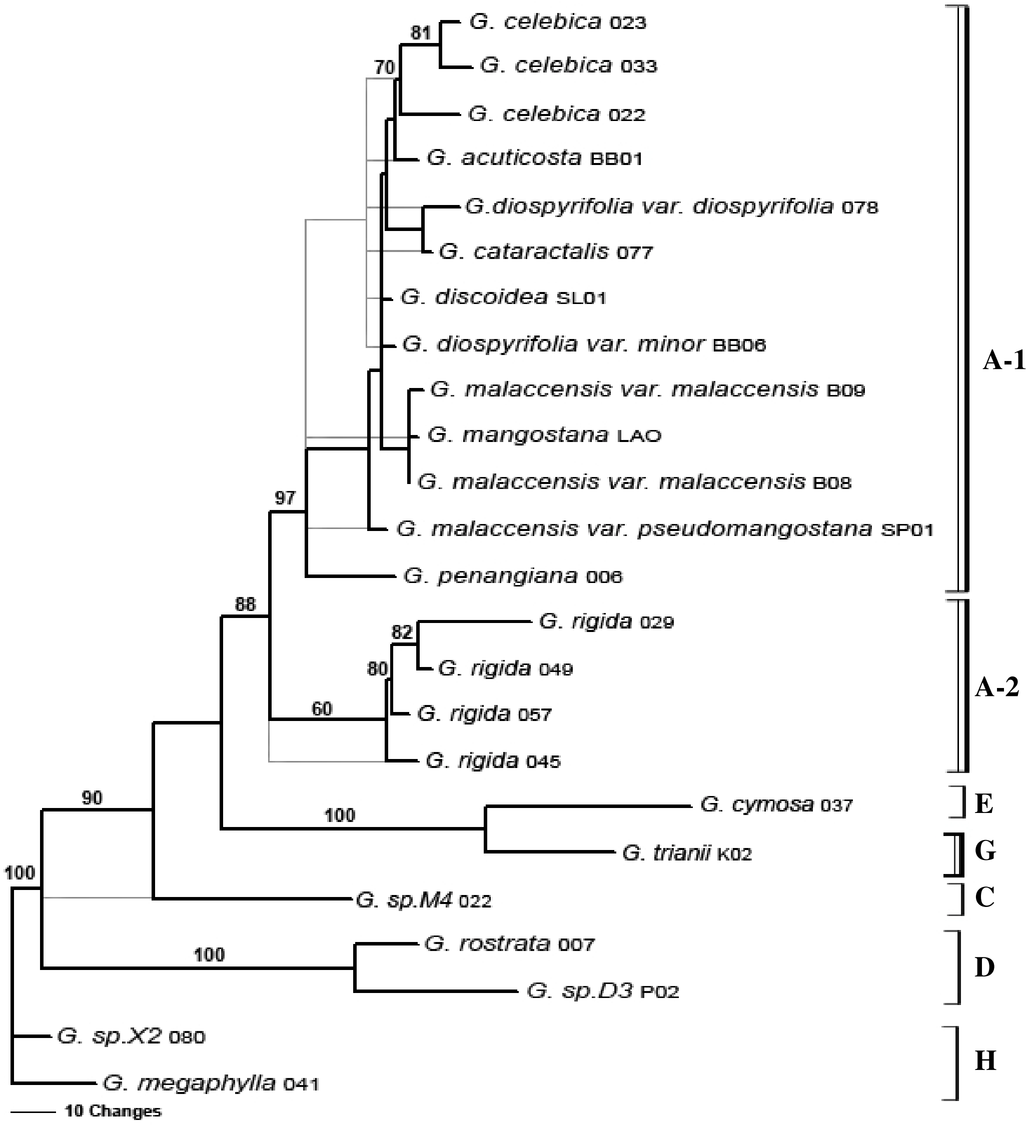


Figure 5.7. One of 10, 000 most parsimonious trees from the analysis of the *trn*S-G and *trn*D-T regions combined. Numbers above branches indicate bootstrap values (shown for values above 60% only). The grey branches indicate the strict consensus tree. Tree length=514 steps. CI=0.87, RI=0.79 and HI=0.14. The double lined bars indicate taxa that were placed in section *Garcinia* sensu Jones (1980).

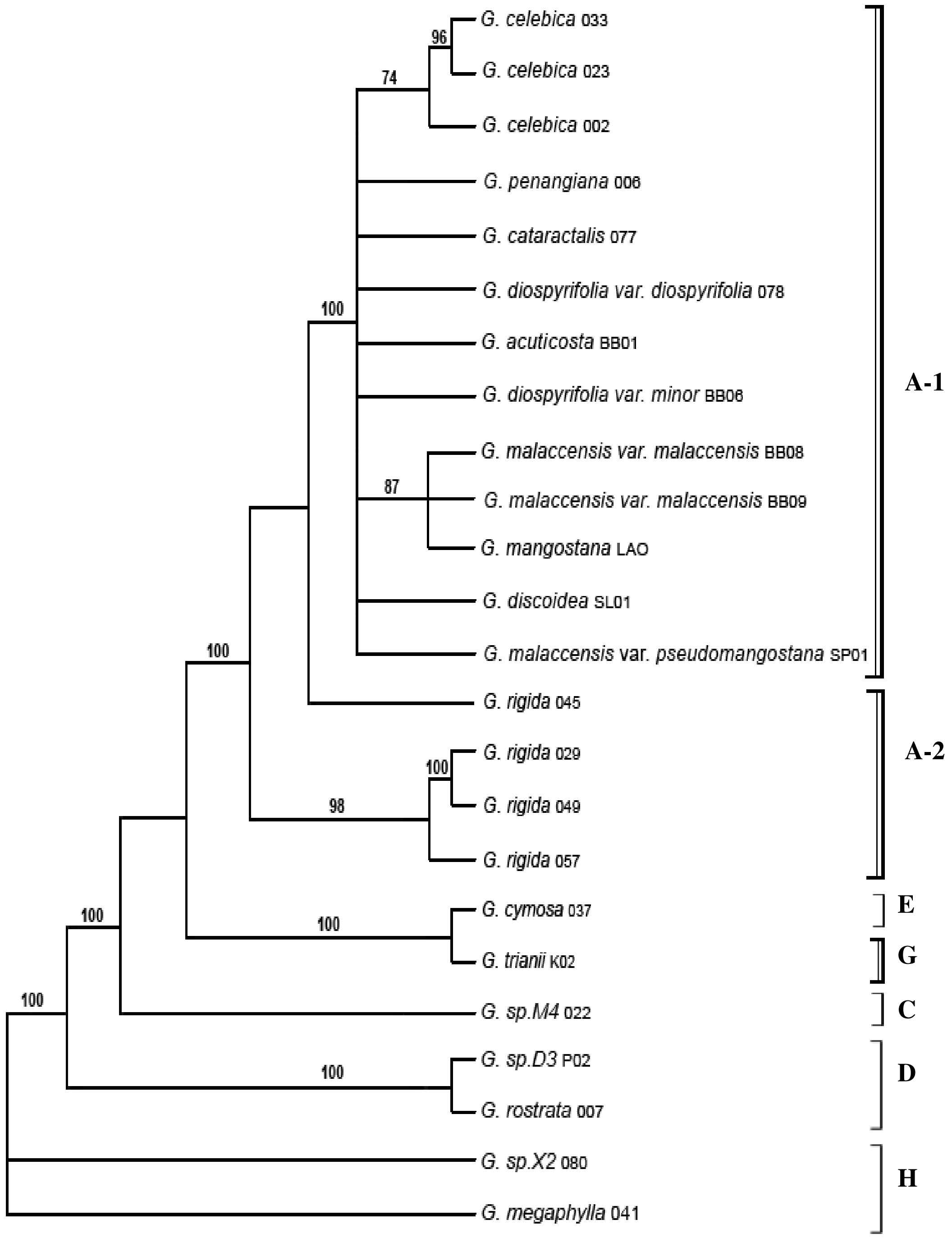


Figure 5.8. Fifty percent Majority Rule consensus tree resulting from Bayesian analysis of combined *trn*S-G and *trn*D-T sequences. Numbers above branches indicate posterior probabilities (shown for values above 60% only). The double lined bars indicate taxa that were placed in section *Garcinia* sensu Jones (1980).

5.4.4 Congruence Test

Two tests were performed to test whether the ITS dataset should be combined with cpDNA dataset. Both ILD tests between ITS and *trn*S-G datasets, and ITS and combined *trn*S-G with *trn*D-T produced results indicating that these data partition had a significantly different signal (both with P= 0.001).

To further investigate the congruence of the two datasets, the tree topologies for each dataset can be compared to assess the degree and sources of incongruence. This method has been practised for some authors, (e.g. Soltis & Kuzoff, 1995; Ronsted et al., 2002) who abandoned the incongruence length difference (ILD) test (Farris et al., 1994) because it indicated significant incongruence even when none was apparent. In sect. *Garcinia* plastid trees show incongruence with the ITS trees especially in the placement of clade **A-2** (*G. rigida*). In the ITS analysis it is placed within clade **A** and as sister to *G. diospyrifolia,* but in the *trn*S-G analysis it is placed outside clade **A** (**A-1),** and as its sister group in the combined plastid analysis.

There appears to be significant incongruence evident both in the ILD test and the comparison of tree topology, and therefore, combined analysis is rejected in this study. This is justified because if separate datasets are incongruent as a result of evolutionary independence, combined analysis may result in reduced resolution or an erroneous estimate of phylogeny (Hardig et al., 2000).

5.4.5 Age Estimation

Three nodes within ITS trees have been calculated using the NPRS method (Sanderson, 1997) to estimate their ages and their standard deviation. Results show that the age for the crown of *Garcinia* is 61.26 ±1.58 MY, the most recent common ancestor of the group of *G. malaccensis* and *G. mangostana* is 8.66 ± 4.43 MY and the split of accessions of *G. rigida* from their most recent common ancestors is 21.58 ± 2.90 MY.

Another method of age estimation as used by Richardson et al.(2001a), estimated that ages for the crown node of *Garcinia* from published rates of woody taxa resulted in a huge range from 25.9 million years (MY) to 631 MY (Table 5.4). The Winteraceae rate gave ages of 575 to 631 MY for the crown of *Garcinia*, however, other rates gave more reasonable ages ranging from 25.9 to 99.7 MY. The Winteraceae age estimates are clearly incorrect (*Garcinia* is estimated to be considerably older than the oldest angiosperm fossils). This either indicates that the Winteraceae rate is incorrect, possibly resulting from errors in the calibration, or it suggests that the problem of rate heterogeneity among lineages is too great to permit use of a rate calculated in one lineage to accurately determine the age of another. Therefore, the ages calculated using the fossil calibration are the most accurate and are those that are discussed below.

Table 5.4. Estimated time of divergence of *Garcinia* based on the published ITS data.

Species (Source)	**Habit/Minimum Generation Time (estimated)**	**Published Calibrated Rate (s/s/y)**	**Age of crown node of *Garcinia* (MY)**
Gossypium (Mes et al., 1996)	Perennial shrubs/ ~1-3 yrs.	5.0 – 9.0 x 10^{-9} (ITS 1)	55.0 – 99.7
Gossypium (Mes et al., 1996)	Perennial shrubs/ ~1-3 yrs.	2.5 – 4.5 x 10^{-9} (ITS 2)	27.9 – 49.8
Inga (Richardson et al., 2001a)	Tree & Shrubs/~2-3 yrs.	2.34 x 10^{-9}	25.9
Phylica (Richardson et al., 2001b)	Tree & Shrubs/~2-3 yrs.	2.44 x 10^{-9}	27.0
Winteraceae (Suh et al., 1993)	Tree & Shrubs/~6-10 yrs.	3.2 – 5.2 x 10^{-10}(ITS 1)	575.0
Winteraceae (Suh et al., 1993)	Tree & Shrubs/~2-3 yrs.	3.6 – 5.7 x 10^{-10} (ITS 2)	631.0

5.5 Discussion

5.5.1. Utility of ITS and cpDNA Sequences

A total of 10 species of *Garcinia* out of 17 species belonging to sect. *Garcinia* sensu Jones (1980) were collected and successfully sequenced for the ITS region. Nine species of sect. *Garcinia* were sequenced for the *trn*S-G region and six for *trn*D-T. Among these regions, ITS provides most phylogenetic resolution because of the higher level of variation compared to cpDNA. The phylogenetic analyses also produced ITS trees in which infrageneric and species relationships could be resolved. This result is in accordance with previous findings based upon studies using fewer samples (Nazre, 2000; Rismita-Sari, 2000; Yapwattanaphun et al., 2004) that showed that ITS provides greater phylogenetic information in *Garcinia* than other markers.

Nazre (2000) demonstrated that chloroplast markers of *trn*L-*trn*F are too conserved to resolve inter-specific relationships. To improve this resolution, two markers of cpDNA reported to be highly variable were sequenced in this study. However, the two chloroplast markers (*trn*S-G and *trn*D-T) combined still did not produce better resolution than ITS. This is because the chloroplast evolves at a slower rate compared to nuclear DNA (Palmer, 1987) and in *Garcinia* it appears that this rate difference may be accentuated. Although variation in chloroplast markers is insufficient to resolve inter-species relationships it does provide some good information on infrageneric relationships. It also indicates that some species might be of hybrid origin as shown by the contrasting topologies observed between ITS and cpDNA datasets (see discussion in section 5.5.4). Because of the better resolution and sampling of ITS, most of the discussion on the relationships within sect. *Garcinia* that follows will focus on the ITS trees.

5.5.2. Section Garcinia and Morphology

The trees from the phylogenetic analyses indicated that sect. *Garcinia* sensu Jones is paraphyletic. In the ITS analysis, the members of the section are found in two clades, **A** and **G** (Figure 5.3 & 5.4) but in the *trnS-G* analysis, species from sect. *Garcinia* sensu Jones were found in three clades, clade **A-1, A-2,** and **G** (Figure 5.5 and 5.6). Sect. *Garcinia* therefore should constitute only clade **A** as shown in the ITS analysis or clades **A-1** and **A-2** in the *trn*S-G analysis, where the support values are significant and also supported with morphological evidence (Chapter 4). The incongruence in the position of clade **A-2** in the *trn*S-G analysis may be due to a hybridisation event (see 5.5.4 below). However, in the combined plastid analysis, an increased taxon sampling is necessary to confirm whether sect. *Garcinia* is paraphyletic as indicated by the nuclear dataset.

Clade **A** contains most species that had been previously recognised as members of sect. *Garcinia* and the high support values for this clade are similar to those in previous studies (Nazre, 2000; Rismita, 2000; Yapwattanaphun et al., 2004). Another clade containing species from Jones's section *Garcinia,* clade **G**, consists of three species *G. maingayi, G. trianii* and *G. costata.* This clade is supported by significant morphological evidence and it should therefore be treated as a different section. The most distinct character is the stout and ribbed leaves that are not found in other members of sect. *Garcinia* (see Chapter 6). Following Whitmore's (1973) artificial grouping, Jones (1980) placed these species into sect. *Garcinia* because of male floral characters; stamens in the centre, surrounding the fungiform pistillode and the 2-thecous anthers. These morphological characters are homoplasious, i.e. both clades **A** and **G** share these characters. However, upon close investigation the stamens for species in clade **A** differ from those in clade **G** by the shape of the bundles with four lobes fused together whereas clade **G** does not have these four lobes (Figure 4.8).

Evidently, the morphological characters that support the monophyly of sect. *Garcinia* are a combination of both reproductive and vegetative features. The most important of these are the male flowers, especially the stamens and as Whitmore (1973) has demonstrated, leaf characters could also be used for classification. Jones (1980) also used these characters for her sectional classification. In the absence of the male flower as shown in *G. discoidea* and *G. acuticosta*, the fruit characters, i.e. borne terminal, solitary and with distinct protruding stigma, together with leaf characters could be used.

5.5.3. Phylogenetic Relationships within Sect. Garcinia

Species in sect *Garcinia* can be grouped into four groups, as shown in figure 5.8 below, that also have significant morphological support. These groups are with one exception (Group 3), monophyletic.

Group 1: This group is moderately (64%) supported by BV but highly supported by PP (98%) and consists of three species, *G. celebica*, *G. acuticosta* and *G. discoidea*. No male flowers were found (from herbarium specimens and living trees) for *G. acuticosta*. However, a combination of leaf characters, e.g. pointed cross section of midrib, narrowly elliptic of leaf shape, inconspicuous secondary nervation could be used to differentiate these three species from other species in sect. *Garcinia* which supports the suggestion of Whitmore (1973) that there is variation in leaf morphology that can differentiate groups of *Garcinia* species. The fruit characters that are shared by this group include: borne terminal, solitary with a thick fruit wall, ovoid or globose, with a distinct and prominent stigma that is either weakly to strongly raised and is either concave or discoid.

G. celebica is a heterogeneous species, both in terms of molecular and morphological features, and is moderately supported by bootstrap values (79%) and highly supported by posterior probability (100%). Previously, *G. celebica* was divided into many species with many synonyms. The distribution of this section encompasses eastern India to Sulawesi partly because regional floras by different authors treated them as distinct from each other (see chapter 6 for explanation). The heterogeneous nature of the morphological characters is seen clearly in the leaves and fruits of *G. celebica.* The leaves vary in shape and size, from elliptic or wide elliptic to lanceolate, sub-orbiculate or round and the fruit shape also varies but characters that unite the species are the four lobed bundles of stamens surrounding the fungiform pistillode. This variation, together with its widespread distribution, might explain why within *G. celebica* there is considerable molecular variation. Richards (1990a) showed that two *G. celebica* populations in Peninsular Malaysia are facultatively agamospermic and this breeding system might explain morphological variation in this species (see Chapter 2).

The other species in this group are the newly described *G. discoidea* and *G. acuticosta*. The male flowers of *G. discoidea* are similar to *G. celebica* but are larger, with thicker sepals and petals and stout pedicels. Despite the absence of male flowers in *G. acuticosta*, it shares fruit characters that are very similar to *G. celebica* and *G. discoidea*, i.e. borne on a terminal branch, solitary, with a thick wall, but may be distinguished by the rather discoid stigma and the margin being not so clearly lobed as in *G. celebica*. Vegetative characters also differentiate *G. acuticosta* and *G. discoidea* from *G. celebica* as they have leaves that are elliptic, ovate, oblong or round with the main veins raised on both sides and with fine and distinct secondary nervation.

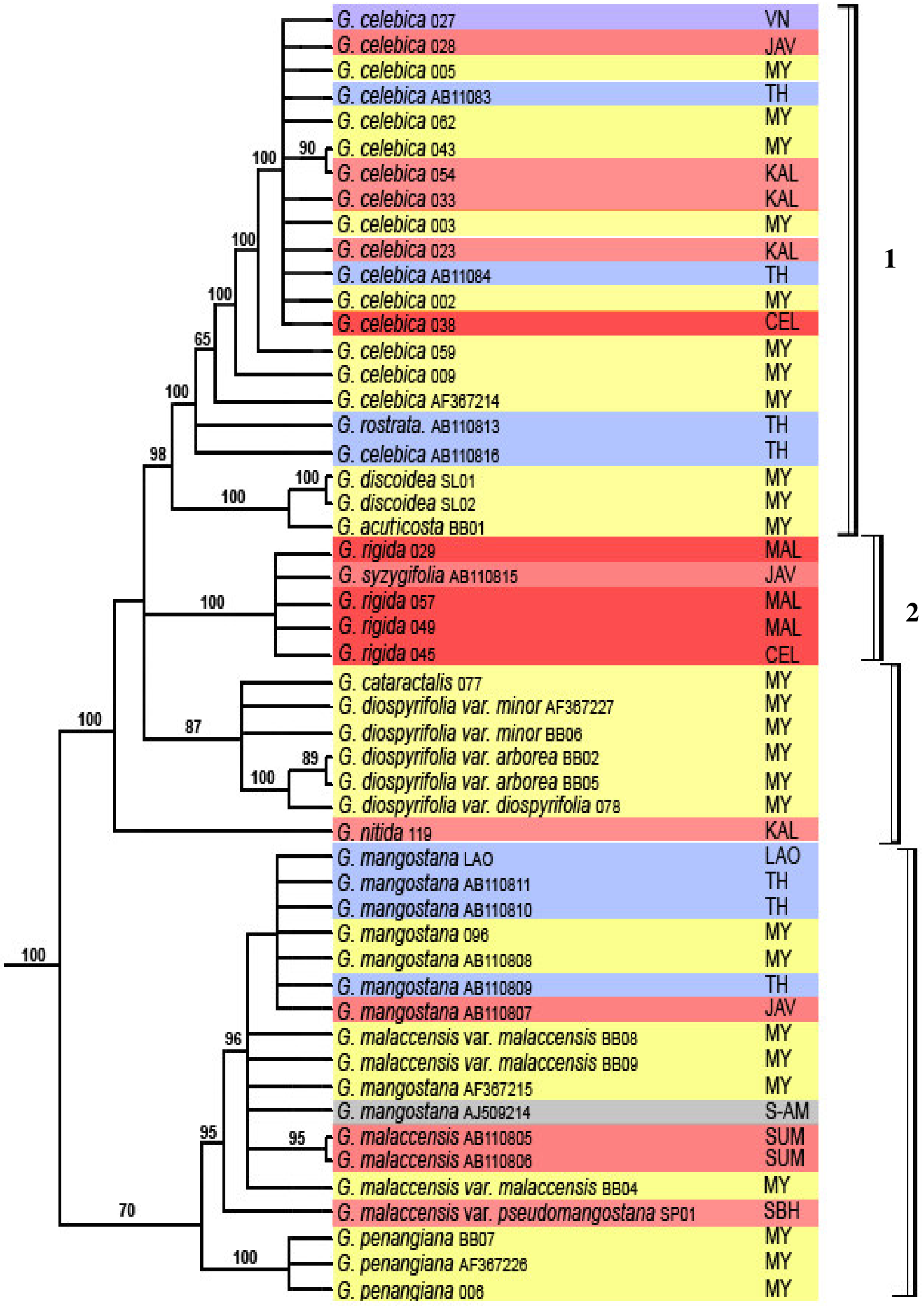


Figure 5.9. Groups within section *Garcinia* inferred from Bayesian analysis of ITS. Origin of samples collected; CEL=Sulawesi, JAV=Java, KAL=Kalimantan, LAO=Laos, MAL=Maluku, MY=Peninsular Malaysia, SBH=Sabah, SUM=Sumatra, TH=Thailand and VN=Vietnam.

Group 2: Group 2 is a strongly supported clade consisting of the poorly known species *G. rigida* (*G. sizygiifolia* as explained above is probably a misidentification). The ITS analysis placed *G. rigida* within clade **A** in sect. *Garcinia* but in the *trn*S-*G* analysis, it is placed outside of the clade, as the sister of clade **G** (*G. costata* and *G. trianii*). This contrasting topology could be evidence of hybridisation in the ancestor of *G. rigida*. Speciation from hybridisation processes in *Garcinia* is probable, for instance in *G. mangostana,* a species of suspected hybrid origin (Richards, 1990c). Determining the parents of *G. rigida* would need more detailed molecular studies utilising more variable plastid and nuclear markers and accessions of a wider sample of species. Since the samples for this study were collected from cultivated plants in the Bogor Botanic Garden, it is difficult to confirm the hybrid origin of this species.

Available information on *G. rigida* indicates that it is a rare species (four specimens) with a scattered distribution in Indo-china and Sumatra. In BO, the cultivated trees were indicated to have originated from Maluku and Sulawesi. Morphologically the leaves resemble *G. celebica* but differ largely with the glandular line pattern being more distinct and the lines more widely spaced. The fruit is similar to that of species in group 3, but is thin walled, rather rigid when dry and not easily ruptured. The fruit colour is paler and the stigma a flattened-discoid shape compared to the bright red or maroon colour and concave or convex discoid and lobed stigmas found in species in group 3.

Group 3: *G. diospyrifolia*, *G. cataractalis* and *G. nitida* share the same thin fruit wall; the fruit is easily ruptured when dry, and the mature fruit usually turns reddish and has a smooth surface. These species are indicated as related, but not monophyletic by the ITS analyses. While *G. diospyrifolia* is distributed in Sumatra, Peninsular Malaysia and Borneo, *G. cataractalis* is restricted to Peninsular Malaysia and *G. nitida* to Borneo. The latter differs from the other two species by the size of the tree which can reach 30 m, while *G. diospyrifolia* and *G. cataractalis* are small trees to 15 m.

Within *G. diospyrifolia,* three varieties are observed that have morphological support; *G. diospyrifolia* var. *arborea* (62% BV and 89% PP) is sister to *G. diospyrifolia* var. *diospyrifolia* (78% BV and 100%PP). The relationship of *G. diospyrifolia* var. *minor* is unresolved with respect to other varieties of this species and *G. cataractalis*. Both *G. diospyrifolia* var. *diospyrifolia* and *G. diospyrifolia* var. *arborea* are widely distributed varieties found in Sumatra, Peninsular Malaysia and Borneo but *G. diospyrifolia* var. *minor* is only found in Peninsular Malaysia. Morphologically, these three varieties differ by the stature of the tree. *G. diospyrifolia* var. *diospyrifolia* is a slender and small treelet to 5 m, *G. diospyrifolia* var. *minor* is a bushy tree to 12m and *G. diospyrifolia* var. *arborea* is a medium-sized tree to 20 m.

Unlike other species in the group, *G. cataractalis* is a rheophyte and can be distinguished from *Garcinia diospyrifolia* and *G. nitida* by its small, very narrow elliptic leaves. *Garcinia nitida* on the other hand is a big tree, with leaves that nearly resemble *G. diospyrifolia,* but is characterised by the flask-shaped fruit where the stigma is distinctly elongated to 10 mm.

Group 4: This group contains the widely cultivated *G. mangostana* together with *G. malaccensis* and *G. penangiana*. The monophyly of this group is moderately supported by the MP bootstrap (81%) and low PP values of BI analysis (70%). The common characters shared between the species are the stamens being in a central bundle that is conical, four-angled or nearly spherical. *Garcinia mangostana* is only known in cultivation and many authors believed that it is the product of hybridisation of closely related species (Whitmore, 1973; Richards, 1990c). See section 5.5.4. for a discussion on the origin of mangosteen.

A clade with 87% BV and 95% PP consists of representatives of *G. malaccensis* and *G. mangostana* although neither of these species are themselves monophyletic (Figure 5.2, 5.3 and 5.9). Within this clade *G. malaccensis* var. *pseudomangostana* is sister to the clade containing the other representatives of these species. Paraphyly of *G. mangostana* might suggest multiple origins of cultivation.

In general, there are three groups of *G. malaccensis* from the molecular data*;* the Peninsular Malaysian group (*G. malaccensis* var. *malaccensis*), the Sumatran group which is moderately supported as a monophyletic clade, and the Sabah group (*G. malaccensis* var. *pseudomangostana*). It is difficult to ascertain the variety of *G. malaccensis* from Sumatra since no herbarium specimens of wild origin have been seen but contacts in Bogor Botanic Gardens (Rismita-Sari & Irawaty, pers. com) indicate the origin of trees in cultivation there is Sumatra.

The group that is sister to *G. malaccensis* var. *pseudomangostana* is moderately supported by BV (62%) and PP (96%). Morphologically, the two varieties of *G. malaccensis* are extremely similar vegetatively but the male flowers of *G. malaccensis* var. *malaccensis* have long 4-angled conical-shaped stamens, whereas *G. malaccensis* var. *pseudomangostana* has shorter four-angled square-shaped stamens (Figure 4.7). Both varieties have the pistillode present or absent but the size is small (less than 5 mm long). *Garcinia mangostana,* however, has a long four-angled stamen surrounding the prominent fungiform pistillode, while the leaves resemble *G. malaccensis* but with the venation more prominent and stout.

Garcinia penangiana is the sister to the rest of the group 4 clade and has stamen bundles which resemble *G. malaccensis* var. *pseudomangostana* but it differs chiefly by the absence of the pistillode, the sepals and petals being rather thinner and the veins on the leaves are much closer to each other.

5.5.4. Hybridisation and Origin of Mangosteen

The phylogenetic trees indicated that nuclear and plastid data were incongruent (Figure 5.3 – 5.8). A possible explanation for this discordance is hybridisation and/or introgression amongst species found in different lineages, as has been shown in other studies. For example Kyndt et al. (2005) demonstrated that discrepancies of the chloroplast and nuclear markers in the Caricaceae were evidence of hybrid species of *Vasconcellea*.

Chloroplast DNA is maternally inherited in angiosperms and is a non-recombining molecule, and as a result hybrid species should retain the same sequences as their maternal parents. Nuclear markers in contrast are biparentally inherited, but some, such as ITS, may be subjected to concerted evolution. Koch et al. (2003) outlined three possibilities for ITS in individuals that result from hybridisation between two different species with different ITS sequences: 1) unidirectional concerted evolution leads to the loss of one copy and fixation of the second; 2) concerted evolution results in new ITS sequences that represent a mixture of the two parental sequences; 3) both parental ITS sequences are retained in a 'non-concerted evolution' situation. Concerted evolution is a molecular process that homogenises different loci within multigene families (Arnheim et al., 1980). It is driven by two molecular processes, gene conversion and unequal crossing over (Koch et al., 2003) and is only effective with sexual reproduction.

Evidence for hybridisation in this study of *Garcinia* can be seen from the incongruence in the position of *G. rigida*. The ITS trees (Figure 5.3 and 5.4) show that *G. rigida* is nested within clade **A** (sect. *Garcinia*) and is closely related to *G. diospyrifolia,* but in the *trn*S-G chloroplast trees (Figure 5.5 and 5.6), it is nested outside clade **A** while in the combined parsimony analysis (Figure 5.7 and 5.8), *G. rigida* is sister to clade **A**. Pinpointing the exact maternal parent of this species based on the plastid phylogeny presented here is difficult as the number of species sampled is insufficient. However, the maternal parent may be more closely related to a species outside of sect. *Garcinia*. The absence of any polymorphism in the electropherograms of ITS sequences of *G. rigida* (Appendix VIII) is consistent with a hybrid origin followed by concerted evolution and homogenisation to fixation to an ITS type of paternal parent related to *G. diospyrifolia*. This phenomenon is known as chloroplast capture, an introgression of the cytoplasmic genome of one species into the nuclear background of another (Soltis et al., 1991). *Garcinia rigida* is a rare species that is widely distributed from Indo-china to Sumatra and Maluku. The hybrid origin of this species is intriguing and merits further investigation. Because information on this species is limited, further investigation to determine its parentage should include more species and additional markers as the current study can not give a clear picture of its relationships.

Another hybrid species and the most famous member of sect. *Garcinia*, is the mangosteen (*G. mangostana*), and its relationship with wild relatives has been the subject of great interest. A number of attempts have been made to determine its relationships. Richards (1990c) was the first to suggest from cytological and morphological evidence that mangosteen arose from hybridisation of male *G. hombroniana* (= *G. celebica*) and female *G. malaccensis*. This claim follows on from the work of Whitmore (1973), who also suggested the close affinities of mangosteen with *G. malaccensis* and *G. hombroniana*. Richards (1990c) speculated that mangosteen might be an offspring of a single event, but he also suggested that there was a possibility that the cross might have occurred on more than one occasion.

Using ITS sequence data from a total of 17 species of *Garcinia*, Yapwattanaphun et al. (2004) found that mangosteen is closely related to *G. malaccensis* rather than to *G. hombroniana* (=*G. celebica*). They also concluded that the other ancestral parent may not be *G. hombroniana,* but could also be *G. rostrata, G. sizygiifolia* or *G. speciosa* (Yapwattanaphun et al., 2004). This, however, may be misleading as indicated earlier in this chapter due to the dubious identification of a few species in this work.

Morphologically, Richards (1990c) suggested that the affinities of mangosteen were with *G. hombroniana* (=*G. celebica*) and *G. malaccensis* based on female flower and fruit characters. However, as demonstrated above, the most significant characters used to infer relationships in sect. *Garcinia* are from the male flower. Male flower characters in this study (Chapter 6) show that mangosteen is more similar to the group of *G. malaccensis, G. venulosa* and *G. penangiana* than it is to *G. celebica*. The male flower for this group including mangosteen has mainly 4-angled stamen bundles with fungiform pistillode (or without pistillode) (Figure 4.9) whereas *G. celebica* has 4-bundles of stamens surrounding the fungiform pistillode (Figure 4.8a & 4.9a). The ITS trees (Figure 5.3 and 5.4) also demonstrated that *G. malaccensis, G. penangiana* and mangosteen form a group (*G. venulosa* was not sequenced) that is monophyletic although not highly supported.

The male mangosteen stamens are 4-angled surrounding the base of a prominent fungi-form pistillode (Figure 4.9b). In contrast male flowers of *G. malaccensis* have a smaller or absent pistillode (Figure 4.9c & d). *Garcinia venulosa* (Figure 4.9e) and *G.*

penangiana (Figure 4.9f) do not have a pistillode and the stamen bundles are somewhat shorter. However, there is variation in male flowers in different varieties of *G. malaccensis. Garcinia malaccensis* var. *malaccensis,* found in Peninsular Malaysia and Borneo has nearly conical, 4-angled or nearly round stamens, and the pistillode is very small or sometimes absent. *Garcinia malaccensis* var. *pseudomangostana* has shorter, 4-angled stamens bundles, with or without a pistillode and is only found in the eastern part of Borneo (Sabah and Kalimantan).

If mangosteen arose from hybridisation between male *G. celebica* and female *G. malaccensis* as claimed by Richards (1990c), the ITS sequence should reflect either both parental sequences, one of the putative parents sequences or perhaps a new sequence that is a combination of both parental types, i.e. one of the three possibilities suggested by Koch (2003). There is support for the role of *G. malaccensis* in the origin of mangosteen from the ITS trees that place these species in the same monophyletic group.

Richards (1990a) stated that mangosteen is an obligate agamospermous species mainly based on the absence of male individuals. If mangosteen is indeed an obligate agamospermous species this would indicate that no sexual reproduction has occurred since the F1 generation. Thus, concerted evolution in the nrDNA would not have occurred and both parental ITS sequences should be retained throughout the succeeding obligate apomictic generations as for example in *Passiflora* (Lorenz-Lemke et al., 2005). If *G. celebica* is one of the parent species, sequences of *G. celebica* should be retained in the hybrid and there should be many polymorphisms detected in mangosteen sequences generated from a single individual, i.e. sites at which e.g. both an A and a T are present each state representing that of one of each of the parents. These polymorphisms should be frequent given the sequence divergence between accessions of *G. celebica* and the *G. mangostana*/*G. malaccensis* clade (Figure 5.9). However, the electropherograms of ITS sequences of mangosteen accessions indicated that there are no polymorphisms observed (see appendix VIII) which would rule out the possibility of *G. celebica* being one of the parents for mangosteen provided mangosteen is an obligate agamosperm. If obligate agamospermy in mangosteen were confirmed then this would indicate that *G. malaccensis* is one of the parents and only another closely related species with an identical sequence to *G. malaccensis* could be the other parent for mangosteen or that mangosteen is a ‘cross’ between two varieties of *G. malaccensis* with identical ITS sequences.

Two mangosteen accessions (AF 367215, AJ509214) have sequences identical or nearly identical to *G. malaccensis* var. *malaccensis* (BB04, BB08, BB09) from Peninsular Malaysia and other accessions of mangosteen are nested within the *G. malaccensis* clade (Figure 5.3). This suggests that the other parent of mangosteen may be another variety of *G. malaccensis.* However, at present only two varieties of *G. malaccensis* (*G. malaccensis* var. *malaccensis* and *G. malaccensis* var. *pseudomangostana*) are described (Chapter 6). More varieties may await description, for example, individuals from Sumatra (Figure 5.3) which have ITS sequences that are slightly different from other varieties. If mangosteen is confirmed as an obligate agamosperm then sequencing of more accessions of *G. malaccensis* and related species will be necessary to determine more accurately its parents.

However, mangosteen could also be a facultatively agamospermous species in which sexual reproduction occurs from time to time. Male individuals have been reported in Peninsular Malaysia (Idris & Rukayah, 1987). The rare occurrence of males may be related to the cultural practice of people in Peninsular Malaysia (and Southeast Asia generally) who chop down any male fruit trees because they believe they are of no benefit to them. A male tree reported by Idris and Rukayah (1987) had the same fate when a research team from the National University of Malaysia (UKM) visited the village where it had been seen and found that the tree had been chopped down because the villager felt it was not worth keeping trees which did not produce any fruit. Burkill (1935) also recorded a report from Chavelier (1919; cited in Burkill 1935) that villagers in Indo-china had practised the same action towards mangosteen trees that bore male flowers. The occurrence of male trees of mangosteen might not be as rare as first thought and that increases the possibility that sexual reproduction might have occurred in the past.

If mangosteen is a facultative agamospermous species, i.e. there is some sexual reproduction, then the possibility that *G. celebica* or some other *Garcinia* species is a parent cannot be ruled out. Based on the molecular data in this study, concerted evolution in ITS sequences of mangosteen might have followed possibility one of Koch et al. (2002) resulting in only one of the parental sequences being retained. In other words, concerted evolution has homogenised the sequence in favour of one of the parents. Even though there is no information on how much sexual reproduction is needed for ITS sequences to homogenise in mangosteen, other findings such as in *Armeria* (Fuertes Aguilar et al., 1999) and *Tragopogon* (Kovarik et al., 2005) indicate that concerted evolution and homogenisation to one parental sequence could occur at a very rapid rate (within two and thirty generations respectively). Results from age estimation (5.4.5) suggest that the most recent common ancestor of *G. malaccensis* and *G. mangostana* can be dated to 8.66 MYA (± 4.43 MYA) suggesting there has been ample time for mangosteen to reproduce sexually that could result in concerted evolution and homogenisation of ITS copies in favour of one of the parents.

Yapwattanaphun et al. (2003) used Amplified Fragment Length Polymorphism (AFLP) to determine that from 20 individual mangosteens investigated, variation existed although the level of polymorphism was relatively low. However, they suggested that this variation resulted from somatic mutation and concluded that all mangosteen trees were a clone originating from a single hybrid ancestor. Ramage et al. (2004) who investigated 37 accessions of mangosteen using a Randomly Amplified DNA Fingerprinting (RAF) technique, disagreed with the single origin theory and suggested two alternatives. The first possibility was that mangosteen might have arisen from independent hybridisation events and multiple hybrids were developed in cultivation. The second view postulated that backcrossing events occurred between male and a closely related female species. Ramage et al. (2004) found that there is considerable genetic variation in mangosteen but some phenotypic differences (e.g. crown and leaf shape), might result from environmental differences or cultural practices such as pruning techniques and shading of the trees, rather than from genetic factors. Variation in ITS sequences amongst accessions of mangosteen in this study suggests multiple origins (Figure 5.3 and 5.4). This supports the AFLP data of Yapwattanaphun et al. (2003), and the RAF data of Ramage et al. (2004).

Resolution and support values within plastid trees (Figure 5.5- 5.8) are poor. However, these trees, particularly those from the combined analysis (Figure 5.7 and 5.8), are consistent with Richards, (1990c) claim that *G. malaccensis* is the maternal parent for mangosteen. Interestingly, mangosteen individuals have unique *trn*S-G chloroplast sequences (Figure 5.5 and 5.6). Combined plastid trees (Figure 5.7 and 5.8) indicate that the most closely related taxon is *G. malaccensis* var. *malaccensis* from Peninsular Malaysia. Within *G. malaccensis,* there is strong evidence of genetic variation between varieties as shown by *G. malaccensis* var. *pseudomangostana* from Sabah that is distinct from individuals from Peninsular Malaysia as shown in the combined analysis of cpDNA (Figure 5.7 and 5.8). More accessions could be sequenced to determine whether any individuals of *G. malaccensis* had a sequence that matched that of mangosteen.

At present the parental species of mangosteen cannot be determined with any confidence, although it seems likely that *G. malaccensis* is one (probably maternal). If the reproductive strategy of mangosteen can be confirmed as obligate agamospermy, then the possibility that *G. celebica* is one of the parents can be ruled out. In order to determine this, more work, especially investigation into the breeding system, needs to be done. Given the current data, a number of hypotheses for the origin of the mangosteen still remain and these could be further tested by adding more accessions of mangosteen and putative parents and also additional molecular data. Additional and more variable plastid regions could confirm the maternal parent, as the markers used here have low levels of variability. Highly variable low copy number nuclear genes could also be sequenced. These markers are less frequently subjected to concerted evolution (Small et al., 2004) and would therefore retain each paternal sequence. These markers have been used to determine the parents of hybrids in *Paeonia* (Sang & Zhang, 1999), *Glycine* (Doyle et al., 1999), *Clarkia* (Ford & Gottlieb, 1999), rice (Ge et al., 1999) and *Elymus* (Mason-Gamer, 2001). This approach could also be used to confirm the putative hybrid parents of *G. rigida*.

5.5.5. Distribution and Biogeography of Sect. Garcinia

The distribution of sect. *Garcinia* is centred in Southeast Asia and spreads westwards to eastern India, and to the east across Wallace's line to New Guinea (Figure 3.1). Because the sampling of species in this study is limited with most of the species sampled being from the Southeast Asian region, it is not possible to determine the area of origin of the section. However, the fact that most of the species in sect. *Garcinia* are distributed mainly on the west side of Wallace's line suggests an origin here. The most widely distributed species *G. celebica* is found on both sides of Wallace's line. Other species of *Garcinia,* for example species from clade **C** (sect. *Macrostigma*) and clade **D** (sect. *Discostigma*) distributed to the east of Wallace's Line are also placed apically in the phylogenetic trees (Figure 5.2 and 5.3). The age estimation for the crown of *Garcinia* of

61.26 +/-1.58 MY and an age of 21.58 +/-2.90 for the split of accessions of *G. rigida* from their most recent common ancestor on the west side of Wallace's Line is consistent with a Miocene dispersal event from west to east after the Sahul and Sunda shelves converged (c. 20 MY), and this fits the theory of recent dispersal of species across this biogeographic division (Morley, 1998).

5.6 Conclusion

The ITS analyses in this study provide the best resolution of species relationships in sect. *Garcinia* and non-coding chloroplast sequence data are less informative. Most of the sections delimited by Jones (1980) prove to be monophyletic but sect. *Garcinia* is paraphyletic. Section *Garcinia* should only constitute clade **A** (or **A-1** & **A-2** from cpDNA) because of the molecular support values and also morphological characters that distinguish it from clade **G** (*G. maingayi, G. trianii* and *G. costata*) that should be separated to become part of sect. *Brindonia* or should probably be treated as a new section. Stamen characters outlined by Whitmore (1973) and Jones (1980) are the most significant ones supporting monophyly of sect. *Garcinia.*

The occurrence of hybridisation events in sect. *Garcinia* in the wild is demonstrated by the incongruence between ITS and cpDNA trees but further studies should be made to determine the parental species, for example of *G. rigida.* Another hybrid species, the cultivated mangosteen could be the product of hybridisation between varieties of *G. malaccensis* provided that it is confirmed as an obligate agamosperm. However, if mangosteen is a facultative agamosperm other *Garcinia* species besides *G. malaccensis* could be involved in its parentage.

CHAPTER 6

TAXONOMIC REVISION OF *GARCINIA* SECTION *GARCINIA*

6.1 Introduction

The following taxonomic revision is based on the studies of morphological variation and phylogenetic analysis of DNA sequences that have been discussed in previous chapters. Species concepts and the nature of species delimitation used in this study will be briefly discussed.

6.2 Agamospermy and Species Delimitation

The role of breeding systems in affecting phenotypic form cannot be ignored especially in *Garcinia* which is known to be agamospermous. Even though only three species of sect. *Garcinia* i.e., *G. celebica, G. mangostana* and *G. penangiana* have been confirmed as agamospermous, based on embryological studies (Richards, 1990a; Chapter 3), there may be other agamospermous species in the section as indicated by the low male ratio observed from herbarium specimens.

The problem with facultatively agamospermous species is that they produce morphologically similar lineages of asexual progeny, along with occasional sexual progeny. These sexual progeny result in more lineages that are slightly morphologically different from the original ones (Richards, 2003). This variation is not restricted to morphological characters but extends to cytological and molecular differences (Stace, 1998).

Garcinia is a problematic group of plants for the taxonomist (Ashton, 1988c). This is demonstrated by the large numbers of unidentified specimens in most herbaria visited during this study. Even for a well-documented geographical area such as Malaysia, some species included in floristic accounts have been left unnamed (Whitmore, 1973; Ashton, 1988a; Kochummen, 1997) because the authors believed they might occur outside Malaysia and therefore have an existing binomial name. The problem is a lack of a recent monographic revision, the last of which covering *Garcinia* on a world-wide basis was completed 80 years ago (Engler, 1925). Since that time many new species have been described.

There have been attempts to give special ranks to apomictic taxa to reflect their special nature in that they are ‘different from’ or ‘not equivalent’ to sexual species (Stace, 1998). The term ‘agamospecies’ was originally introduced by Turesson (1929) and defines populations whose constituents could be regarded on morphological, cytological or other grounds as having had a common origin (Babcock & Stebbins, 1938; Davis & Heywood, 1963). Love (1960) then proposed that the category agamospecies should be employed at the subspecific level but the proposal was never really accepted and name changes were not formalised. Many other terms similar or equivalent to agamospecies have been used, for example formae apomictae, agamotype, apomictic-coenospecies, apomict, agamotype, amphimictic group (Davis & Heywood, 1963). Agamospermous taxa have not been widely accepted at the specific or subspecific rank, and the aggregate species concept (e.g. Weber, 1998) has been proposed as an alternative because a broad definition of agamospermous species that may contain many segregate agamospermous lineages has been maintained by many users (e.g. *Taraxacum officinale* agg.). The formal use of the term aggregate species is rejected by the ICBN but continues to be used informally (Stace, 1998). The microspecies concept has also been used to describe a uniform population or lineage that is morphologically distinguishable from other populations but the term has no real taxonomic definition rather than recognition of a certain type of variation (Asker & Jerling, 1992).

Although I believe it is necessary to consider the role of agamospermy in species delimitation in *Garcinia,* it is almost impossible in this under-studied group of plants. Not only is little known about the biology, cytology and mode of reproduction of *Garcinia* species but, in certain areas, some species are under represented in herbaria because of under-collection, e.g. *G. exiguus* (Borneo)*, G. cataractalis* (Peninsular Malaysia) and *G. ochraceus* (New Guinea) or because they are very rare. Therefore, a pragmatic approach as proposed by Stace (1998) has to be used in sect. *Garcinia* without too much emphasis on the breeding system.

This is also the approach in taxonomic works on other genera known to have agamospermous species in the tropical forest such as *Shorea, Mangifera* and *Lansium* (Ashton, 1988a). These place little emphasis on breeding systems, but have proven to be stable classifications. These works use a relatively narrow species concept and recognise discontinuity of morphological variation at species or infraspecific rank (e.g. subspecies or variety). A similar approach to species delimitation is adopted in this study.

6.3 Species concept used in this study

The justification for the use of a particular species concept in a taxonomic work is important because different taxonomists use different approaches to classifying the organisms they study. The biological species concept (Mayr, 1970) defined species as 'groups of interbreeding natural populations which are reproductively isolated from all other groups'. This seems ideal for application to sexual organisms by stressing the 'reproductive isolation' mechanism where two different species will not interbreed. However, as outlined above, so little is known about breeding in *Garcinia* that this concept cannot be used. Furthermore, even if ample breeding data were available, the possibility of widespread agamospermy and the hybrid origin of species (Chapter 5) in sect. *Garcinia* could not easily accommodate this concept. In terms of practicality, particularly when using herbarium specimens, the biological species concept is impossible to implement.

Alternatively, the phenetic species concept (Cronquist 1978) defined as 'phenetically distinct groups (species) that are separated from others by discontinuities' uses overall similarities for comparison and is very difficult to apply in dioecious groups such as *Garcinia,* especially with a limited number of specimens. For example, the absence of male specimens in *G. acuticosta* and *G. cataractalis* means that only female characters can be used in species delimitation. Another difficulty is how to give weight to character states within an agamospermous species such as *G. celebica* when comparing them to unknown breeding type of other species. Therefore, the phenetic species analsysis is rejected for this treatment.

Hennig (1966), who introduced the cladistic method, gave the name phylogenetic sytematics to the use of empirical methods to form classifications. Cladistics uses derived characters (apomorphies) to define groups and requires taxa to be monophyletic. Two competing species concepts were born out of Hennig's phylogenetic philosophy, the Monophyletic Species Concept (MSC), for example Baum (1992), and the Phylogenetic Species Concept (PSC), for example Nixon & Wheeler (1990). The MSC assumes that species are the smallest monophyletic unit that can be distinguished while the PSC states that monophyly is not demonstrable at species level and species are the smallest diagnosable units where constant characters are sought (Luckow, 1995). According to Wheeler & Platnick (2000), the phylogenetic species concept has its origin in the work of Rosen (1978, 1979) who defined a species as a geographically constrained group of individuals with some apomorphous characters.

In section *Garcinia*, the concept chosen is highly dependent on the availability of data and the practicality in use of the end product. This is because a concept which is firmly rooted in theory but which is difficult or impossible to apply to the study of real organisms is not much use (Cracraft, 2000). Using this logic, species delimitation within this work follows the essence of the Phylogenetic Species Concept based upon the definition by Wheeler and Platnick (2000) where a species is defined as the smallest aggregation of (sexual) populations or (asexual) lineages diagnosable by a unique combination of character states. Within this concept, important synapormorphic characters are identified to define the species limits and cladistic analysis of molecular data can be used to investigate further the nature of the species. In relation to agamospermy, because the PSC is applicable to both sexual and asexual organisms, this fits well.

Species with considerable intraspecific variation which might reflect agamospermy are treated as a single species with no intraspecific taxa if the infraspecific variation is continuous and with no obvious geographical patterns (e.g. *G. celebica*). However, if there are distinct variations and discontinuous patterns within the species, varietal rank is used because there is diagnosable variation within the species (e.g. *G. diospyrifolia* var. *diospyrifolia*). Although many proponents of the PSC, including Wheeler and Platnick (2001), do not recognise ranks below species level, they are, however, accepted, for instance, in the works of Nixon & Wheeler (1990) and Davis & Nixon (1992) where there are fixed differences detected among populations of the same species.

6.4 Groups in Section *Garcinia*

Grouping the species facilitated their identification, especially when using fertile specimens. Even though some of the groups, e.g. Group I and II are monophyletic in the phylogenetic analysis, none will be given taxonomic rank as they are used here only for identification purposes. Moreover, further study is needed, especially phylogenetic analysis before declaring these groups natural and worthy of a taxonomic name.

Group I *– Stamen bundles conical or 4-angled; fruit wall thick or thin; calyx thickly leathery; stigmas separate or in bundles; secondary veins brochidodromous.*

The shape of the stamens is more or less conical and 4-angled; a pistillode is absent or, if present, fungiform. The fruit is like a mangosteen with a thick wall except for *G. penangiana* and *G. venulosa,* with a thin wall but which is not easily ruptured, thickly leathery, with a persistent calyx and tipped with segregated bundles of stigmas, fused in the middle.

Species: ***G. mangostana*, *G. malaccensis, G. penangiana*** and ***G. venulosa***.

Group II *–Stamen bundles 4-lobed, open at maturity; fruit wall thick; calyx leathery; stigma lobed and sunken or convex; secondary veins brochidodromous.*

Stamens 4-lobed, united at the base and encircling the pistillode at the centre. Pistillode fungiform. Fruits with thick wall as in *Group I,* the stigma usually raised but sunken in the middle or convex with 4-5(7) lobes, the lobes sometimes indistinct.

Species: ***G. acuticosta**, **G. celebica*** and ***G. discoidea***.

***Group III** –Stamen bundles 4-lobed; fruit wall thick; calyx leathery; stigma skull-cap shaped; secondary veins cladodromous.*

Stamens as in *Group II*. Fruits small with thick wall, tipped with the sessile, rugose, skull-cap shaped stigma.

Species: ***G. harmandii*** and ***G. moselleyana***.

***Group IV** – Stamens bundles minutely 4-lobed, usually not open upon maturity; fruit wall thin and easily ruptured; calyx leathery; stigma sunken, skull-cap shaped or flattened; secondary veins brochidodromous.*

The lobing of the stamen bundles is not as distinct as in *Group II*, always surrounding the fungiform pistillode. Fruits with thin wall and the stigma raised or not, discoid or sunken, weakly lobed or not.

Species: ***G. cataractalis**, **G. diospyrifolia, G. exiguus, G. nitida*** and ***G. ochraceus*** **.**

***Group V** –Stamens bundles minutely 4-lobed; fruit wall thick and very hard; calyx leathery; stigma sunken or flattened; secondary veins brochidodromous.*

The stamens as in *Group IV* but the fruits with thick wall and the stigma thinly flattened or usually sunken.

Species: ***G. sangudsangud.***

***Group VI** – Flowers unknown; fruit wall thin; calyx leathery; stigma discoid; secondary veins brochidodromous.*

No information on the flowers. The fruit wall closely allied to *Group IV* but not easily ruptured, and with a discoid stigma.

Species: ***G. rigida.***

6.5 Generic Description

Garcinia L.

Garcinia L. Sp. Pl. (1753) 443; Juss., Gen. Pl. (1789) 256; Blume, Bijdr. 5 (1825) 213; Miq., Fl. Ind. Bat. 1, 2 (1859) 506; Pierre, Fl. Forest. Cochinch. 1 (1882) 1; Backer & Bakh. f., Fl. Java 1 (1963) 90; Koord. & Valeton, Bijdr. Boomsoort. Java (1903) 356; King, J. As. Soc. Beng. 59 (1890) 148; Ridl., Fl. Mal. Penins. 1 (1922) 167; A.C. Sm. & S. Darwin, J. Arnold Arb. 55 (1974) 243; Seem., Fl. Vit. (1865) 10; A.C. Sm., Fl. Vit. Nova 2 (1981) 342. — *Mangostana* Rumph., Herb. Amboin. (Rumphius) 1 (1741) 132, Rumph. ex Gaertn., Fruct. Sem. Pl. 2(1), (1790) 105. — Type: *Garcinia mangostana* L.

Rheedia L., Sp. Pl. (1753) 1193; Planch. et Triana, Ann. Sci. Nat. (Bot.) ser. 4,14 (1860) 306; Hammel, Ann. Missouri Bot. Gard. 76 (1989) 927. — *Mammea* sensu Vahl, Eclog. Amer. 2 (1798) 40, pro parte quoad *M. humilis* Vahl. — *Lamprophyllum* Miers in Trans. Soc. London, 21 (1853) 249, pl. 26. — Type: *Rheedia laterifolia* L. [= *Garcinia humilis* (Vahl) C.D. Adams].

Cambogia L., Gen. Pl., ed. 5 (1754) 225. — Type: *Garcinia gummi-gutta* (L.) N. Robson.

Oxycarpus Lour., Fl. Cochinch. (1790) 647. — Type: *Oxycarpus cochichinensis* Lour. [= *Garcinia cochichinensis* (Lour) Choisy].

Verticillaria Ruiz et Pav., Fl. Peruv. Prodr. 81, (1794) pl.15 — Type: *Verticillaria acuminata* Ruiz et Pav. [= *Garcinia madruno* (Kunth.) Hammel].

Xanthochymus Roxb., Pl. Coromandel 2 (1798) 51, pl.196. — Type: *Xanthochymus pictorius* Roxb.[= *Garcinia xanthochymus* Hook. f.].

Brindonia Thouars in Dict. Sc. Nat. 5 (1804) 339. — Type: *Brindonia indica* Thouars. [= *Garcinia indica* (Thouars) Choisy].

Stalagmitis Murray in Commentat. Soc. Regiae Sci. Gott. 9 (1789) 173. — Type: *Stalagmitis cambogioides* Murray [= *Garcinia ovalifolia* Oliv.].

Hebradendron Graham in Hooker, Companion Bot. Mag. 2, (1836) 199, pl. 27. — Type: *Hebradendron cambogioides* Graham [= *Garcinia morella* Desr.].

Discostigma Hassk., Cat. Hort. Bot. Bogor. (Hassk.) (1844) 212. — Type: *Discostigma rostrata* Hassk. [=*Garcinia rostrata* (Hassk.) Hook. f.].

Ternophyllum Thwaites in Hooker's J. Bot. Kew. Gard. Misc., 6 (1854) 70. — Type: *Ternophyllum zeylanicum* Thwaites [= *Garcinia ternophylla* (Thwaites) Thwaites].

Rhinostigma Miq., Fl. Ned. Ind., Eerste. Bijv. (1860) 495. — Type: *Rhinostigma parvifolia* Miq. [= *Garcinia parvifolia* Miq.].

Pentaphalangium Warb. in Bot. Jahrb. 13 (1891) 382; Engl. in Engl. & Prantl, Naturl. Pflanzenfam. 3, 6 (1893) 240. — Type: *Pentaphlangium crassinerve* Warb. [=*Garcinia crassinervis* (Warb.) Kosterm.].

*Tree*s to 30 m tall, occasionally shrubs. *Exudate* yellow, white or cream. *Twigs* angled or not, wrinkled lengthwise when dry. *Petiole* often finely striate horizontally, stout, broadly channelled on the adaxial surface and sometimes with ligule (an excavation at the base of the petioles clasping the twigs). *Lamina* leathery or papery, variable in shape but mainly elliptic; apex acute, acuminate or attenuate; base acute to cuneate or decurrent; midrib flattened to raised above, usually raised; margin entire and finely revolute; secondary veins brochidodromous or cladodromous. *Glands* fine, closely arranged in dark grey-black to greenish interrupted wavy lines or a mix of short and long lines, and sometimes also with dashes or small dots. *Inflorescences* terminal or axillary; flowers solitary or to 40 in thyrses or glomerules, flowers functionally dioecious; sepals and petals 2-5. *Male*: stamens in a central, annular mass or in 2-5 lobes or bundles, fused or separated; with or without pistillode; anthers with 1, 2, 4 thecae or multi-thecous, sessile or with a short filament. *Female*: staminodes present or absent; ovary 2-13 locular, rarely unilocular, each locule with a solitary ovule; stigma raised or sessile sometimes elongated to 3 cm, discoid, flattened, convex or sunken, sometimes with a corrugated surface, margin with or without lobes, crenate or entire. *Fruit* a berry, rarely dehiscent, globose or ovoid, stigma with or without neck. Seed with fleshy edible pulp.

Distribution – Pantropical

6.6 Section Description

Garcinia section *Garcinia*

Garcinia sect. *Mangostana* (Rumph. ex Gaertn.) Choisy, Mem. Soc. Hist. Nat. Paris 1 (1), (1823) 210 excl. *G. cambogia* (*G. gummi-gutta*) & *G. morella*; Planch. & Triana, Ann. Sci. Nat. Bot. ser. 4, 14 (1860) 325; Lanessan, Adansonia 10 (1871) 285; Lanessan, Mem. Gen. Garcinia (1872) 14; Pierre, Fl. Forest. Cochinch.1 (1882) 11; Vesque in A. DC., Monogr. Phan. 8 (1893) 253, pro parte; Engler in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 3(6), (1925) 221. — *Garcinia* subgenus *Mangostana* (Rumph. ex Gaertn.) Wight, Ill. Ind. Bot., 1 (1840) 120 excl. *G. merguensis.* — *Mangostana garcinia* Rumph. ex Gaertn., Fruct. Sem. Pl., 2(1) (1790) 105. — Type: *Garcinia mangostana* L.

Garcinia sect. *Conocentrum* Pierre, Fl. Forest. Cochinch.1 (1882) 10; Engler, in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 3(6), (1925) 224. — Lectotype (proposed here): *Garcinia malaccensis* Hook. f.

Garcinia sect. *Echinostigma* Pierre, Fl. Forest. Cochinch.1 (1882) 10, pl. 60; Engler, in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 3(6), (1925) 223. — Lectotype (proposed here): *Garcinia harmandii* Pierre.

Garcinia sect. *Gamodesmis* Pierre, Fl. Forest. Cochinch.1 (1882) 10; Engler, in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 3(6), (1925) 223. — Lectotype (proposed here): *Garcinia moselleyana* Pierre.

Garcinia sect. *Kiras* Pierre, Fl. Forest. Cochinch.1 (1882) 12. — Lectotype (proposed here): *Garcinia celebica* L.

Garcinia sect. *Simosanthera* Pierre, Fl. Forest. Cochinch.1 (1882) 18; Engler, in Engler & Prantl, Nat. Pflanzenfam., ed. 2, 3(6), (1925) 221. — Lectotype (proposed here): *Garcinia nitida* Pierre.

Garcinia sect. *Sphaerocentrum* Pierre, Fl. Forest. Cochinch.1 (1882) 11. — Lectotype (proposed here): *G. cumingiana* Pierre [= *Garcinia venulosa* (Blanco) Choisy]

Tree or small tree to 25 m tall or bushy tree. *Exudate* yellow, white or cream. *Twigs* usually angled, stout, wrinkled lengthwise when dry. *Petiole* finely striate horizontally when dry, stout. *Lamina* leathery, pale brown or pale grey-brown, greenish, or reddish when dry, variable in shape but mainly elliptic, oblong or ovate; apex acute or acuminate; base acute to cuneate or decurrent; midrib flattened and inconspicuous, slightly or strongly raised above, strongly raised and sometimes angular (when dry) below; margin entire and finely revolute; secondary veins brochidodromous or sometimes cladodromous; tertiary veins fine and reticulate. *Glands* fine, closely arranged, dark grey, black or greenish, in interrupted short or long wavy lines, dashes and dots or a mixture, running from midrib to the margin across the secondary nervation, nearly parallel or not to the midrib. *Inflorescences:* terminal or rarely axillary, males with 1-18 flowers in a cluster; females usually solitary but also in groups of 2-3 flowers; bracts triangular, thickly leathery. *Male flower* with 4 sepals and petals or rarely 5 (*G. moselleyana*); leathery or papery; stamens in a central bundle, 4-angled or minutely to strongly 4-lobed; with or without pistillode, pistillode fungiform; anthers 2-thecous, recurved, dehiscing by longitudinal slits. *Female:* staminodes absent or present as fungiform or free stamen-like, surrounding the ovary; stigma raised or sessile, usually with corrugated surface, margin with lobes. *Fruit* globose or ovoid with thick or thin wall, stigma with or without neck; calyx persistent. Seed with fleshy edible pulp.

Distribution – 16 species and 5 varieties, eastern India to New Guinea.

Habitat & Ecology – Lowland to montane forest.

6.7 Identification Keys

6.7.1 Key to species from vegetative characters

1. a. Leaves with one intra-marginal vein or none…..…………..…………….………....**3**
b. Leaves with two intra-marginal veins ……..……..…………..……...................**2**

2. a. Secondary veins prominent, thick and raised on both sides; cultivated tree……………………………………………….……………**9. *G. mangostana***
b. Secondary veins visible and raised below, weakly raised above; wild tree...**8. *G. malaccensis***

3. a. Leaf small, less than 1.0 cm wide ……..…………………………….……..….**4**
b. Leaf big, more than 1.0 cm wide……...……..……………..……………….……**5**

4. a. Leaf very narrowly elliptic, length : breadth ratio > 3, to 8 cm long……………….……………………………………………**2.** ***G. cataractalis***

b. Leaf elliptic, length : breadth ration < 2, to 2.5 cm long……………………………………….……..………..…**6.** ***G. exiguus***

5. a. Leaf mainly elliptic or ovate……………………………….…………………**6**

b. Leaf spathulate or obovate.……….…………….…………………**7.** ***G. harmandii***

6. a. Midrib raised above……………………………….………………………**7**

b. Midrib flattened or slightly sunken above…………………..…**10.** ***G. moselleyana***

7. a. Cross section of midrib (lower part of the lamina) square above……………….…………..……………………………………..……**8**

b. Cross section of midrib (lower part of the lamina) convex above……………………………………..……………..………..…..……**12**

8. a. Glandular lines invisible or visible but not raised below…….………..……..**9**

b. Glandular lines prominent and raised below…………..……..…**13.** ***G. penangiana***

9. a. Glandular lines clearly visible below……………..………..………………**10**

b. Glandular lines invisible below..………………………………**12.** ***G. ochraceus***

10. a. Glandular lines a mixture of long and short wavy lines, dashes and dots……………………………………………………….…………..……**11**

b. Glandular lines dominated by long wavy lines, with occasional short lines…………………………………….……………..…**4.*****G. diospyrifolia***

11. a. Glandular lines: many short wavy lines between long lines………………………………………………………..…**11.** ***G. nitida***

b. Glandular lines: many dots and dashes between long lines……………………………….……….…..…**15.** ***G. sangudsangud***

12. a. Secondary nervation visible and distinct below……………………………**13**

b. Secondary nervation faint, inconspicuous or invisible below………………………………………….………..…**5.** ***G. discoidea***

13. a. Leaves elliptic or ovate, twice as long as wide or less……………..……..…..**14**

b. Leaves narrowly elliptic, 3 times as long as wide or more..……………………………………………………**1.** ***G. acuticosta***

14. a. Base of petiole without ligule-like appendage…….…………………………..**15**

b. Base of petiole with ligule-like appendage……….……..……**16.** ***G. venulosa***

15. a. Glandular lines closely arranged, c. 0.5 mm apart, usually not raised below…………………………………………………..…………**3.** ***G. celebica***

b. Glandular lines closely arranged, c. 1.0 mm apart, usually raised below……………………………………………………..…**14.** ***G. rigida***

6.7.2 Key to species for fertile specimens

1. a. Fruit wall thick or thin but rigid, and not easily ruptured when dry; inflorescences solitary, or with up to 16 flowers; stamens in distinct 4-lobed bundles or in a bundle of 4-angled or conical-shape…………. …………………………..………………**2**

b. Fruit wall thin and easily ruptured with fingernail when dry; inflorescences solitary, in pairs or triads and rarely fours; stamens in weakly 4-lobed bundles…………….…………………………..……………………....**Group IV**

Key to species for Group IV

i. a. Leaves small, less than 1.0 cm wide…….…………………….……………...**ii**
b. Leaves more than 1.0 cm wide………..…..…………………….………**iii**

ii. a. Fruit small, less than 11 mm long; stigma nearly sessile...**6. *G. exiguus***
b. Fruit more than 11 mm long; stigma elongated, 6 mm long………………………………………..………...**2. *G. cataractalis***

iii. a. Stigma sessile or raised to 2 mm long, flattened, convex-discoid or skull-cap shaped...**iv**
b. Stigma raised and elongated to 10 mm long, with flattened-discoid or sunken surface…………………………….……………….………..**11. *G. nitida***

iv. a. Stigma sessile, flattened-discoid but slightly sunken in the middle, margin crenate…………………………………….……....……**12. *G. ochraceus***
b. Stigma sessile or weakly raised to 2 mm long, skull-cap shaped, convex-discoid or occasionally sunken, margin 4-6 lobed……………………………………….....…....**4. *G. diospyrifolia***

2. a. Secondary veins brochidodromous or cladodromous with 1 intra-marginal vein or none; stigma on fruits with weakly lobed or irregularly dentate margin, raised to 8 mm or occasionally sessile; stamens 4-lobed, attached at the base of pistillode, pistillode in central ……………………...…..……………..……………………**3**
b. Secondary veins brochidodromous with 2 intra-marginal veins, occasionally one intra-marginal vein; stigma on fruits distinctly lobed, square or wedge-shaped,

sessile or weakly sessile; stamens 4-angled or nearly cruciform, pistillode on top of stamen bundles or absent …………………………………….……………...**Group I**

Key to species of Group I

i. a. Forest species found in the wild; mature fruit yellowish or reddish, turning brownish or reddish when dry; pistillode of male flower very small to 3 mm long, or absent……………………………..……………………….…………**ii**

b. Cultivated species, not found in the wild; mature fruit dark purplish turning blackish when dry; pistillode of male flower distinct more than 5 mm long……..……………………..……………………..……….***G. mangostana***

ii. a. Twigs and pedicel stout; leaves with two intra-marginal veins, cross section of midrib convex; calyx of fruit thickly leathery, stigma bundles square, fused or separated; stamen bundles conical or square...……………………………….**iii**

b. Twigs and pedicel slender; leaves with intra-marginal veins, cross section of midrib square; calyx of fruit thinly leathery, stigma bundles wedge-shaped, fused; stamen bundles cruciform……………………………….***G. penangiana***

iii. a. Found in Peninsular Malaysia, Sumatra and Borneo; stamens conical or square; pistillode very small on top of stamen bundle or absent; stigma on fruit weakly raised or sessile, surface corrugated, stigma bundles sometimes separate when mature……………..………………….…….**8. *G. malaccensis***

b. Found only in Philippines; stamens square; pistillode absent; stigma on fruit sessile, with smooth surface, stigma bundles not separate when mature…………………………………….………..…..……**16. *G. venulosa***

3. a. Secondary veins brochidodromous...……………..…………….………………**4**

b. Secondary veins cladodromous ………………………….…………...…...**Group III**

Key to Species of Group III

i. a. Inflorescences terminal; flowers with 4 sepals and petals; leaves mainly elliptic…..…………………….…………………………**7.** ***G. harmandii***

b. Inflorescences terminal and axillary; flowers with 5 sepals and petals; leaves spathulate or obovate………………………..…..…………**10.** ***G. moselleyana***

4. a. Distinctly 4-lobed stamens; fruit wall thick or thin and stigma with lobes, sunken or convex surface; glandular lines long, wavy……..…………………..…………..…**5**

b. Minutely 4-lobed stamens; fruit wall thick and stigma without lobes, sunken or flattened; glandular lines long, wavy with many dashes and dots…..**Group V [15.** ***G. sangudsangud*****]**

5. a. Glandular lines distinct and raised below, c. 1 mm apart; fruit with thin wall, less than 0.5 mm thick……………………..……………….. **Group VI [14.** ***G. rigida*****]**

b. Glandular lines faint, not raised below, less than 1 mm apart; fruit wall thick, more than 1 mm thick………..……………………..…………….…….……**Group II**

Key to species of Group II

i. a. Secondary nervation conspicuous and visible below; glandular lines fine but visible; sepals and petals thinly leathery; fruit usually drying brownish….…**ii**

b. Secondary nervation inconspicuous or invisible below; glandular lines invisible or very faint; sepals and petals thickly leathery; fruit drying blackish……………………………………………………..…..**5.** ***G. discoidea***

ii. a. Stigma raised to 2 mm long, discoid with nearly flattened surface, weakly 4-5 lobed, margin entire; male flower not known………………....**1.** ***G. acuticosta***

b. Stigma raised and elongated to 8 mm long, surface sunken or convex, 4-8 lobed, margin revolute; male flowers with 4-bundles of stamens……………………..…………..………………………..…**3. *G. celebica***

6.8 Species Descriptions

1. Garcinia acuticosta Nazre sp. nov. – Figure 6.1; Map 6.1.

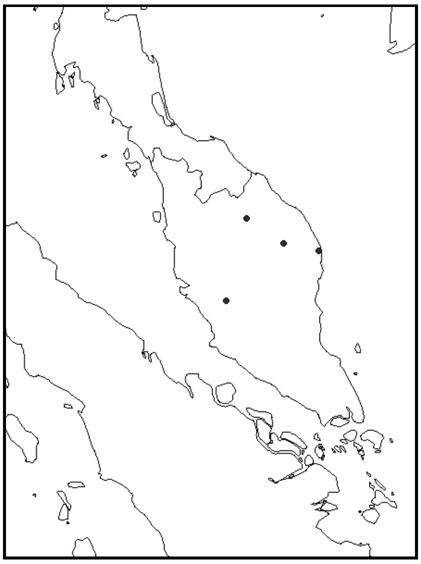
— Type: Loh Hoy Shing FRI 13410 (holo KEP; iso L). Selangor, Peninsular Malaysia. (Etymology: Lat. from sharp midrib when dry)

Small tree to 10 m tall. *Bole*: bark greyish-brown or reddish, flaking; inner bark reddish-brown; sapwood yellowish-red. *Exudate* white turning yellow. *Twigs* angled, stout, strongly longitudinally striate when dry, dark brown or chocolate to pale brownish (greenish-yellow in new specimens). *Petiole* finely striate horizontally, stout, darker than the leaves, 0.8-1.4 cm long. *Lamina* thickly to thinly leathery, pale brown or pale grey-brown, darker and shiny above, narrowly elliptic, 16.0-21.0 x 1.8-2.4 cm; apex acute or bluntly acuminate; base acute to cuneate; midrib nearly same colour as petiole, weakly raised above, raised and sharply angled in cross section below when dry; margin entire and very finely revolute; secondary veins fine, visible above and inconspicuous below, brochidodromous, closely arranged, weakly raised; tertiary veins nearly invisible, fine and very faint. *Glands* fine, dark grey-black to greenish interrupted wavy lines, nearly parallel to the midrib, running across the secondary veins to the margin. *Inflorescences* probably terminal. *Male flower* not seen. *Female* flower not seen. *Fruit* terminal, solitary, ovoid, green turning yellow, surface smooth and wall thick, 5.0-5.3 x 2.3-3.7 cm; with 4 prominent thick leathery sepals, to 1.3 cm long; stigma weakly raised to 2 mm or sessile, black, discoid, flattened or slightly convex with 4-5 weak lobes, and hardened, to 5.5 mm across.

Distribution –Peninsular Malaysia.

Habitat & Ecology – Lowland and hill forest to 500 m, rare.

Notes – Previously, material of this species has been placed in *G. opaca* King (synonym of *G. diospyrifolia*) though it has very different leaves and fruit. The dry leaf usually has a raised and sharp midrib on the abaxial surface when dry, and the fruit walls are thicker than in *G. diospyrifolia*. Molecular data suggest that it is closely related to *G. discoidea* but it differs in leaf shape and the glandular lines are more widely spaced.



Map 6.1. Distribution of *Garcinia acuticosta* Nazre.

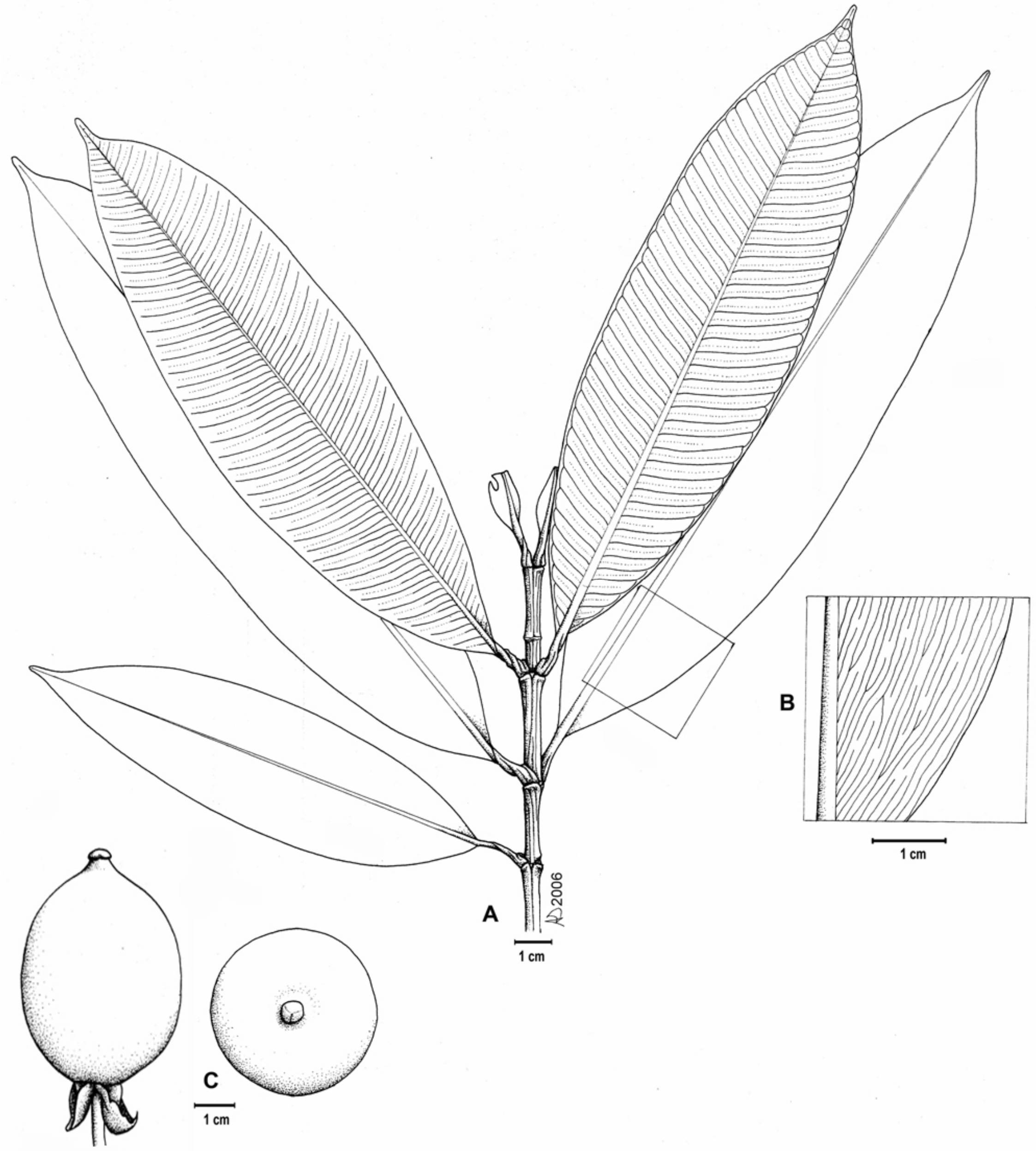


Figure 6.1. *Garcinia acuticosta* Nazre. **A**. habit (male); **B**. glandular lines; **C**. fruit and stigma [*Nazre BB01,* E]. Drawn by Anna Dorward.

2. **Garcinia cataractalis** Whitmore – Figure 6.2; Map 6.2.

Garcinia cataractalis Whitmore, Gard. Bull. Singapore 26(2) (1973) 274. — Type *Whitmore FRI* (holo KEP, iso K) Terengganu, Peninsular Malaysia.

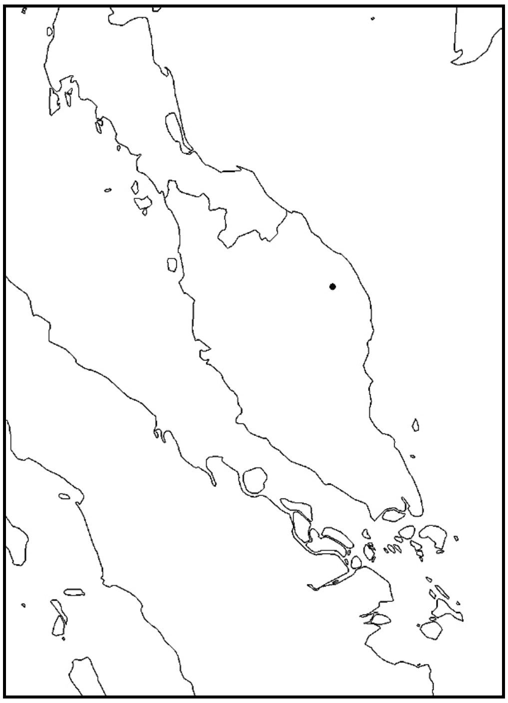
Bushy tree to 2.5 m tall. *Twigs* angled, slender, longitudinally striate when dry, pale grey-brown to greenish. *Petiole* finely striate horizontally, pale grey-brown to greenish and whitish, 0.3-0.7 cm long. *Lamina* thinly leathery, pale brown or brown, darker and shiny above, very narrowly elliptic, 2.5-7.4 x 0.3-0.8 cm; apex acute or attenuate; base cuneate or decurrent onto petiole; midrib raised above, raised and sharp below; margin entire and finely revolute; secondary veins very faint above, invisible below; tertiary venation not visible. *Glands* fine, closely arranged and slightly raised below, dark grey-black to brown, continuous and interrupted wavy lines, nearly parallel to the midrib. *Inflorescences* perhaps terminal. *Male flower* not seen. *Female flower* not seen. *Fruit* globose to ovoid, weakly 2-3 lobed when dry, dark maroon or reddish-brown, smooth, 1.9-2.1 x 1.8-2.0 cm; stigma elongated to 6 mm long, skull-cap shaped with 4-5 weak lobes, blackish, to 4 mm across; four persistent, leathery, elliptic sepals, 0.5-0.6 x 0.3-0.5 cm; seeds 4 with a translucent aril, sour.

Distribution – Peninsular Malaysia.

Habitat & Ecology – The only rheophytic species in the section, usually found on flooded riverbanks.

Note – An endemic species only recorded in Peninsular Malaysia. *G. cataractalis* is a new inclusion to sect. *Garcinia* not previously listed by Jones (1980). Whitmore (1973) described the fruit as being terminal or axillary but I have yet to find any specimens with the fruit borne in axils. This is an easily identified species which is characterised by being a dense and bushy small tree with very narrow, small, elliptic leaves.

The fruits resemble those of *G. diospyrifolia* and *G. nitida* but it is more closely related to *G. diospyrifolia* with which it shares similar vegetative characters of glandular lines and the nervation on the leaves. Molecular analysis and morphology supported the inclusion of *G. cataractalis* in sect. *Garcinia*.



Map. 6.2. Distribution of *Garcinia cataractalis* Whitmore.

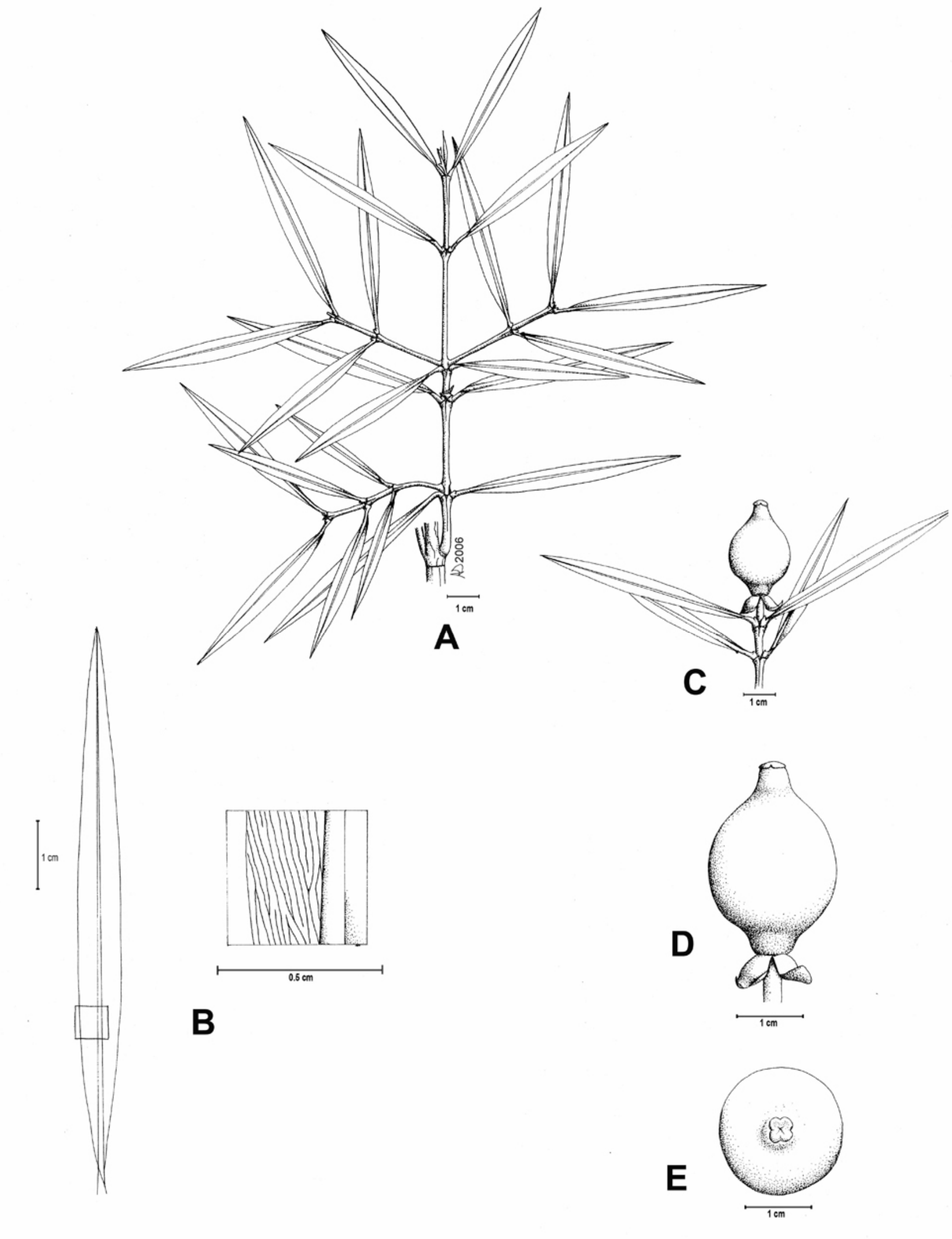


Figure 6.2. *Garcinia cataractalis* Whitmore. **A**. habit (female); **B**. lamina and glandular lines; **C**, **D**, **E**. fruits and stigma. [*Whitmore FRI 20350,* K]. Drawn by Anna Dorward.

3. **Garcinia celebica** L. – Figure 6.3; Map 6.3.

Garcinia celebica L. in Stickman, Herb. Amboin. (Linn.) (1754) 119; Linnaeus, Syst. Nat., ed. 12 (1767) 326 & in Murray, Syst. Veg. ed. 13 (1774) 368; Miquel, Fl. Ned. Ind. 1 (1859) 507; Planch. & Triana, Ann. Sci. Nat. ser. 4, 14 (1860) 173; Pierre, Fl. Forest. Cochinch. 1 (1882) 13; Vesque, Monogr. Phan. 8 (1893) 404; Boerlage, Cat. Pl. Phan. 2 (1901) 69; Koorders & Valeton, Bijdr. Boomsoort. Java 9 (1902) 367; Merrill in Interpr. Herb. Amb. (1917) 373; Backer & Bakhuizen, Fl. Java (Spermatoph.), (1963) 387. — *Mangostana celebica* Rumph. ex Gaertn., Fruct. Sem. Pl. 2(1), (1790) 105. — Lectotype (proposed here): "*Mangostana celebica"* in Rumphius, Herb. Amboin. (Rumphius) 1 (1741) 134, pl. 44.

Garcinia cornea L. in Murray, Syst. Veg. ed. 13 (1774) 368; Blume, Bijdr. Fl. Ned. Ind. (1825) 214; Roxb., Fl. Ind. ed. 2, 2 (1832) 629; Miquel, Fl. Ned. Ind. 1 (1859) 506; Lanessan, Mem. Gen. Garcinia (1872) 21; Pierre, Fl. Forest. Cochinch. 1 (1882) 12 & Fl. Forest Cochinch. 1 (1883) pl. 78B; Merrill in Interpr. Herb. Amb. (1917) 374. — *Garcinia porrecta* Anders. in Lanessan, Mem. Gen. Garcinia (1872) 21, nom. nud. — *Garcinia porrecta* Laness. in Vesque, Monogr. Phan. 8 (1893) 397, nom. illegit. — Lectotype (proposed here): *"Lignum corneum"* in Rumphius, Herb. Amboin. (Rumphius) 3 (1743) 55, pl. 30.

Garcinia speciosa Wall., Pl. Asiat. Rar. 3(11) (1832) 37, pl. 258 ; Planch. & Triana, Ann. Sci. Nat. ser. 4, 14 (1860) 171; Hook f., Fl. Brit. India 1 (1872) 260; Kurz, Forest. Fl. Burma (1877) 88; Pierre, Fl. Forest. Cochinch. 1 (1882) 14 & Fl. Forest Cochinch. 1 (1883) pl. 79I & 79H; King, J. Asiat. Soc. Bengal, Pt. 2 Nat. Hist. 59 (1890) 154; Vesque, Monogr. Phan. 8 (1893) 402; Parkinson, Forest. Fl. Andaman Isl. (1923) 90; Craib, Fl. Siam 1 (1931) 117; Maheshwari, Bull. Bot. Surv. India 6 (1964) 123. — Lectotype (proposed here): *Wallich 4855* (K), Mertaban & Amherst, Burma.

Garcinia fabrilis Miq., Fl. Ned. Ind. Eerste. Bijv. 496 (1861). — Lectotype (proposed here): *Diepenhorst HB 2152* (L), Priaman, Sumatra, Indonesia.

Garcinia basacensis Pierre, Fl. Forest. Cochinch. 1 (1882) 15, pl.58; Vesque, Monogr. Phan. 8 (1893) 398. — Lectotype (proposed here): *Harmand 1074* (lecto P; iso K) Laos.

G. benthami Pierre, Fl. Forest. Cochinch. 1 (1882) 12, pl.55 & 56; Vesque, Monogr. Phan. 8 (1893) 392; Boerlage, Cat. Pl. Phan. 2 (1901) 70. — Lectotype (proposed here): *Pierre 700* (lecto P [barcode P329872]; iso A, K), Cambodia.

Garcinia ferrea Pierre, Fl. Forest. Cochinch. 1 (1882) 12, pl.57. — Lectotype (proposed here): *Pierre 3634* (lecto P), Cambodia.

Garcinia hombroniana Pierre, Fl. Forest. Cochinch. 1 (1882) 12 & Fl. Forest Cochinch. 1 (1883) pl.79D, 79E & 79F; King, J. Asiat. Soc. Bengal, Pt. 2 Nat. Hist. 59 (1890) 155; Vesque, Monogr. Phan. 8 (1893) 395; Ridley, Fl. Malay Penin. 1 (1922) 171; Engler, Nat. Pflanzenfam. ed. 2, 21 (1925) 223; Craib, Fl. Siam. 1 (1931) 115; Whitmore, Tr. Fl. Malaya 2 (1973) 212. — Lectotype (proposed here): *Hombron s.n.* (P), Malacca, Peninsular Malaysia.

Garcinia riedeliana Pierre, Fl. Forest. Cochinch. 1 (1882) 12, Fl. Forest. Cochinch.1 (1883) pl.79A. — Lectotype (proposed here): *Riedel s.n.* (K) Gorontalo, Sulawesi.

Garcinia rumphii Pierre, Fl. Forest. Cochinch. 1 (1882) 13 & Fl. Forest Cochinch. 1 (1883) pl.77A; Vesque, Monogr. Phan. 8 (1893) 400. — Lectotype (proposed here): *Treub 4169* (P), Bangka Island, Indonesia.

Garcinia kurzii Pierre, Fl. Forest. Cochinch. 1 (1882) 14 & Fl. Forest Cochinch. 1 (1883) pl.78C. — *Garcinia speciosa* Wall., King, J. Asiat. Soc. Bengal, Pt. 2 Nat. Hist. 59 (1890) 155; Vesque, Monogr. Phan. 8 (1893) 403. — Lectotype (proposed here): *Kurz 24* (P), South Andaman

Garcinia affinis Pierre, Fl. Forest. Cochinch. 1 (1882) 15 & Fl. Forest Cochinch. 1 (1883) pl.78C & 79G, nom. illegit.

Garcinia jawoera Pierre, Fl. Forest. Cochinch**.** 1 (1882) 37. — Lectotype (proposed here): *Pierre 4607* [= Blume 1273] (lecto P; iso L), Java towards Tandjoor, Indonesia.

Garcinia krawang Pierre Fl. Forest. Cochinch. 1 (1882) 37. — Lectotype (proposed here): *Korthals 1313a* (P), Lampei Island, S. Kalimantan, Indonesia.

Garcinia kingii Pierre ex Vesque, Monogr. Phan. 8 (1893) 407. — Lectotype (proposed here): *King's Collector s.n.* (K), Andaman Island.

Garcinia porrecta Wall. ex Vesque, Monogr. Phan. 8 (1893) 390, nom. inval. — *Garcinia porrecta* Wall., Numer. List (1831) 4852, nom. nud.

Tree to 30 m tall. *Bole* fluted, sometimes with steep buttresses dark brown to pale grey-brown, fissured and flaking to expose cream bark; inner bark pink. *Exudate* white, cream or yellow. *Twigs* slightly angled or distinctly 4-angled, drying brownish or reddish brown, striate longitudinally. *Petiole* stout, finely horizontally striate, dark brown or yellowish to greenish, especially in newly collected specimens, 7-23 mm long. *Lamina* variable in shape and size, from elliptic or broadly elliptic to lanceolate, sub-orbiculate or round, 3.3-17.5 x 1.7-11.0 cm, leathery, pale brown or reddish brown when dry but rather greenish in new specimens, usually paler below; apex acute, acute-acuminate, shortly acuminate or blunt; base cuneate to slightly decurrent, obtuse or acute; margin entire, weakly and finely revolute; midrib weakly or strongly raised above, raised and slightly pointed below; secondary veins visible or faint on both sides, slightly raised, brochidodromous; tertiary veins conspicuous, reticulate. *Glands* visible below as fine, black, pale green or brown, closely arranged, c. 0.5 - 0.8 mm apart, wavy, lines running about 45 degrees from the midrib towards the margin. *Inflorescences* terminal; males in clusters of 2-14(18) flowers of different sizes, pedicel slender or stout, angular, to 2.0 cm long, female flowers usually solitary or sometimes in pairs or triads; sepals and petals four; bracts triangular, to 1.7 cm long. *Male flowers* sometimes fragrant, pedicel slender to stout, four angled, variable in size to 25 mm across when open; sepals green to yellowish green, concave, ovate, leathery, usually thicker than petals, 5-8 x 6-7 mm; petals cream to yellowish, oblong, ovate or obovate-elliptic, thinly papery or leathery, 4.3-5 x 9-10 mm; stamens in four lobed bundles, opposite petals; anthers 2-thecous, nearly sessile; pistillode dark blackish, fungiform, stipe short to 3 mm long or sometimes nearly sessile. *Female flower* solitary, 10-12 x 12-15 mm across; sepals ovate, concave, thickly to thinly leathery, 5-9 x 4-6 mm, brown; petals green yellowish, obovate or broadly elliptic, thinly coriaceous; staminodes absent; ovary sub-globose or flask-shaped, locules 4-6; stigma discoid or weakly concave, to 5 mm wide. *Fruits* ovoid to ellipsoid or globose, sometimes shiny, smooth or occasionally wrinkled, green but reddish when mature, pale cream brown or brown to reddish brown when dry, variable in size, to 5.0

cm across; stigma usually raised to 8.0 mm, surface concave or weakly convex, smooth or wavy and corrugated, margin minutely 4-8 lobed; calyx persistent, concave and leathery; seeds 4-6 with a white aril.

Distribution – Eastern India to Malesia

Habitat & Ecology – Mainly found on the coast and in lowland forest near the sea but also distributed in inland forest to lower montane forest (1200 m alt.). Occasionally, also found on limestone.

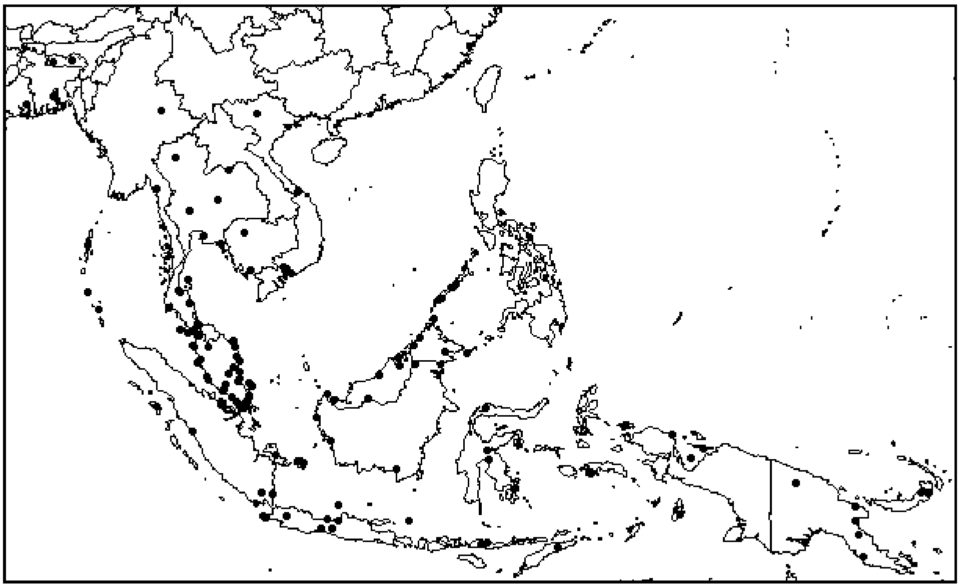
Notes – The taxonomic confusion and resulting long synonymy of *G. celebica* has two sources;

1) Nomenclatural problems

The epithet *celebica* has priority in the long list of synonyms. The species was called *Mangostana celebica* by Rumphius (1741) in his pre-Linnaean Herbarium Amboinensis. Stickman (Linnaeus, 1754), who revised Rumphius's work, validated the name and placed this species under *Garcinia* together with *G. mangostana* L. Some time later Murray (Linnaeus, 1774) added another Rumphius species, *Lignum corneum*, as *G. cornea* L. According to Murray (Linnaeus, 1774), *G. cornea* and *G. celebica* differ from each other by their inflorescences (trifloris vs. unifloris). This distinction does not work, especially in the male flowers. There is no surviving type specimen to accompany these two species except in the descriptions and figures by Rumphius (1741). Based on this, other works, such as Miquel (1859 & 1860) and Pierre (1882-1885), acknowledged *G. celebica* and *G. cornea* as two different species and further described new closely related species (e.g. *G. fabrilis* Miq., *G. hombroniana* Pierre) defined by their geographical distributions. Confusion over the true identity of the Rumphius species may be one of the reasons why numerous other species have been described from throughout its distribution. Most new names (*G. affinis, G. basacensis, G. benthami, G. calleryi, G. ferrea, G. hombroniana, G. jawoera, G. krawang, G. kurzii, G. rumphii*) were created by Pierre (1882-1885) largely based on geographical distribution, the latex colour and the position of the stamen lobes (opposite petals or sepals). The characters that unite all the previous names are in the male flowers and the fruit: the stamens being in four distinct lobes surrounding the pistillodes, thinly leathery sepals and petals; and mature fruits usually with a neck and a sunken stigma with lobes.

2) The usage of characters and discontinuity of variation

The usage of the stamen lobes as an important character by Pierre (1882-1885) when describing new species from different geographic regions is misleading because some specimens he observed were still in bud and the mature bundle positions cannot be ascertained at this stage. The colour of the latex is also not a stable character: for example, within *G. celebica* (*G. hombroniana*) in Peninsular Malaysia, Whitmore (1973) found that the colour could be white, opaque or yellow, though the cause of this variability is not known. There is also more variability in the other characters used by Pierre (1882-1885) and Whitmore (1973): for example the length of the pedicel, the shape of the fruit and the degree of elongation (neck) of the stigmas. I found that there are no clear cut discontinuities in these morphological characters or any characters exclusive to certain geographical areas. One explanation for this variation is facultative agamospermy in *G. celebica* which has been confirmed by Richards (1990b) in a population in Peninsular Malaysia. However, proving the effect of agamospermy on variation by using herbarium materials is impossible. It will be interesting if further study could look at this problem, especially at the population level.



Map 6.3. Distribution of *Garcinia celebica* L.

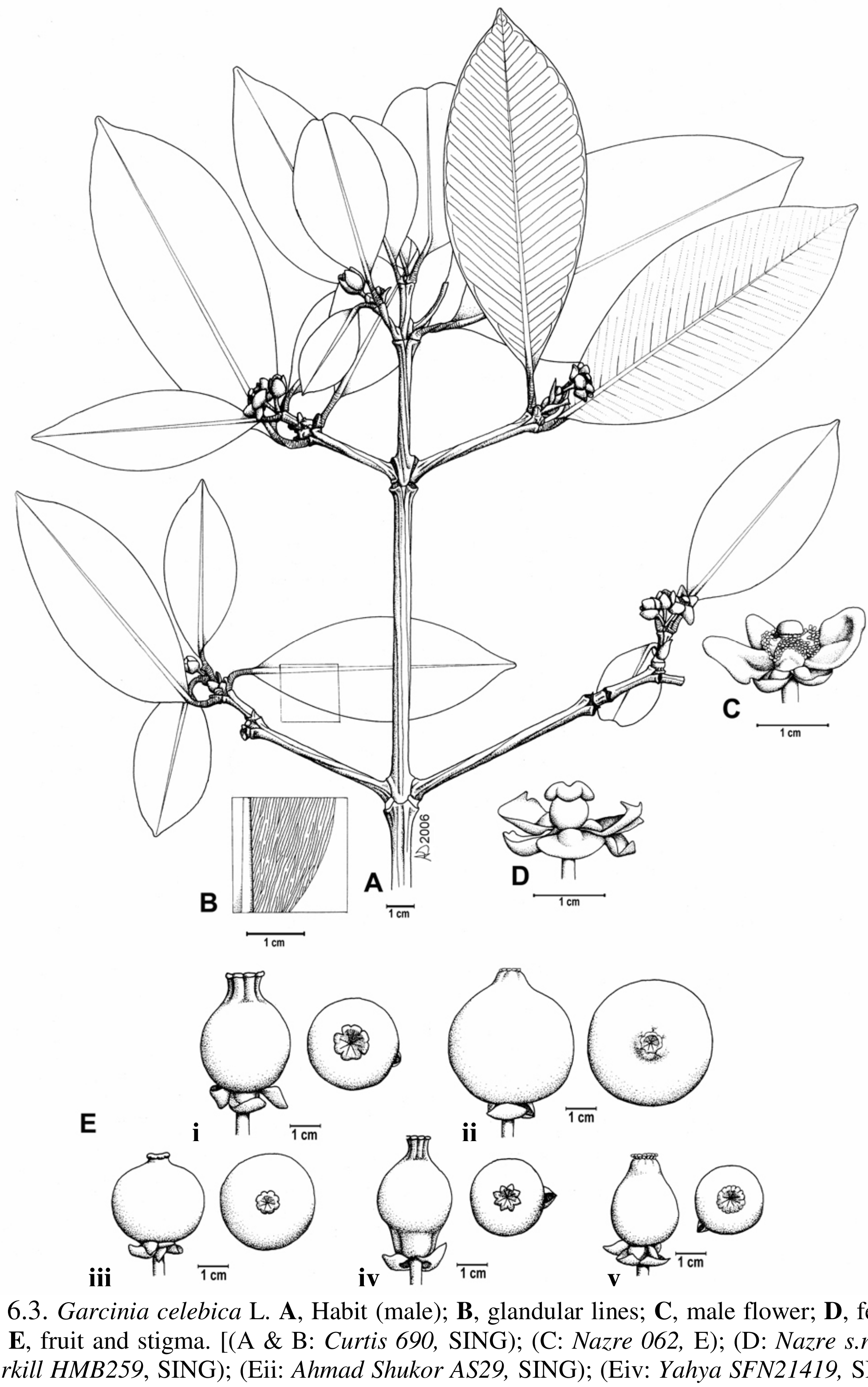


Figure 6.3. *Garcinia celebica* L. **A**, Habit (male); **B**, glandular lines; **C**, male flower; **D**, female flower; **E**, fruit and stigma. [(A & B: *Curtis 690,* SING); (C: *Nazre 062,* E); (D: *Nazre s.n.,* E); (Ei: *Burkill HMB259*, SING); (Eii: *Ahmad Shukor AS29,* SING); (Eiv: *Yahya SFN21419,* SING); (Ev: *Pierre 700,* K)]. Drawn by Anna Dorward.

4. **Garcinia diospyrifolia** Pierre – Map 6.4.

Garcinia diospyrifolia Pierre, Fl. Forest. Cochinch. 1 (1882) 37. — Lectotype (proposed here): *Korthals s.n.* (lecto L; iso K, UC), Gunung Sekubang, Kalimantan.

Slender or bushy, medium sized tree to 15 m tall. *Exudate* white or light yellow. *Twigs* slender, angled, longitudinally wrinkled when dry, brownish red to brown or yellowish. *Petiole* finely horizontally striate, close and nearly parallel, dark brown to black or reddish brown, 0.7-1.6 cm long. *Lamina*: leathery, dull dark green above, green below, and when dry turning reddish brown or grey brown to brownish, darker and slightly shiny above, pale below, elliptic to narrowly elliptic, elliptic-oblong or elliptic-obovate, 8.0-13.0 x 2.5-5.5 cm; usually with caudate apex, sometimes attenuate or acuminate, to 20 mm long; base cuneate or decurrent onto petiole; midrib raised but with flattened surface or nearly square in cross section above, especially at the base of the lamina, raised and sharp below; margin entire and finely revolute. *Nervation:* secondary veins visible, fine and closely arranged, sometimes conspicuous above, brochidodromous; tertiary veins invisible. *Glands* fine but clearly visible below (not visible on the older specimens), dark brown to blackish short and long wavy lines, running across the secondary veins from midrib to the margin. *Inflorescences* terminal, male flowers 1-3, female solitary; sepals and petals 4. *Male flower*: rarely found, pedicel slender, slightly angular, to 10 mm long, sepals yellowish turning brown when dry, concave, ovate, leathery, usually thicker than petals, 5-6 x 6-7 mm; petals reddish turning dark-maroon to brownish when dry, oblanceolate or obovate, 4.0-7.5 x 5.0-6.5 mm; stamens in four weak lobes not open or weakly open at maturity, enclosing the pistillode; pistillode dark blackish, fungiform in shape; anther 2-thecous. *Female flower* with a flask-shaped ovary to 10 mm long, tipped with a convex or skull-cap shaped stigma, margin wavy; staminodes absent. *Fruit:* ellipsoid, ovoid or flask shaped, reddish-brown or bright maroon, wall smooth, thin, easily ruptured when dry, to 3.7 x 5.0 cm; calyx leathery, tipped by a small skull-cap shaped, convex-discoid or occasionally sunken stigma, sessile or weakly raised to 2 mm long, to 2 mm across, margin with 4-6 lobes; sepals thinly leathery, reddish brown, elliptic, concave; seeds 4, with white aril.

Distribution – Peninsular Malaysia and Borneo.

Habitat & Ecology – A common treelet or small tree from lowland to lower montane forest.

Notes – *G. diospyrifolia*, described by Pierre (1882-1885) from Borneo (Kalimantan), and *G. opaca*, described by King (1891) from Peninsular Malaysia, are the same species. Whitmore (1973) created a new variety of *G. opaca* (var. *dumosa*) differing mainly in the overall appearance of the tree in Peninsular Malaysia (bushy vs. tree) and listed specimens that he studied. Curiously, he included KEP 97842 collected from Gunung Benom which is a tree.

Key to varieties

1. a. Slender or bushy tree to 12 m tall..**2**
   b. Medium sized tree to 20 m tall……………………………………**c.** var. *arborea*

2. a. Slender tree to 7 m tall; fruit turning reddish on drying, ovoid or flask-shaped, stigma raised……………………………………………...…..**a.** var. *diospyrifolia*

b. Bushy tree to 12m tall; fruit turning brownish on drying, globose, stigma sessile……………….………………………………..……….……**b.** var. *minor*

a. var. **diospyrifolia** – Figure 6.4.

Garcinia opaca King, J. Asiat. Soc. Bengal, Pt. 2 Nat. Hist. (1890) 160. — Lectotype (proposed here): *King's Collector 7232* (lecto K; iso P), Perak, Peninsular Malaysia.

Garcinia opaca var. *dumosa* Whitmore, Gard. Bull. Singapore 26 (1973) 277. — Type: *Mohamad Shah bin Mohamad Nur 1560* (holo SING) Bukit Terom, Pahang, Peninsular Malaysia.

Slender tree to 7 m tall. *Lamina* 9.0-15.0 x 3.5-5.0 cm; midrib raised, square in cross section above. *Fruit* green turning reddish or dark maroon when dry; ovoid to flask-shaped, stigma discoid or skull-cap shaped, flattened or sunken, margin lobed.

Distribution: Peninsular Malaysia and Borneo.

b. var. **arborea** Nazre var. nov. – Figure 6.5.

— Type: *Rahim Ismail KEP 97842* (holo KEP; iso K, L) Gunung Benom, Pahang, Peninsular Malaysia.

(Etymology: Lat. from its stature, a tree)

Small to medium sized tree to 20 m tall. *Lamina* 7.0-12.5 x 2.0-5.0 cm; midrib raised, square in cross section above. *Fruit* green turning reddish brown when dry; ovoid, stigma discoid, lobes not distinct.

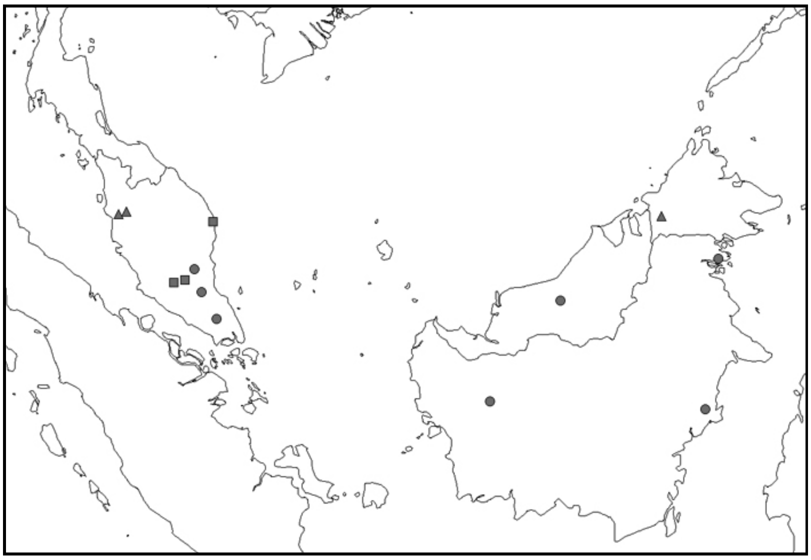
Distribution: Peninsular Malaysia and Borneo.

c. var. **minor** Ng ex Nazre var. nov. – Figure 6.6.

— Type: *K.M. Wong 32216* (holo KEP) Pasoh, Negeri Sembilan, Peninsular Malaysia. (Etymology: Lat. from its small leaf)

Treelet and bushy tree to 12 m tall; bole greenish, to pale brown, smooth to scaly. *Lamina* small, 3.5-8.5 x 1.7-4.5 cm; midrib raised above. *Fruit* green turning red, smooth, brownish when dry with distinct dark reddish-brown or blackish longitudinal wavy lines, very closely arranged; globose or ellipsoid, to 3.5 cm across.

Distribution: Peninsular Malaysia



Map 6.4. Distribution of *Garcinia diospyrifolia* Pierre. *G. diospyrifolia* var. *diospyrifolia* (circle); *G. diospyrifolia* var. *arborea* (triangle); *G. diospyrifolia* var. *minor* (square).

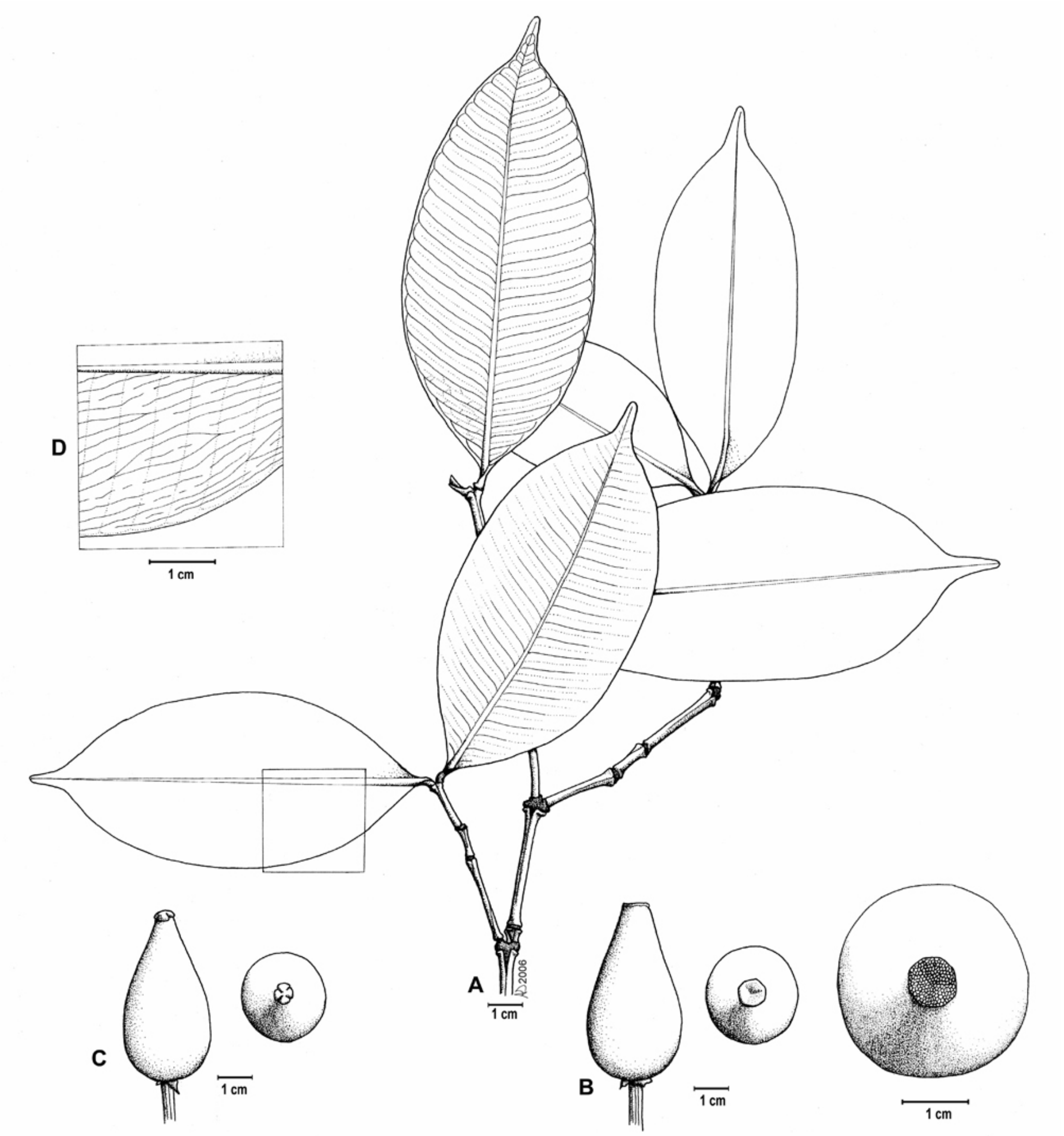


Figure 6.4. *Garcinia diospyrifolia* var. *diospyrifolia.* **A**. habit (female); **B, C**. fruit and stigma; **D**. glandular lines. [(A, B, C. D: *Soegeng 47,* L); (B: *Kochummen 7773,* L)]. Drawn by Anna Dorward.

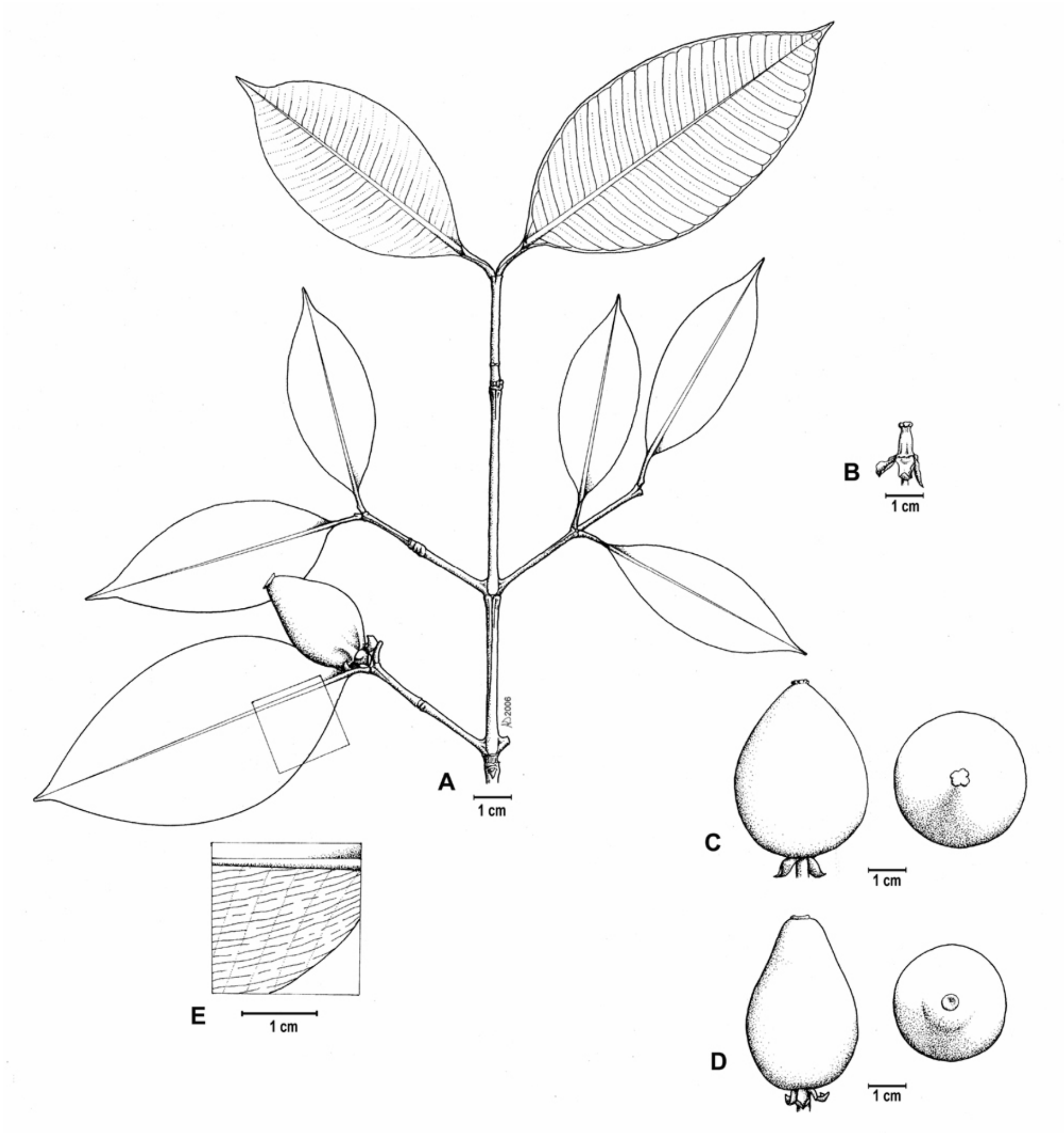


Figure 6.5. *Garcinia diospyrifolia* var. *arborea* Nazre. **A.** habit (female); **B**. female flower; **C**, **D**. fruit and stigma; **E**: glandular lines [(A, B, C, E: *King's Collector 7232,* P); (D: *Pereira JTP65,* E)]. Drawn by Anna Dorward.

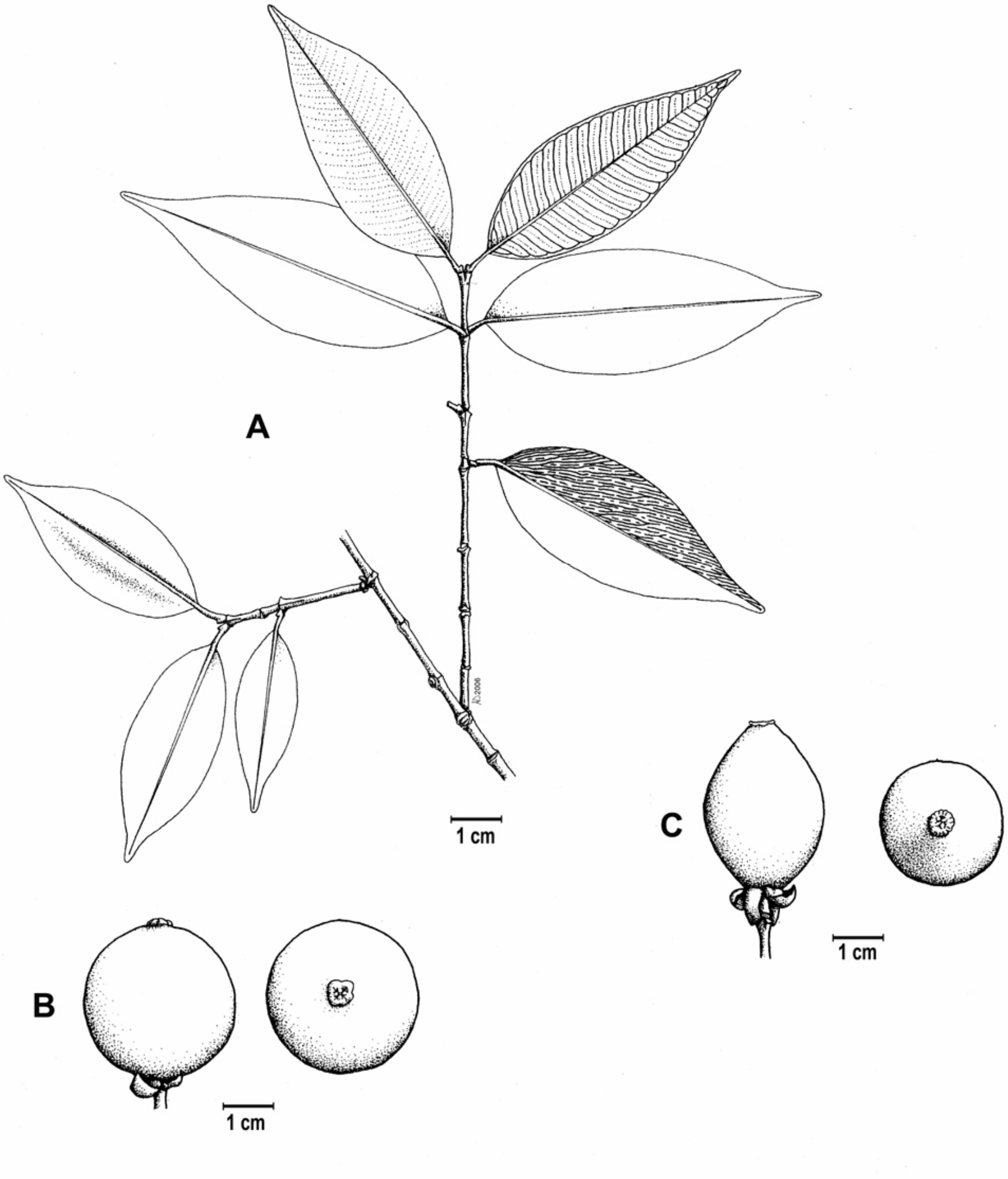


Figure 6.6. *Garcinia diospyrifolia* var. *minor* Ng ex Nazre. **A**. habit (female); **B**, **C**. fruit and stigma [(A, B: *Wong 32216,* A); (C; *Rosemary 541,* L)]. Drawn by Anna Dorward.

5. **Garcinia discoidea** Nazre sp. nov. – Figure 6.7; Map 6.5.

Garcinia hombroniana variety A Whitmore, Gard. Bull. Singapore 26 (1973) 277. — Type: *Corner 34940* (holo SING), Johor, Peninsular Malaysia

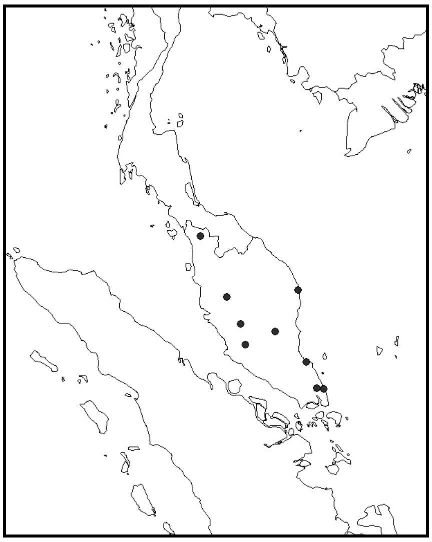
(Etymology: Lat. from discoid shape of stigma)

Tree to 20 m tall. *Bole:* bark greyish brown, dippled and flaking, inner bark reddish brown, sapwood yellowish red. *Exudate* white turning pale yellow or cream. *Twigs* angled, stout, longitudinally wrinkled when dry, dark brown to yellowish or pale green. *Petiole* finely striate horizontally, stout, dark brown to reddish brown (or brownish-yellow to yellowish in new specimens), 1.3-2.5 cm long. *Lamina* thickly leathery, dark brown to brown-maroon (pale brown or pale grey-brown to greenish in new specimens), darker and shiny above, elliptic to broadly elliptic, oblong or ovate, 7.6-20.6 x 2.7-9.3 cm; apex blunt, acute or acuminate; base obtuse to cuneate; midrib same colour as petiole, slightly raised above, raised and sharp below; margin entire and finely revolute; secondary veins fine, visible above but inconspicuous and nearly invisible below, closely arranged, brochidodromous; tertiary veins invisible. *Glands* very fine, inconspicuous, visible on new specimens especially at the base of the leaf, invisible on much older specimens, closely arranged dark grey-green to blackish, interrupted wavy lines, nearly parallel to the midrib, running from midrib across secondary veins to margin. *Inflorescences* possibly terminal. *Male flowers*: rarely found, sepals and petals 4, very thickly leathery, outer usually thicker; pedicel to 15 mm long, stout, angled; sepals concave, broadly ovate, 9.5-11.5 x 11.0-13 mm; petals broadly ovate or oblanceolate, 12.0-13.0 x 11.0-14 mm; stamens arranged in 4-lobed central bundle surrounding the pistillode; pistillode fungiform; anthers 2-thecous, sessile. *Female* flower not seen. *Fruit* solitary and terminal, ellipsoid or ovoid, green when unripe, pale to dark brown or blackish maroon when dry, smooth and finely horizontally striate or sometimes with fine lenticels, 2.0-5.6 x 0.6-4.0 cm; tipped by discoid black stigma, slightly raised to 3 mm, surface flattened or sometimes sunken in the middle, weakly 4-lobed, to 10 mm across; with thick leathery prominent sepals, always curved downwards; seeds 1-4 with a white aril.

Distribution – Peninsular Malaysia widespread but uncommon.

Habitat & Ecology – Hill forest from 600 m to montane forest. Occasionally found in swamp forest.

Notes – The male flowers closely resemble *Garcinia celebica* L. with stamens in 4 lobes. The flowers of *Garcinia discoidea* are, however, much thicker and leathery. The leaf differs from *G. celebica* by being much thicker and the secondary veins are almost invisible on the lower surface.



Map 6.5. Distribution of *Garcinia discoidea* Nazre

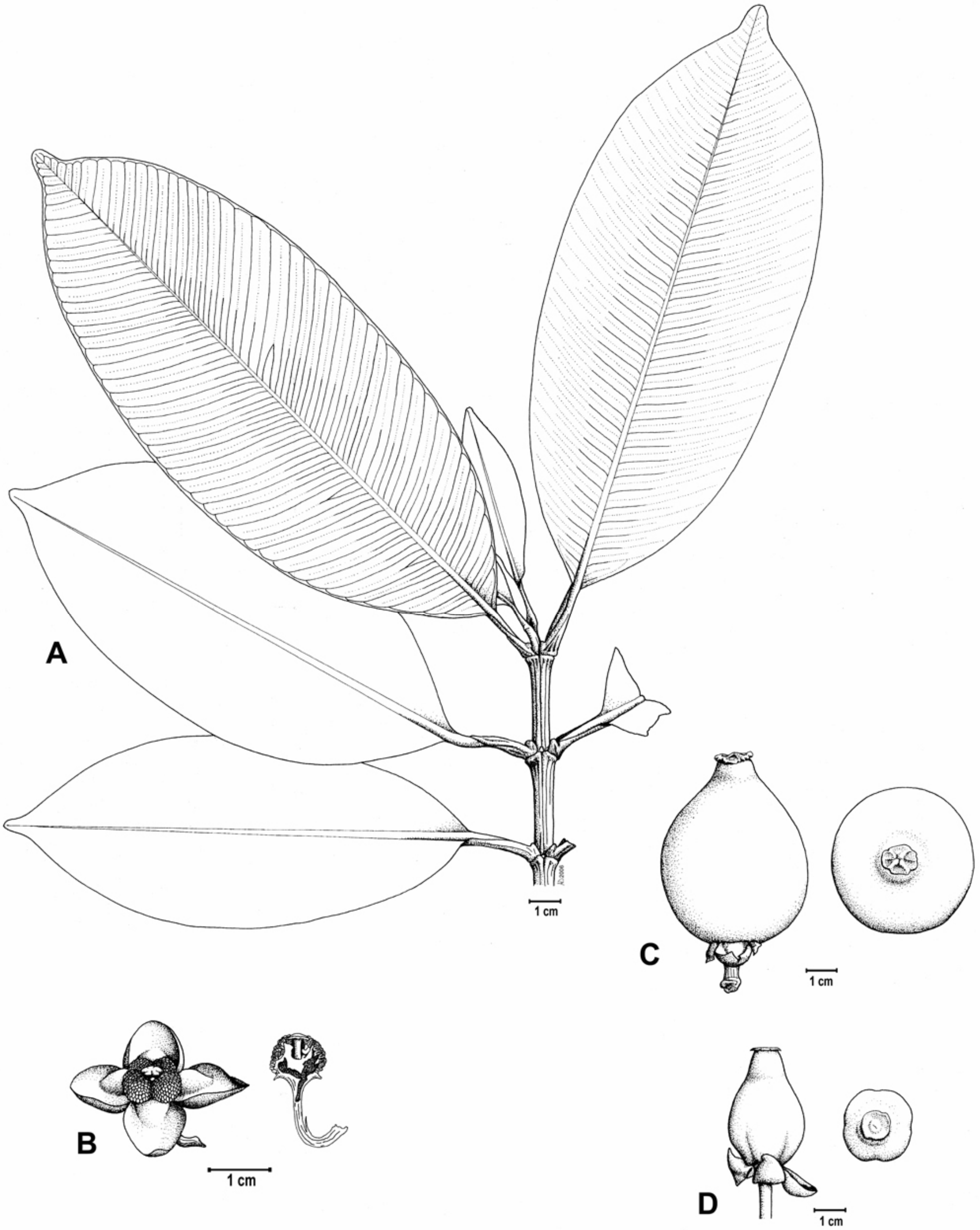


Figure 6.7. *Garcinia discoidea* Nazre. **A**. habit (female); **B**. male flower; **C**, **D**. fruits and stigma. [(A, C: *Shamsul SA02-10,* E); (B: *Corner s.n.,* SING); (D: *Kadim KN307,* L)]. Drawn by Anna Dorward.

6. **Garcinia exiguus** Nazre sp. nov. – Figure 6.8; Map 6.6.

— Type: Paul Chai S31750 (holo SAR; iso L) Bintulu, Sarawak.
(Etymology: Lat. from small size in all parts of the specimens)

Tree to 20 m tall. *Bole:* bark dark brown, flaking, smooth and dippled, inner bark reddish. *Exudate* yellow. *Twigs* angled, stout, longitudinally finely wrinkled when dry, dark brown to pale brownish green, sometimes with very a small leaf-like, terminal bud. *Petiole* finely striate horizontally, dark brown or pale brown, to 0.5 cm long. *Lamina* thickly leathery, pale brown or greenish brown, shiny above, elliptic, 8.1-20.6 x 2.7-9.3 mm; apex acute or bluntly acuminate; base acute to cuneate; midrib raised above and below; margin entire and finely revolute; secondary veins very faint to nearly invisible above, fine and inconspicuous below, brochidodromous; tertiary veins invisible. *Glands* clearly visible below, fine and slightly raised above and raised below, arranged in dark grey-black to greenish interrupted wavy lines, running nearly parallel to the midrib to the margin. *Inflorescences* probably terminal. *Male* flower not seen. *Female* flower not seen. *Fruit* globose or ellipsoid, shiny green turning yellow, wall smooth with finely longitudinal striae, dark maroon to brown, small 9.5-10.5 x 8.5-11.0 mm; stigma sessile or slightly raised, flattened, discoid or convex, weakly 4-lobed or crenate, black rugose, to 4.5 mm across; with four persistent leathery sepals; seeds not known.

Distribution – Borneo: Sarawak and Brunei. Rare species, only represented by two collections.

Habitat & Ecology – Hill forest.

Notes – The fruits and leaves closely resemble those of *G. nitida* Pierre except that they are smaller.

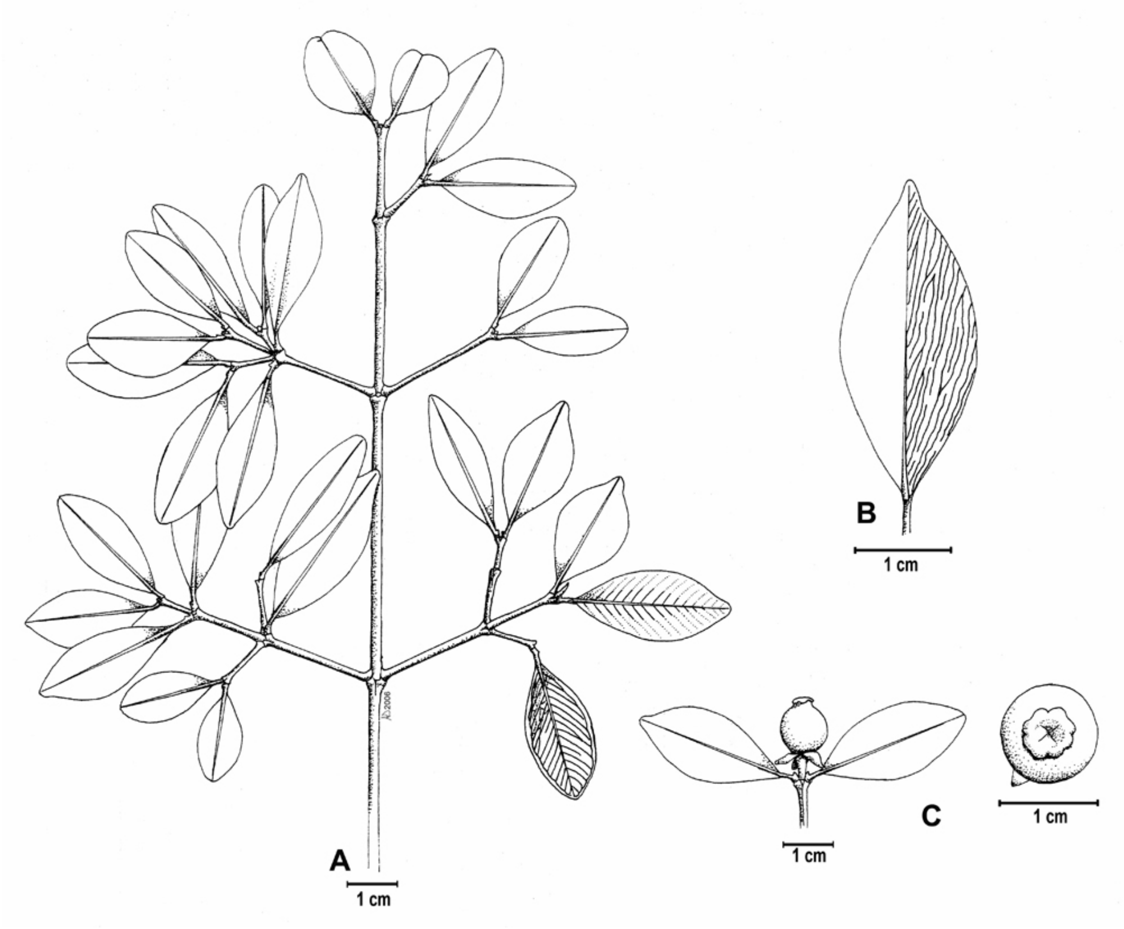
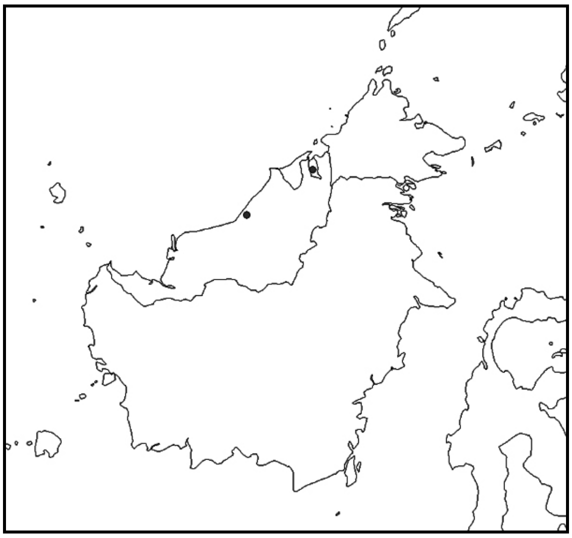


Figure 6.8. *Garcinia exiguus* Nazre. **A**. habit (female); **B**. glandular lines; **C**: fruit and stigma [*Chai S31750,* SAR]. Drawn by Anna Dorward.


Map 6.6. Distribution of *Garcinia exiguus* Nazre

7. **Garcinia harmandii** Pierre – Figure 6.9; Map 6.7.

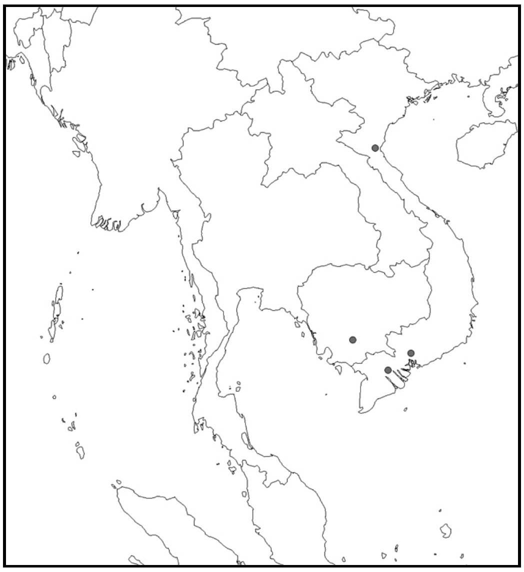
Garcinia harmandii Pierre, Fl. Forest. Cochinch. 1 (1882) 10, pl. 60. — Lectotype (proposed here): *Harmand 349* (P), Laos.

Small bushy tree, 6-10 m tall. *Bole:* no information. *Exudate* yellow. *Twigs* round and slightly angled, longitudinally wrinkled when dry, pale grey-brown to yellowish or blackish. *Petiole* dark brown or blackish, very finely horizontally striate and slightly keeled, stout and short, 0.2-0.9 cm long. *Lamina* leathery, grey-brown or dark brown, spathulate or obovate occasionally elliptic, 3.5-9.2 x 1.3-3.6 cm; apex sharply acuminate to mucronate; base cuneate to acute; margin entire and finely revolute; midrib flattened or slightly sunken above and raised below; secondary veins visible and slightly raised on both surfaces, cladodromous with intra-marginal veins; tertiary veins inconspicuous and fine, a mixture of weakly and transversely ramified and reticulate. *Glands* very fine, inconspicuous to nearly invisible below, invisible above, short wavy lines running across secondary veins. *Inflorescences* terminal; 2-6 flowers in a cluster, usually triads in males; sepals and petals 4; bracts triangular to 2 mm long. *Male flowers* [in bud] 3 to 6; nearly sessile or on a very short pedicel; sepals concave, orbiculate or obovate, coriaceous, to 4 mm long; petals elliptic to oblong to 8 mm long; stamens 4-lobed, opposite petals; pistillodes fungiform. *Female flowers* solitary or in a triad, pedicel short to 3 mm long; bracteole present; sepals concave, orbiculate to 3.5 mm long; petals ovate, to 4 mm long; ovary sub-globose tipped with a black, rugose stigma. *Fruits* small, globose or ovoid 7-10 x 6-11 mm, turning purplish when mature, wall rough and wrinkled when dry; tipped with sessile, black rugose, discoid or skull-cap-like stigma; seeds with a white, sweet aril.

Distribution – Cambodia, Laos, Vietnam.

Habitat & Ecology – Lowland and hill forest.

Notes – Little information is available for this species which is poorly represented in herbaria. The species is characterised by a spathulate leaf with a short pointed apex.



Map 6.7. Distribution of *Garcinia harmandii* Pierre.

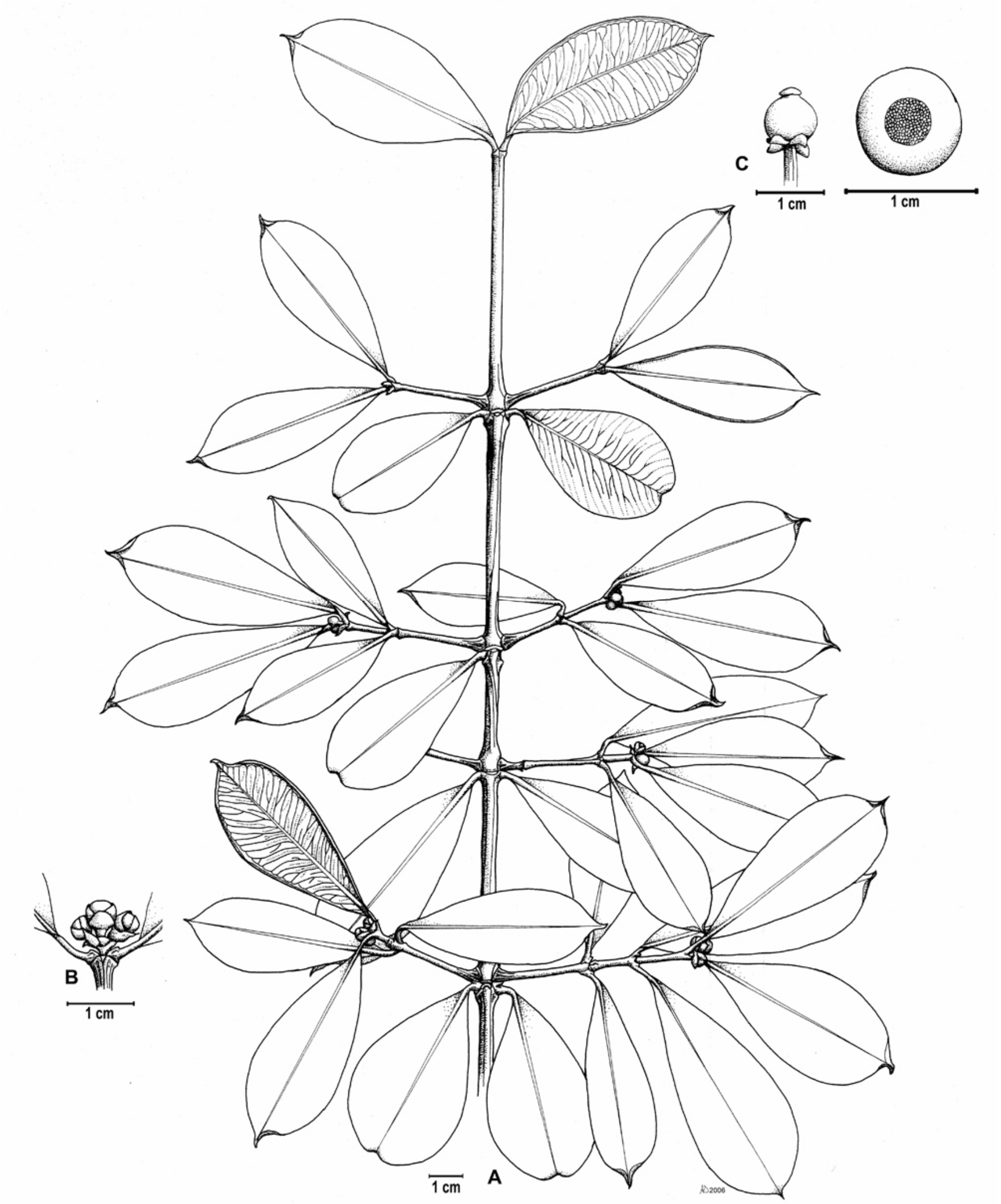


Figure 6.9. *Garcinia harmandii* Pierre. **A**. habit (male); **B**: inflorescence; **C**: fruit and stigma [(A, B: *Pierre 1371,* K); (C: *Thorel 1018,* K)]. Drawn by Anna Dorward.

8. **Garcinia malaccensis** Hook f. – Map 6.8.

Garcinia malaccensis Hook f., Fl. Brit. India 1 (1872) 261. — Lectotype (proposed here): *Maingay 149*[male specimen] (lecto KEP; iso K) Peninsular Malaysia.

Tree to 30 m tall. *Bole:* bark dark brownish to pale cream brown, slightly reddish, smooth and minutely dippled, peeling off with flaking scales; inner bark reddish brown to pink, fibrous or yellowish; sapwood yellowish. *Exudate* yellow. *Twigs* angled, stout, roughly wrinkled longitudinally, sometimes very finely horizontally striate when dry, deep red-brown or pale brown. *Petiole* stout, finely horizontally striate, 0.4-3.0 cm long. *Lamina* thickly leathery, pale brown above and brown or sometimes reddish-brown below, shiny on the upper surface, variable in shape, mainly elliptic to narrowly elliptic, broadly elliptic, ovate or oblanceolate, 9.2-25.5 x 7.0-9.0 cm; apex sharp or bluntly acute to acuminate, sometimes slightly attenuate; base acute to cuneate or obtuse; midrib raised above and strongly raised below; secondary veins fine, visible on both sides, weakly raised above, raised below, fine and closely arranged, brochidodromous with two intra-marginal veins (mainly in female); tertiary veins fine, visible below, randomly reticulate. *Glands* fine but visible below (not in older specimens) and not visible above, dark to grey black wavy lines, closely arranged, running across the secondary veins from the midrib toward the margin. *Inflorescences* terminal in a cluster of 3-5 male flowers and solitary in the female, to 3.3 cm long; sepals and petals 4; bracts thickly leathery, triangular. *Male flowers*: pedicel stout and angular, to 3.3 cm long; sepals yellowish, thickly leathery, concave, orbiculate, broadly elliptic or ovate, 5-8 x 9-13 mm; petals pinkish, elliptic to broad elliptic, 9-15 x 5-9 mm; stamens in a single mass, 4-angled or nearly conical to cylindrical, surrounding the base of the pistillode, to 20 mm long; pistillode very small, to 1 mm long, placed on top of stamen bundles, nearly sessile, fungiform with a small, black, rough, crenate, convex cap, or sometimes pistillode absent. *Female flowers*: pedicel stout, up to 20 mm long; sepals thickly leathery, yellowish or whitish, orbiculate or broadly ovate, 13-17 x 20-25 mm; petals smaller in size, orbiculate, widely obovate, 6-8 x 9-12 mm; ovary surrounded by irregular free staminodes attached at the base; stigma segregated or fused and sunken at the middle, (5-)6-8 closely arranged bundles, the number of bundles usually equalling the number of ovules. *Fruits* green turning yellow or reddish, big, ovoid or pear-shaped, ellipsoid or sometimes globose, 3.0-5.0 x 3.6-7.0 cm, tipped with the 6-8 segregated or fused, rugose, hardened, dark brown or blackish, nearly sessile or sessile stigmas, which is square or nearly wedge-shaped with an irregular blunt dentate margin; sepals persistent, thickly leathery, concave, orbicular or ovate; seeds with a white aril.

Distribution – Peninsular Malaysia to Singapore, Sumatra and Borneo.

Habitat & Ecology – Lowland to hill forest.

Notes – A possible parent species of *G. mangostana* with which it is easily mistaken, especially when sterile. Sometimes also confused with *G. penangiana;* many specimens from Peninsular Malaysia (e.g. in Tree Flora of Pasoh, Kochummen, 1995) have been incorrectly identified as this species. This species is characterised by having two intra-marginal veins (only in female)leaf as in *G. mangostana*, but the male flowers have a distinct 4-angled stamen with a very small pistillode or none at all. The varieties can only be distinguished in fertile and mature material.

Key to varieties

1. a. Stamens 4-angled, nearly conical, more than 6 mm long; fruit ovoid or ellipsoid, stigma raised……………………………………………………….**a.** var. *malaccensis*
   b. Stamens 4-angled, square shaped, less than 6 mm long; fruit globose, stigma sessile...**b.** var. *pseudomangostana*

a. var. **malaccensis** – Figure 6.10.

Male flower: stamens in 4-angled, conical mass, with or without pistillode, long and slender, to 10 mm x 4 mm. *Fruits* green turning reddish or maroon, ovoid or ellipsoid; stigma large with neck, to 17 mm across, segregated bundles, fused and sunken in the middle or separate bundles usually when mature, square to nearly wedge-shaped.

Distribution –Peninsular Malaysia, Sumatra and Borneo.

b. var. **pseudomangostana** var. nov. Nazre – Figure 6.11.

Type: Madani 50575 (holo SAN; iso L) Sandakan, Sabah.
(Etymology: Lat. resembling mangosteen)

Male flower: stamens 4-angled or 4 obscure bundles with or without pistillode, short but wide to 6 mm x 8 mm. *Fruits* green turning yellowish; globose; stigma small without neck, to 5 mm across, bundles fused and weakly sunken in the middle.

Distribution –Borneo (East Coast of Sabah and Kalimantan).

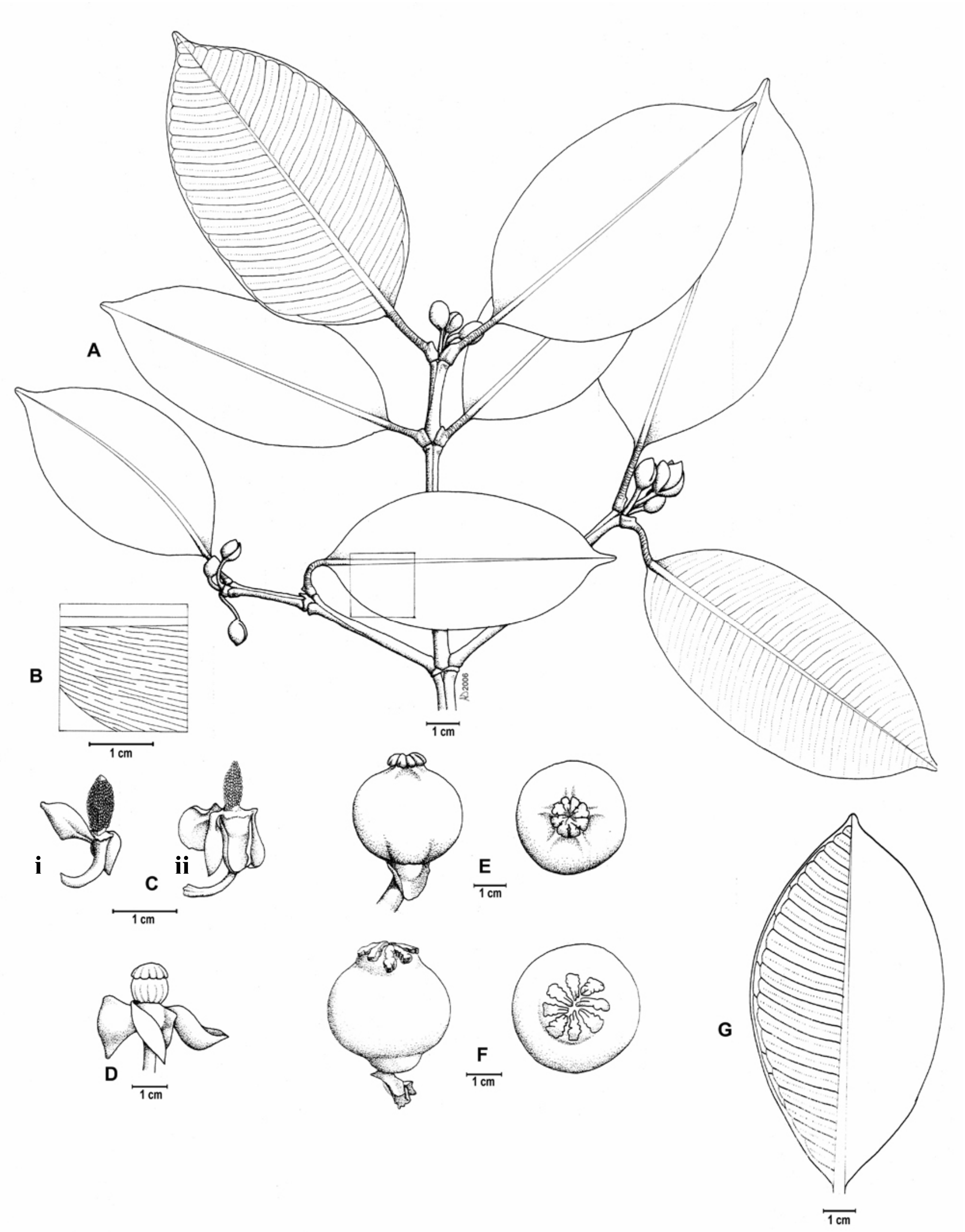


Figure 6.10. *Garcinia malaccensis* var. *malaccensis.* **A**. habit (male); **B**. glandular lines; **C**. male flowers; **D**. female flower; **E**, **F**. fruit and stigma; **G**. secondary nervation with two intra-marginal veins [(A, B, Cii: *Maingay 149*, K); (Ci: *Ashton BRUN3392,* SAR); (D: *Maingay 149/Barcode 489504,* L); (E: *Wyatt-Smith 80555,* L); (F, G: *Whitmore FRI8986,* L)]. Drawn by Anna Dorward.

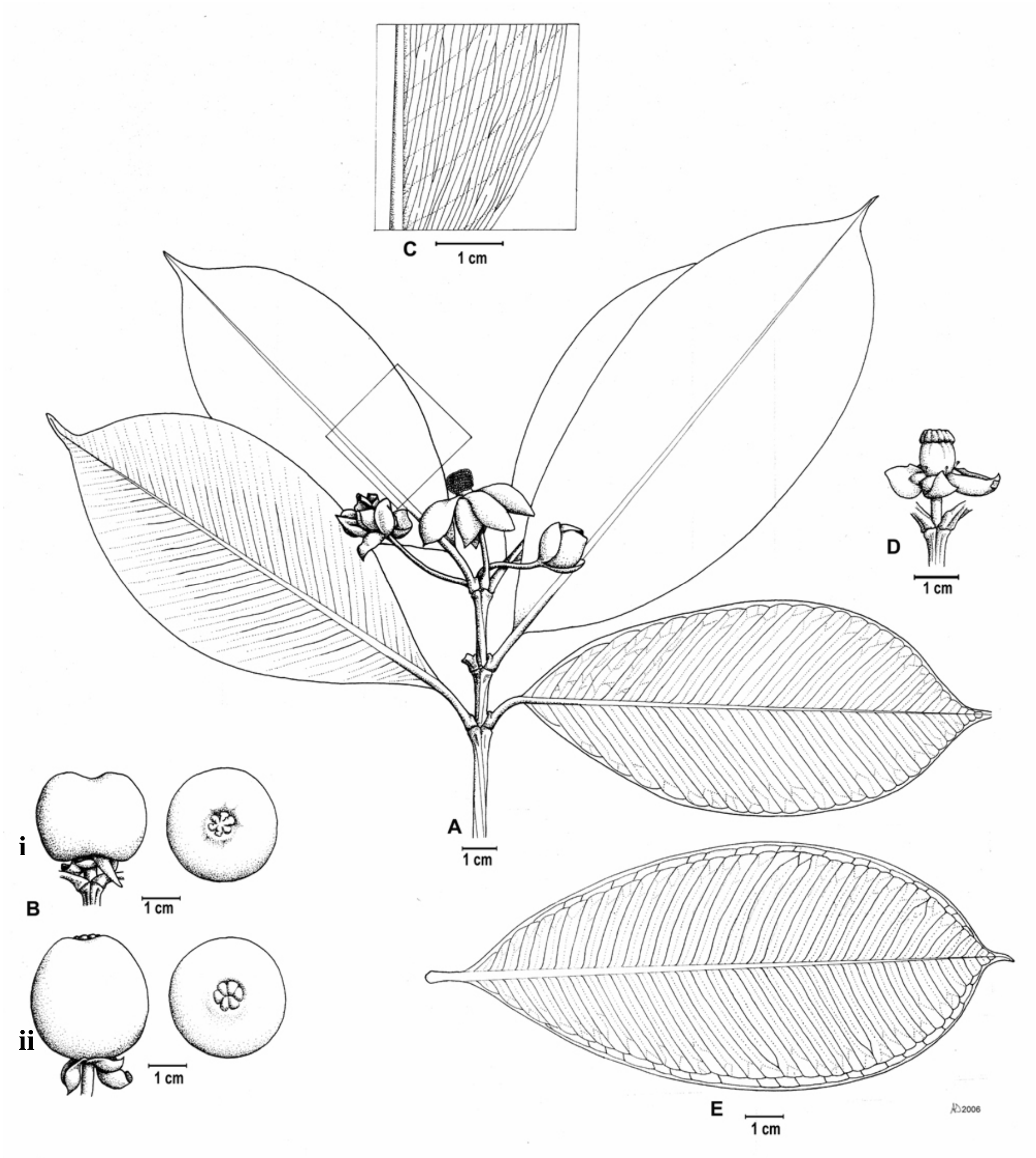
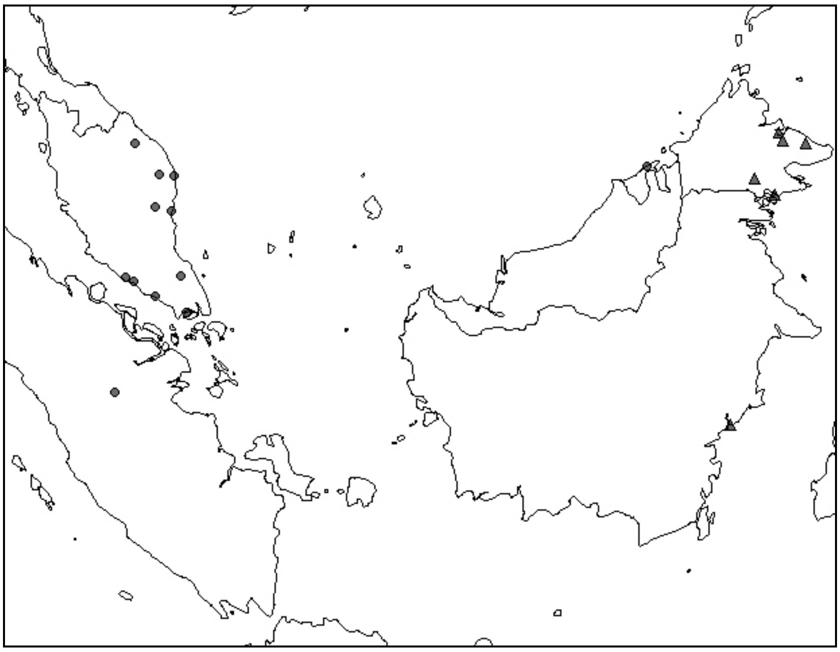


Figure 6.11. *Garcinia malaccensis* var. *pseudomangostana* Nazre. **A**. habit (male); **B**. fruit and stigma; **C**. glandular lines; **D**. female flower; **E**. secondary nervation with two intra-marginal veins [(A, C: *Madani 50574,*L); (Bi: *Meijer SAN 19236,* L); (Bii: *Fidilis & Sumbing SAN 96472,*L); (D, E: *Sigin & Joseph SAN 97194,* L)]. Drawn by Anna Dorward.



Map 6.8. Distribution of *Garcinia malaccensis* Hook. f. *G. malaccensis* var. *malaccensis* (circle)*; G. malaccensis* var. *pseudomangostana* (triangle).

9. **Garcinia mangostana** L. – Figure 6.12.

Garcinia mangostana L., Sp. Pl. 443 (1753); Blume, Bijdr. Fl. Ned. Ind. (1825) 615; Miquel, Fl. Ned. Ind. 1 (1859) 506; Pierre, Fl. Forest. Cochinch. 1 (1882) 11, pl. 54; Boerlage, Cat. Pl. Phan. 2 (1901) 68; Backer & Bakhuizen, Fl. Java (Spermatoph.), (1963) 387. — Lectotype: 'mangoustan' in Garcin, *Philos. Trans., 38* (1734) 1. Designated by Hammel in Jarvis et al., *Regnum Veg. 127* (1993) 28.

Tree to 20 m tall. *Bole* brown to dark brown, smooth, scaly and flaking; inner bark orange or red brown to light brown. *Exudate* yellow. *Twigs* clearly 4-angled, stout, roughly wrinkled longitudinally when dry, deep dark yellowish-brown or pale brown. *Petiole* stout, finely horizontally striate, angled, to 3 cm long. *Lamina* thickly leathery, sometimes shiny on the upper surface, pale brown above and reddish-brown below when dry, elliptic to broadly elliptic, ovate or oblanceolate, 10.0-25.0 x 7.0-9.0 cm; apex acute to obtuse; base cuneate or obtuse; midrib raised above and strongly raised below; secondary veins fine but clearly visible, raised below, brochidodromous with two intra-marginal veins; tertiary veins a mixture of reticulate and scalariform, fine and prominent. *Glands* fine, conspicuous below, invisible above, dark to grey black wavy lines, running across the secondary veins, c. 70º from the midrib to the margin. *Inflorescences* terminal in a cluster of 3-4(5) male flowers and usually solitary in the female but sometimes with 2-3 flowers, male flowers smaller than female; sepals and petals 4. *Male flowers* to 3.0 cm across when open; pedicel round or slightly angled, stout, to 15 mm long; petals and sepals leathery, unequal in size, usually inner parts larger than outer, concave to orbicular, 15-20 mm across; stamens square (4-angled) to slightly cylindrical surrounding the base of pistillode, to 8 mm tall; pistillode broadly fungiform in shape, tipped with a convex or mushroom-like cap, margin lobed and crenate, to 5 mm across; anthers 2-thecous with apical slits, nearly sessile or with a short filament. *Female flower* larger than male to 5.0 cm across when open; pedicel as in the male; sepals and petals as in the male but larger to 20 mm across; ovary surrounded by a few to 20 irregular, free staminodes; ovary dwarf fungiform, tipped with a skull-cap stigma, 4-5 lobed. *Fruits:* large, ovoid or globose, to 6 cm across, tipped with the black, sessile stigma, 4-8 lobed or wedge-shaped bundles, fused in the middle, usually the number of lobes or bundles equalling the number of ovules; seeds with white, gelatinous, edible aril.

Distribution – Cultivated unknown origin.

Habitat & Ecology – Planted throughout tropical countries, especially in Southeast Asia.

Notes – Very similar in its vegetative characters to *G. malaccensis* but differing in having thicker and more prominent midribs and venation. Male trees are rarely found and are only recorded from two localities in Peninsular Malaysia. The male flower was correctly described by Salma & Rukayah (1988). Other descriptions of the male flowers by Roxburgh (1832), King (1891) and Maheshwari (1964) fit the description of *G. celebica* L.

Molecular data suggest that the origin of the species might be from multiple hybridisations between *Garcinia malaccensis* varieties either from Peninsular or East Malaysia (Borneo) if mangosteen is an obligate agamosperm species (Chapter 5). If mangosteen is however, a facultative agamosperm a number of *Garcinia* species could be involved in its parentage, besides *G. malaccensis*.

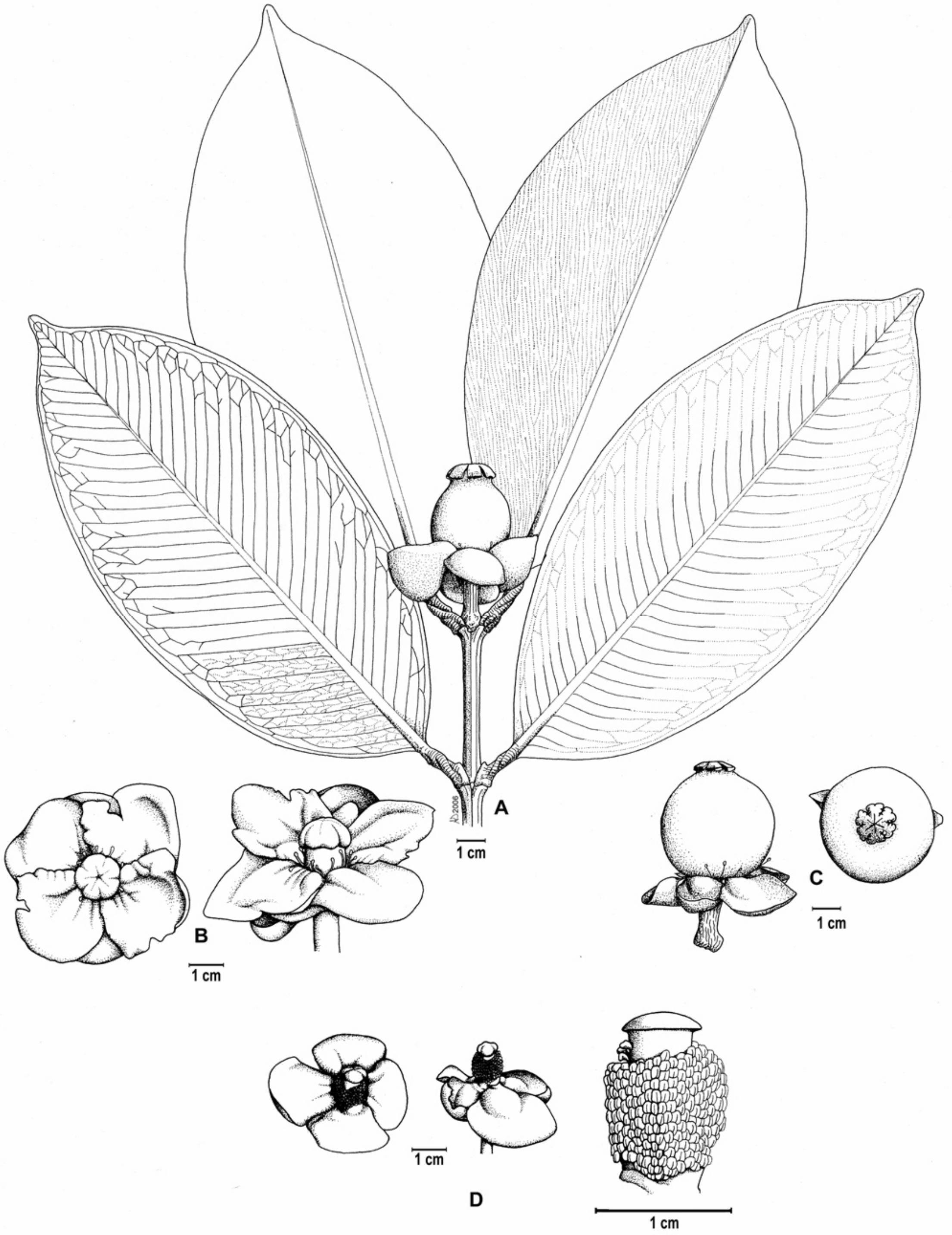


Figure 6.12. *Garcinia mangostana* L. **A**. habit (female); **B**: female flower; **C**: young fruit; **D**: male flower [(A, C: *Sibat S23041*, L.); (B: *Anon,* MARDI); (D: *Shamsudin s.n.,* MARDI)]. Drawn by Anna Dorward.

10. **Garcinia moselleyana** Pierre – Figure 6.13; Map 6.9.

Garcinia moselleyana Pierre, Fl. Forest. Cochinch. 1 (1883) 10. — Lectotype (proposed here): *Moseley s.n.* (K) Basilan Island, Philippines.

Small tree to 3 m tall. *Bole:* no information. *Exudate* yellow. *Twigs* round, longitudinally wrinkled when dry, pale grey-brown to dark-brown. *Petiole* striate longitudinally, same colour as twigs, to 0.6-0.9 cm long. *Lamina* leathery, elliptic or oblong 10.0-15.0 x 3.5-6.0 cm, dark or pale brown; apex acuminate or attenuate; base acute or cuneate; margin weakly wavy or entire and revolute; midrib flattened and inconspicuous to weakly sunken above and strongly raised below; secondary veins clearly visible on both sides, conspicuous and raised below, cladodromous, with fine intramarginal veins; tertiary veins visible below, randomly reticulate. *Glands* not found. *Inflorescences* terminal and axillary, 3-9 flowered, in clusters of variable size and sometimes solitary in females; sepals and petals 5; bracts triangular, to 4.5 mm long. *Male flower* [in bud] nearly sessile or with a short pedicel up to 3 mm long; sepals leathery, concave, broadly ovate or broadly elliptic, two outer, three inner, 4-7 mm long; petals concave, ovate, smaller than the sepals; stamens slightly 4-lobed, enclosing the fungiform pistillode at the centre; pistillode small; anthers 2-thecous. *Female flowers*: sepals and petals as in the male; staminodes lacking; ovary globose, tipped by a small, to 3 mm across, skull-cap shaped, black, peltate stigma. *Fruits* smooth, globose 20-33 x 25-35 mm, black when dry; stigma as in the female flowers; no information on seeds.

Distribution – Philippines, endemic.

Habitat & Ecology – Lowland and hill forest near rivers.

Notes – The only species with pentamerous flowers in the section. A distinct species easily identified by the cladodromous nervation and flattened midrib on the adaxial leaf surface.

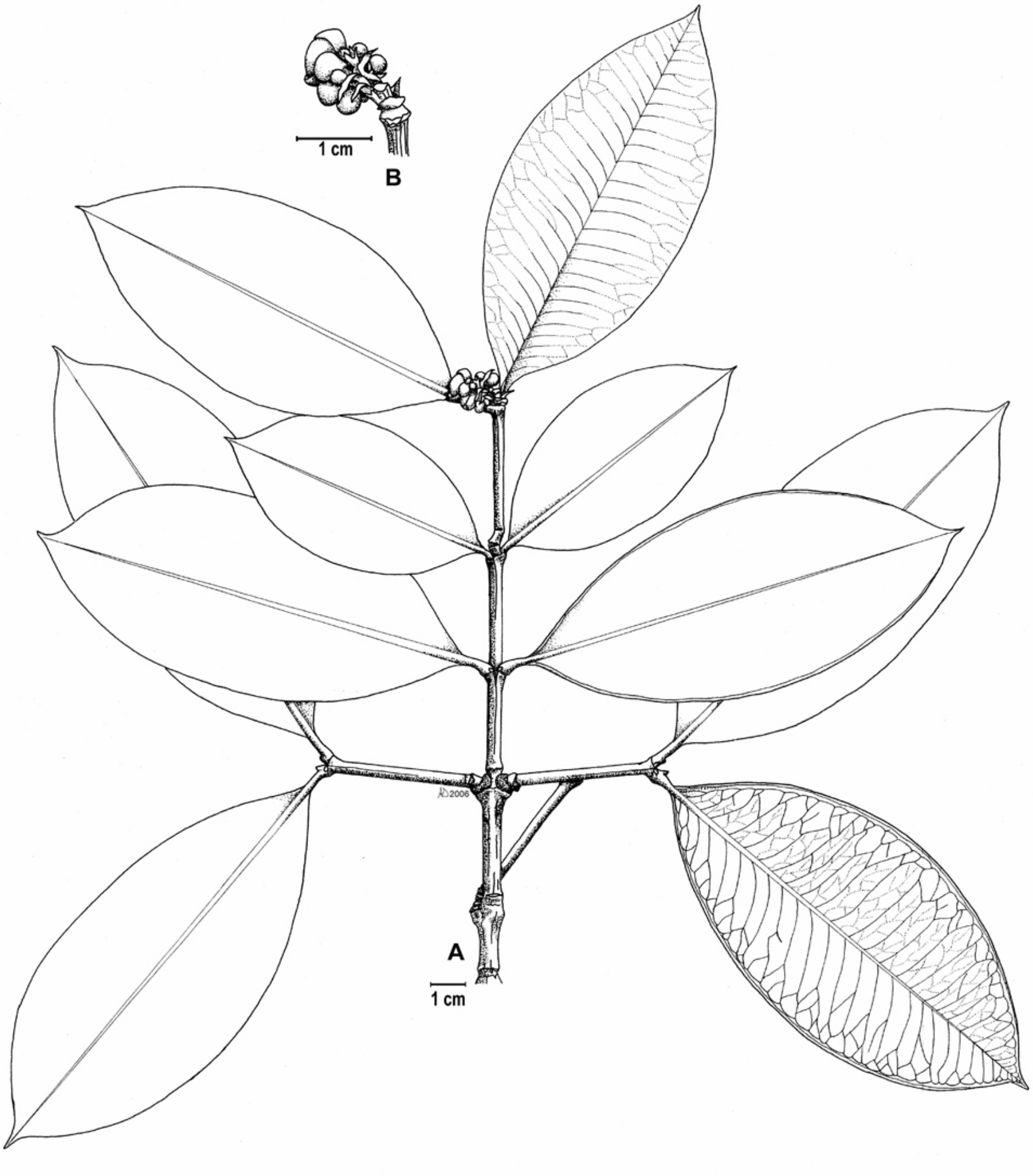
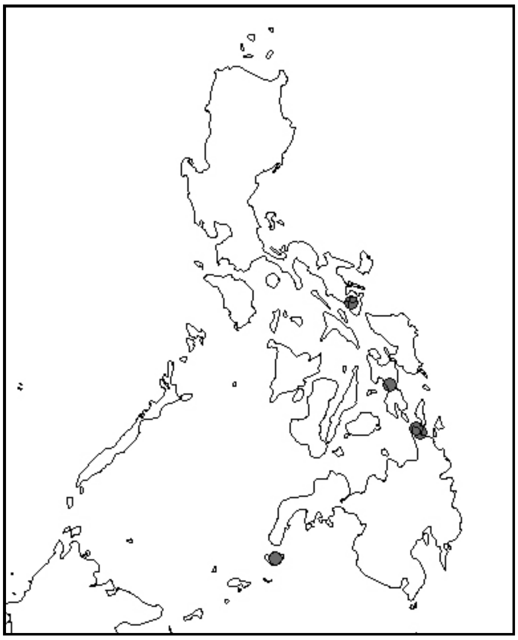


Figure 6.13. *Garcinia moselleyana* Pierre. **A**. habit (male); **B**: inflorescence [*Moseley s.n.,* K]. Drawn by Anna Dorward.



Map 6.9. Distribution of *Garcinia moselleyana* Pierre.

11. **Garcinia nitida** Pierre – Figure 6.14; Map 6.10.

Garcinia nitida Pierre, Fl. Forest. Cochinch. 1 (1882) 18 & Fl. Forest. Cochinch. 1 (1883) pl.80M & 80N. — Lectotype (proposed here): *Beccari 2104* (lecto K; iso A) Sarawak.

Tree to 30 m tall and 45 cm dbh. *Bole:* bark brown, inner bark reddish. *Exudate:* cream or yellow. *Twigs* slightly angled, stout, longitudinally wrinkled when dry, dark pale brown to pale yellowish green. *Petiole* finely striate horizontally, stout, same colour as twigs, 0.3-1.1 cm long. *Lamina* leathery, pale brown to reddish-brown, darker and shiny above, pale below, broadly elliptic, elliptic or sub-orbiculate, 5.0-8.5 x 2.9-3.8 cm; apex to 10 mm long, acute, blunt or blunt-acuminate; base acute to nearly obtuse; midrib raised to nearly square in cross section above, raised below but gradually flattening to the apex; margin entire and finely revolute; secondary veins very fine, sometimes nearly invisible, inconspicuous above, slightly visible below, brochidodromous, very closely arranged; tertiary veins invisible. *Glands* fine but clearly visible below, especially in younger leaves, black to grey-black or dark greyish brown, of interrupted wavy lines, with a mixture of short and long lines and dots, running c. 70º to the midrib across the secondary veins from midrib towards margins. *Inflorescences* terminal, 1-4 flowers on male, solitary, or rarely, in pairs on female; sepals and petals 4; bracts triangular, to 5 mm long. *Male flower* [in bud]: pedicel to 5 mm long; sepals concave, to 7 mm long; petals narrowly obovate, to 7 mm long; stamens in 4 weak lobes, attached at 1/3 from the base of pistillode, surrounding the fungiform pistillode; anthers 2-thecous. *Female flower* not seen. *Fruit* ovoid or flask-shaped to globose, ripening red, pale to dark brown or reddish brown to dark maroon when dry, smooth, thin wall easily ruptured when dry; stigma raised or elongated to 10 mm long, concave with irregular wavy margin to 6 mm across; seeds 4-5 with a white aril.

Distribution – Borneo.

Habitat & Ecology – From lowland to hill forest.

Notes – Closely related to *Garcinia diospyrifolia* and resembling *G. diospyrifolia* var. *minor* but is characterised by being a big tree, the leaves having a mixture of long and short wavy glandular lines, and the fruit with distinct elongated and sunken stigma.

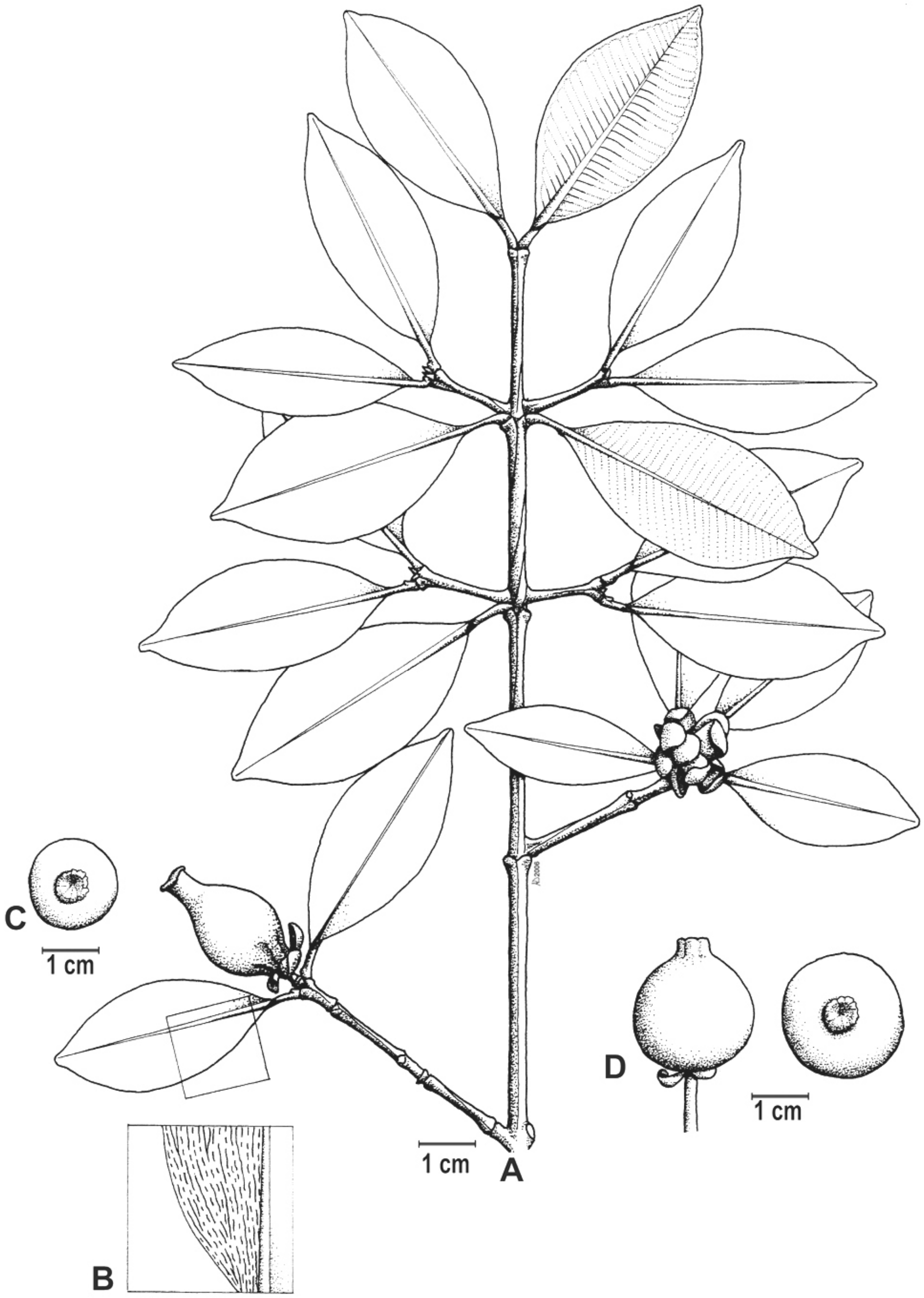


Figure 6.14. *Garcinia nitida* Pierre. **A**. habit (female); **B**. glandular lines; **C**. stigma; **D**: fruit and stigma [(A, C, B: *Argent & Amiril 9318,* K); (D: *Ilias 13317,* K)]. Drawn by Anna Dorward.

Map 6.10. Distribution of *Garcinia nitida* Pierre.

12. Garcinia ochraceus Nazre sp. nov. – Figure 6.15; Map 6.11.

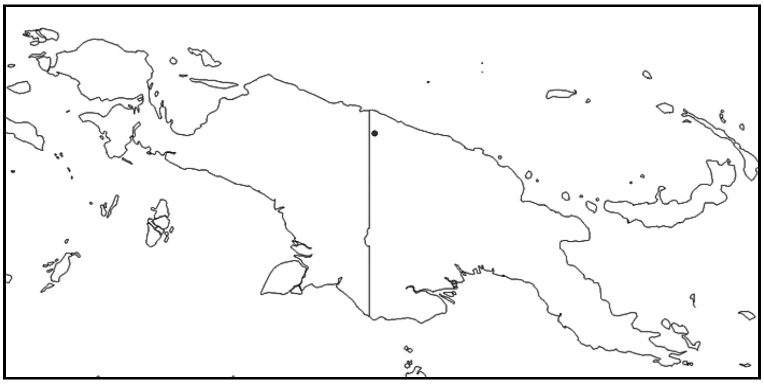
— Type: *Streimann & Martin LAE 52886* (holo E) West Sepik, Papua New Guinea. (Etymology: Lat. from the colour of the stamens)

Small tree to 6 m tall, slender. *Bole:* no information. *Exudate:* no information. *Twigs* slender, round to angled, longitudinally striate when dry; reddish-brown or brownish yellow. *Petiole* finely striate horizontally, darker colour than twigs, 0.5-0.75 cm long. *Lamina* thinly leathery, pale grey-brown or brownish to yellowish, darker and shiny above, slightly glaucous or opaque yellowish below, elliptic, 6.0-9.5 x 2.1-5.3 cm; apex acute and blunt, sometimes blunt-acuminate; base acute to cuneate; midrib yellowish, raised above, flattened or weakly raised below; margin entire and finely revolute; secondary veins inconspicuous on both sides, fine, brochidodromous, closely arranged; tertiary veins invisible. *Glands* faint to invisible, fine, closely arranged in dark grey-black, interrupted, wavy lines, running across the secondary veins, nearly parallel to midrib. *Inflorescences* terminal, 1-2 flowered, female flowers always solitary; bracts not found. *Male flower* with 4 sepals and petals, leathery, outer usually thicker; pedicel 6 mm long; sepals ovate or orbiculate to 6 mm across; petals red turning maroon when dry, oblanceolate or obovate to 10 mm long; stamens yellow, in a mass, weakly 4-lobed central bundle surrounding the pistillode; pistillode fungiform; anthers 2-thecous with a short filament. *Female* flower not seen. *Fruit* globose, cream turning red, reddish or maroon brown to brownish when dry, wall smooth, 1.8-2.3 x 1.8-2.1 cm, tipped with a black stigma, sessile, flattened on the surface but slightly sunken in the middle, margin weakly crenate, to 7 mm across; with thick leathery prominent sepals; unknown seed.

Distribution – New Guinea.

Habitat & Ecology – Lowland rainforest.

Notes – The fruits resemble *G. diospyrifolia* and *G. nitida* but the stigma is rather flat and without lobes. There are also vegetative characters that can differentiate the species: the leaf with faint and nearly invisible venations on the lower surface, and the glandular lines almost invisible.



Map 6.11. Distribution of *Garcinia ochraceus* Nazre.

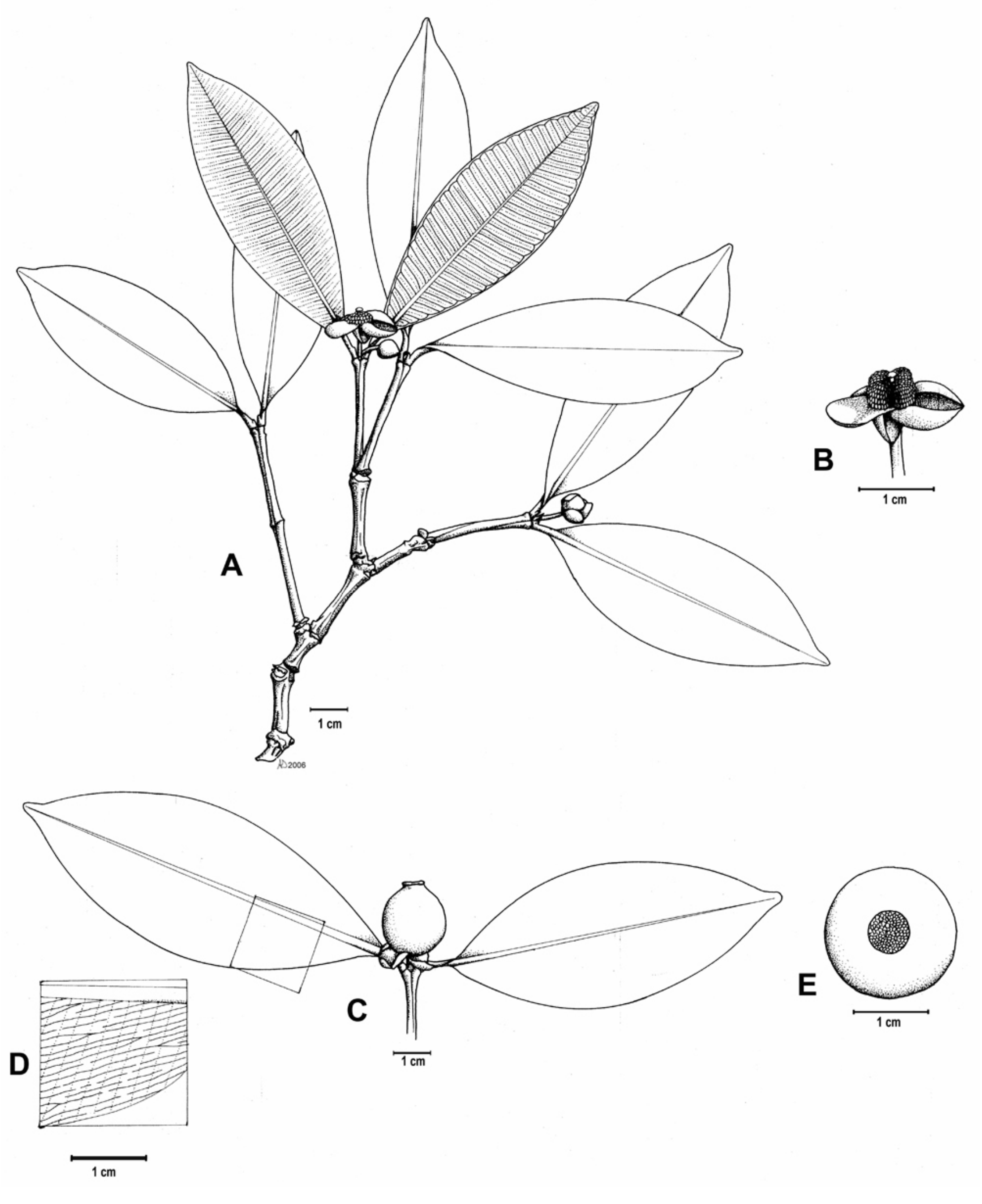


Figure 6.15. *Garcinia ochraceus* Nazre. **A**. habit (male); **B**. male flower; **C**, **E**. fruits and stigma; **D**. glandular lines [(A, B: *Streimann & Martin 52886,* E); (C, D, E: *Streimann & Martin 52890,* E)]. Drawn by Anna Dorward.

13. **Garcinia penangiana** Pierre – Figure 6.16; Map 6.12.

Garcinia penangiana Wall. *ex* Pierre, Fl. Forest. Cochinch. 1 (1882) 37. — Lectotype (proposed here): *Wallich 4852D* (P) Penang, Peninsular Malaysia.

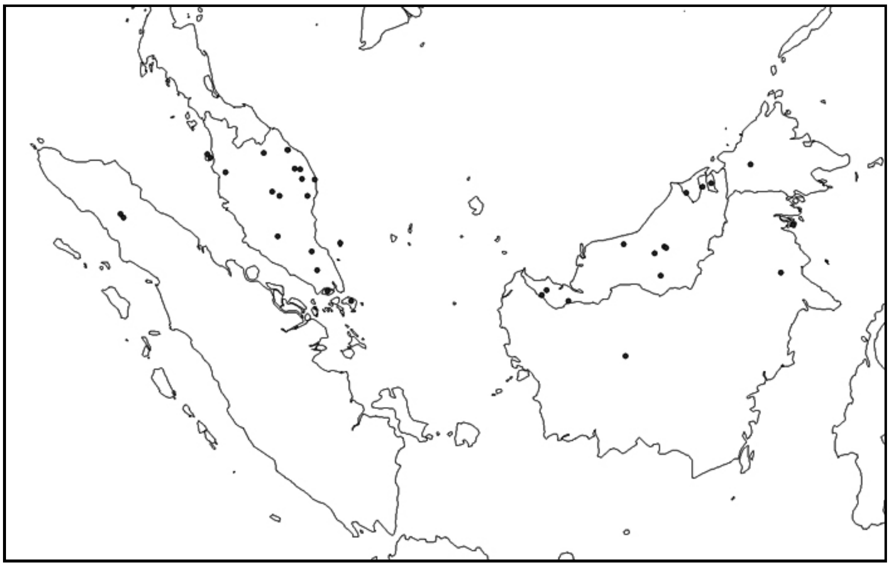
Garcinia fascicularis Wall., Numer. List (1831) *4853*, nom. nud.

Small to medium sized tree to 20 m. *Bole:* bark dark brown to blackish, smooth and flaking; inner bark reddish. *Exudate* white. *Twigs* slender, angular, reddish black or orange-brown and wrinkled longitudinally when dry. *Petioles* stout, finely striate horizontally, 0.7-1.9 cm long. *Lamina* leathery, dark reddish brown above and paler below (distinctly reddish in new specimens), elliptic to narrowly elliptic, 13.2-16.0 x 3.5-6.0 cm; apex bluntly acuminate; base acute; margin entire, finely revolute; midrib slightly raised and square in cross section above, strongly raised below; secondary veins brochidodromous, fine, raised above and below, very closely arranged; tertiary veins very fine, conspicuous below, inconspicuous above, scalariform. *Glands* clearly visible and raised below, a mixture of long and short black wavy lines, running from midrib across secondary veins towards margin. *Inflorescences* terminal, in clusters of 3-10 male flowers of variable size, the females usually solitary but sometimes in pairs; sepals and petals 4. *Male flower*: pedicel slender, 5.0-13 mm long; sepals concave, ovate or orbicular, 3-7 x 4-10 mm; petals oblanceolate or elliptic, 7-15 x 3.2-7 mm; stamens in a cruciform central mass (from above) or slightly 4-angled; pistillodes absent; anthers sessile or on very short filaments, 2-thecous. *Female flower*: pedicel slender or stout, to 7 mm long; sepals and petals as in male flower, deep red or light green; ovary globose, tipped by a black, corrugated stigma in 3-4 bundles. *Fruits* globose or ovoid, green, smooth, dark brown or purplish when dry, tipped with nearly sessile blackish stigma, 3-4 wedge-shaped bundles of many nodule-like surface, segregated or fused (becoming lobed), entire or cracked margin; seeds 3-4(5) with a white aril.

Distribution – Peninsular Malaysia, Sumatra and Borneo.

Habitat & Ecology – Common species in lowland to hill forest sometimes reaching lower montane forest (900 m).

Notes – This species is characterised by the distinct leaf characters: the dry leaf turns reddish, the secondary veins are fine but visible below and closely arranged. Male flowers are particularly distinctive due to the cruciform stamens when dry. However, sterile specimens are always confused with *G. malaccensis* and *G. diospyrifolia*, especially older specimens. Morphologically (also supported by the molecular data) it is closely related to *Garcinia malaccensis* Hook. f., *G. mangostana* L. and *Garcinia venulosa* (Blanco) Choisy.



Map 6.13. Distribution of *Garcinia penangiana* Pierre.

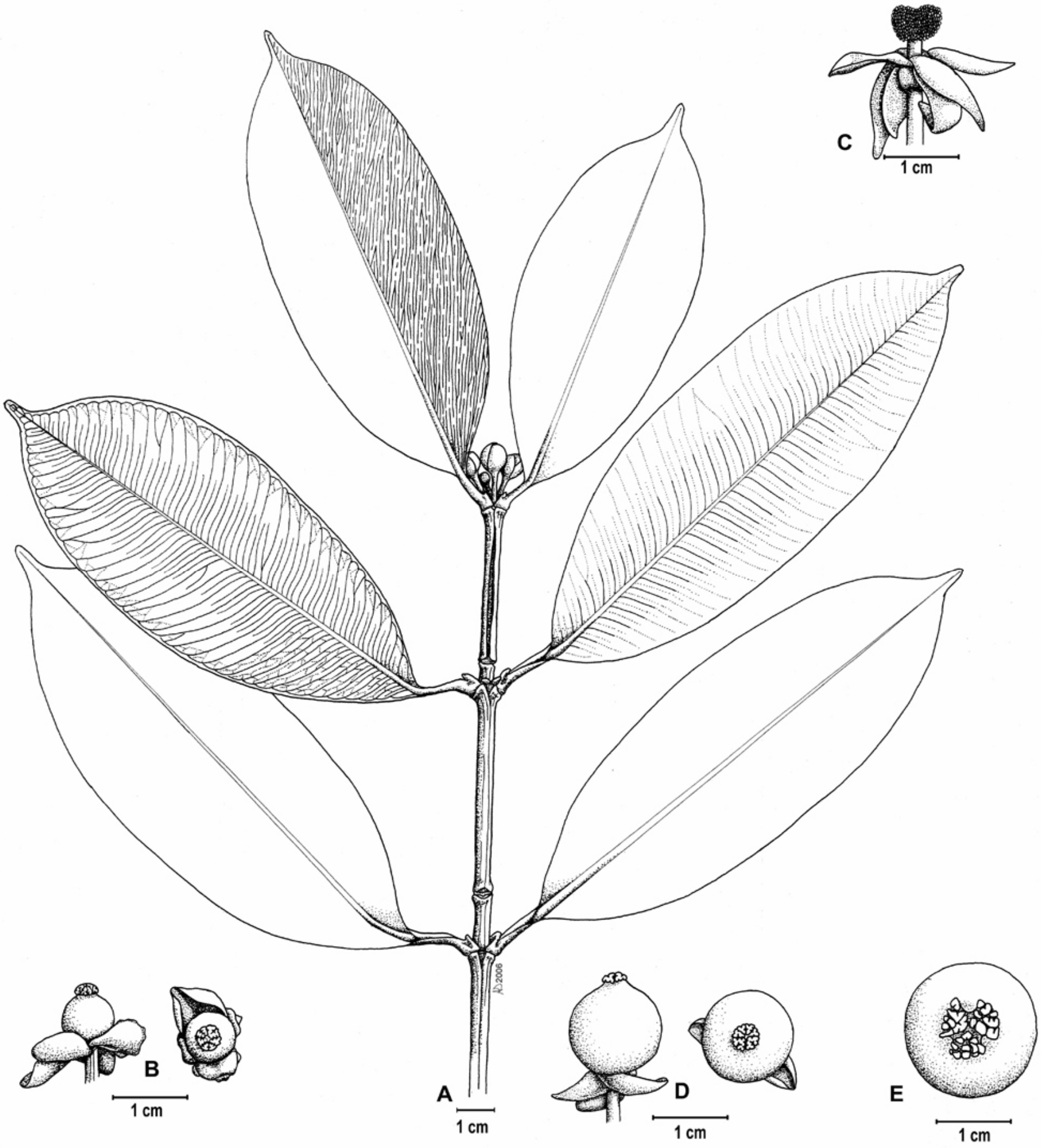


Figure 6.16. *Garcinia penangiana* Pierre. **A**. habit (male); **B**: young fruit and stigma; **C**: male flower; **D**, **E**: mature fruit and stigma [(A, C: *Whitmore FRI 20347*,L); (B: *Sibat S25238,* K); (D; *Sibat S23622,* K); (E: *Sinclair SFN 40794,* SING)]. Drawn by Anna Dorward.

14. **Garcinia rigida** Miq. – Figure 6.17; Map 6.14.

Garcinia rigida Miq., Fl. Ned. Ind., Eerste Bijv. (1861) 493. — Lectotype (proposed here): *Diepenhorst HB646* (lecto BO; iso L) Priaman, Sumatra.

Garcinia schefferi Pierre, Fl. Forest. Cochinch. 1 (1882) 12, pl.59, excl. Harmand 2029. — Lectotype (proposed here): *Harmand 4012* (lecto P; iso K) Condore Island, Vietnam.

Garcinia porrecta var. *schizogyna* Boerl., Cat. Hort. Bogor. 2 (1901) 69. — Nomen. invalidum.

Tree to 30 m tall. *Bole:* sometimes with buttresses, bark light brown or pale grey-dark brown, occasionally exposing dark cream bark under peeling scales; inner bark reddish; sapwood yellow. *Exudate* white, turning cream or yellow. *Twigs* angled, stout, longitudinally wrinkled when dry, dark brown or brown to greenish. *Petioles* stout, finely striate horizontally, 0.6-2.0 cm long. *Lamina* leathery, narrowly elliptic or ovate, elliptic to broadly elliptic, 0.5-18.0 x 3.0-8.0 cm; apex blunt acute to acuminate; base cuneate to acute; margin entire, weakly and finely revolute; midrib slightly raised above and raised below; secondary veins inconspicuous above and slightly raised below, brochidodromous, closely arranged; tertiary veins invisible below, visible above only in new specimens, randomly reticulate. *Glands* black or dark brown to greenish, fine wavy lines running across secondary veins from midrib towards margin, *c.*1 mm apart, clearly visible and weakly raised below (not so in very old specimens). *Inflorescences* probably terminal. *Male flower* not seen. *Female flower* not seen. *Fruit* solitary and terminal; pedicel stout, to 2.0 cm; brown to dark brown and slightly reddish-brown when dry, ovoid or ellipsoid, 2.5-3.2 x 2.0-2.5 cm, thin walled and smooth; stigma raised, discoid but flattened on the surface or slightly sunken in the middle, margin irregularly dentate or weakly 4 lobes; 4 persistent sepals, greenish white, leathery, concave; seeds unknown.

Distribution – Indo-china, Sumatra, Sulawesi and Maluku.

Habitat & Ecology – Lowland, especially near the coast or on islands.

Notes – Specimens cultivated in Bogor Botanic Gardens and labelled as *G. porrecta* var. *schizogyna* (VI.C.145, VI.A.50 & VI.C.235) bear an invalid name and are *G. rigida*. They were collected from Sulawesi and Ambon, Maluku. However, I have not yet found any herbarium material collected from this area from wild individuals of *G. rigida*.

The species is characterised by the fruit: the wall is thin and smooth as in *G. diospyrifolia* but it has a distinct discoid, flattened stigma with a neck. The leaves resemble *G. celebica* but the glandular lines are more distinct and widely spaced. Molecular analysis clearly shows the monophyly of this species and it is quite distantly related to either *G. celebica* or *G. diospyrifolia*. Incongruence between plastid and nuclear phylogenetic trees indicate that it could have arisen from a hybridisation event with maternal origins from species outside section *Garcinia.*

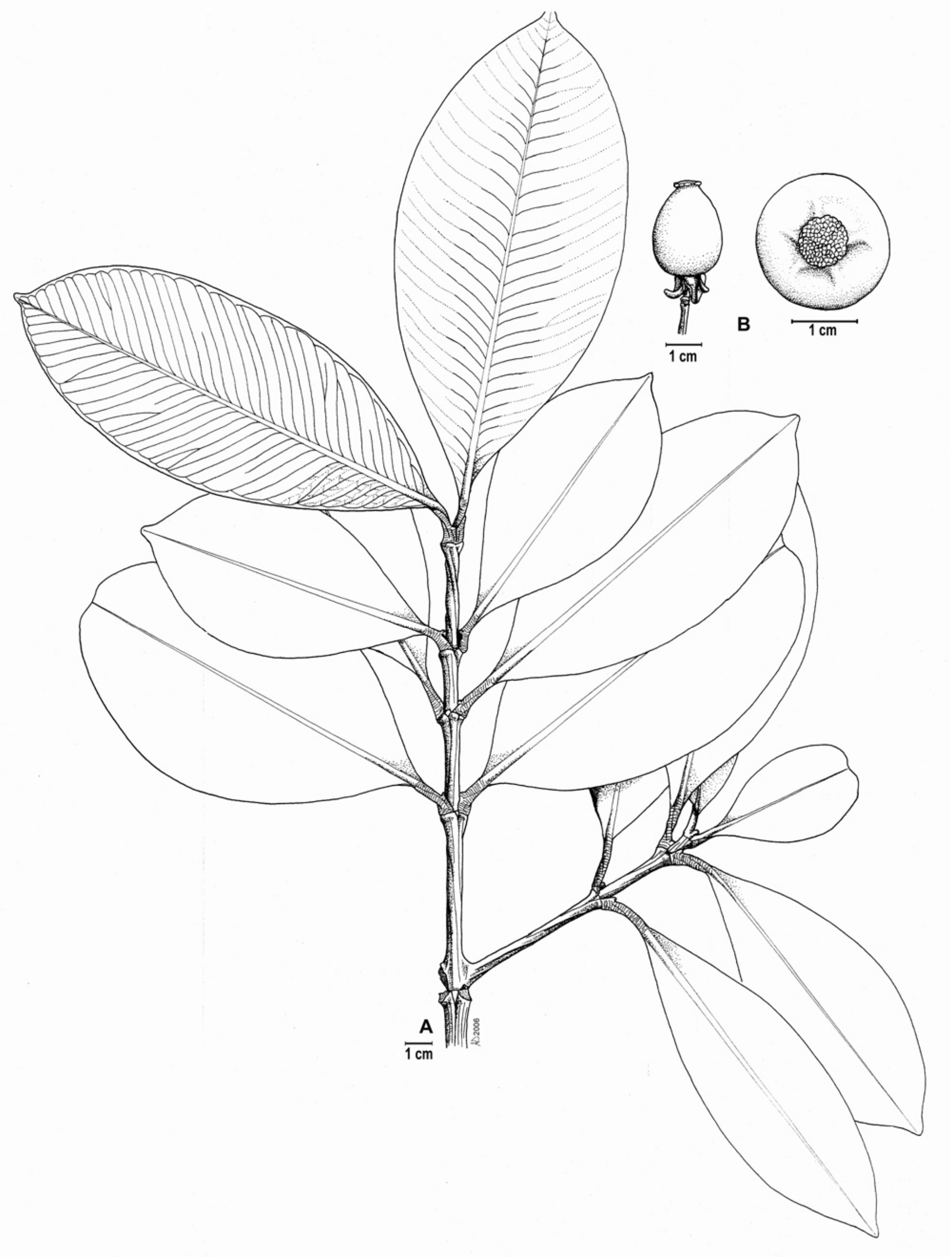
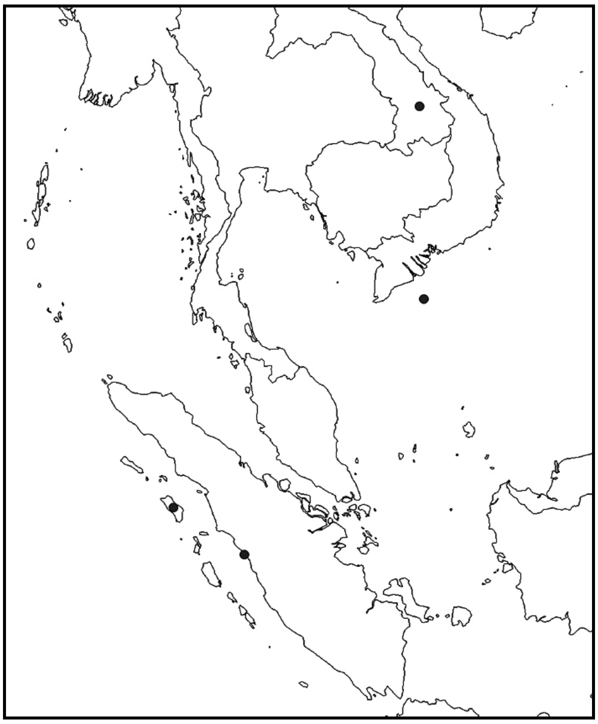


Figure 6.17. *Garcinia rigida* Miq. **A**. habit (female); **B**. fruit and stigma [*Harmand 4012,* K]. Drawn by Anna Dorward.



Map 6.14. Distribution of *Garcinia rigida* Miq.

15. **Garcinia sangudsangud** Nazre sp. nov. – Figure 6.18 ; Map 6.15.

—Type: *Aban Gibot SAN32977* (holo SAN; iso K, L) Tawau, Sabah, Malaysia
(Etymology: local name in Sabah)

Tree to 20 m tall. *Bole:* bark blackish, with papery scales; inner bark reddish brown, sapwood pale red-brown. *Exudate* white. *Twigs* slightly angled especially towards end; pale greyish brown. *Petiole* stout, finely striate horizontally, 0.5-2.0 cm long. *Lamina* leathery; dark brown or pale brown and shiny above, pale greenish brown or brown below, elliptic or narrowly elliptic, 7.2-15.0 x 2.1-5.0 cm; apex with drip tips, blunt acuminate to 13 mm long; base acute; midrib raised above, nearly square in cross section, strongly raised below; margin entire and finely revolute; secondary veins visible on both sides, fine, brochidodromous but intra-marginal veins very fine, closely arranged, inconspicuous above and slightly raised below; tertiary veins invisible. *Glands* fine but visible below, dark grey-green to blackish, mixture of interrupted wavy lines running across secondary veins towards the margin, with many fine dashes and dots in between them. *Inflorescences* terminal, males with 1-3 flowers, females solitary, pedicel short, to 5 mm long; petals and sepals 4. *Male flowers:* [in bud], sepals and petals concave; pistillode a dwarf fungiform shape with a large dome-shaped cap; surrounded by stamens in 4 weak lobes attached at the base of pistillode; anthers sessile, 2-thecous. *Female flower*: sepals thick, ovate; ovary dwarf fungiform, stigma small, hemispherical, turning flat-topped when mature or slightly sunken; staminodes absent. *Fruit* ovoid or globose, 2.5 x 1.6 cm, with a thick and hardened or stony wall, smooth sometimes shiny surface, brown to dark brown; stigma sessile or weakly raised, to 3 mm long, dark brown or blackish, thinly flattened, weakly convex or sunken on surface; seeds unknown.

Distribution – Sabah, Malaysia.

Habitat & Ecology – Lowland and hill forest up to lower montane forest.

Notes –Closely resembling *G. nitida* in its male flower and leaf but distinguished by the thick and hard fruit wall.

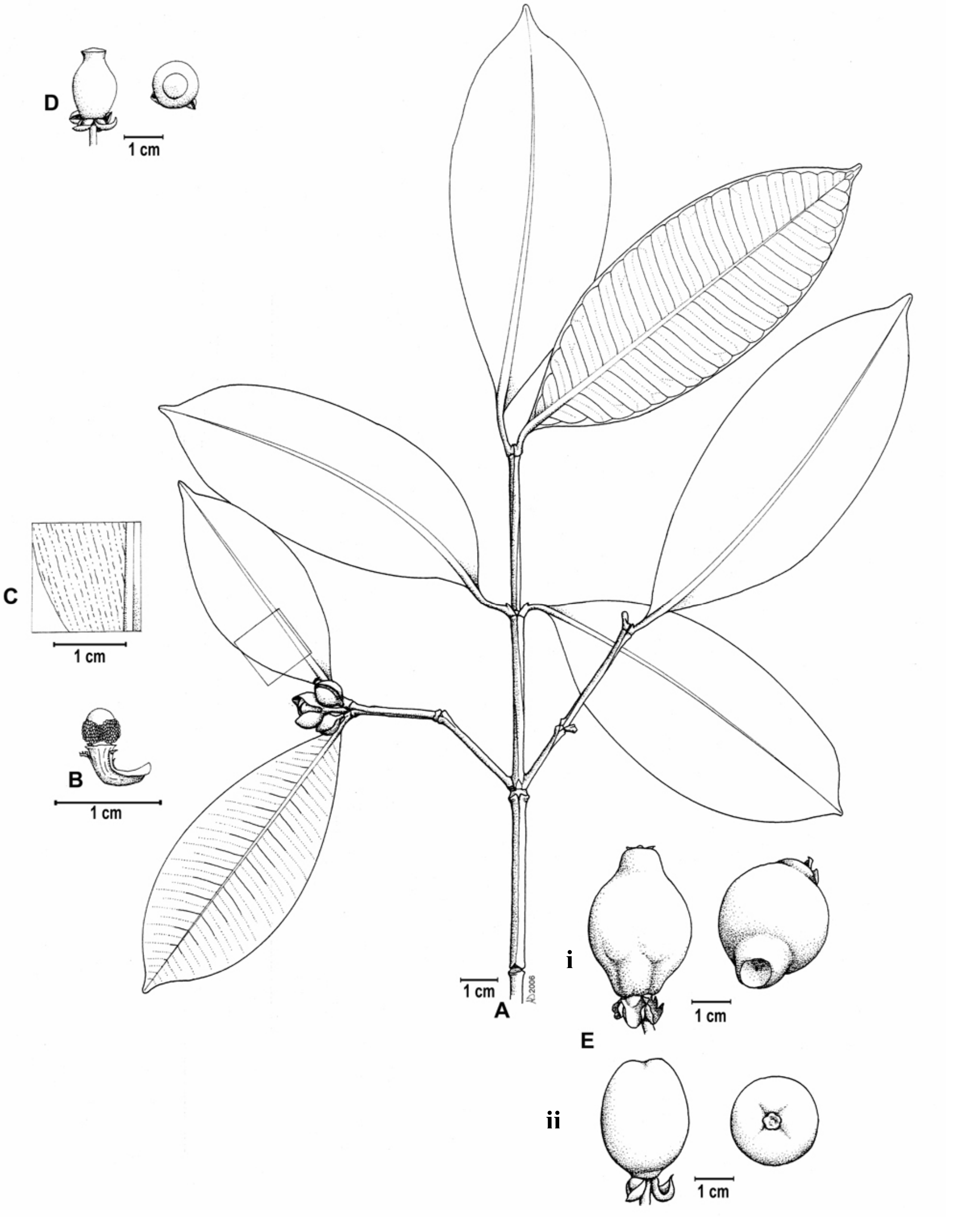


Figure 6.18. *Garcinia sangudsangud* Nazre. **A**. habit (male); **B**. male flower; **C**. glandular lines; **D**. young fruit; **E**. mature fruits and stigma [(A, B, C: *Aban SAN 32914,* L); (D; *Meijer SAN 22942,* L); (Ei: *Muin Chai SAN 33449,* L); (Eii: *Burley 2660*, E)]. Drawn by Anna Dorward.

Map 6.16. Distribution of *Garcinia sangusangud* Nazre

16. **Garcinia venulosa** (Blanco) Choisy – Figure 6.19; Map 6.17.

Garcinia venulosa (Blanco) Choisy, Mem. Soc. Hist. Phys. Nat. 12: 414 (1850). — *Cambogia venulosa* Blanco, Flora de Filipinas (1837) 435. — Neotype (proposed here): *Cuming 1124* [male specimen] (neo K; iso BM).

Garcinia cumingiana Pierre, Fl. Forest. Cochinch. 1 (1882) 11, Fl. Forest. Cochinch. 1 (1883) pl. 78E & 78F. — Lectotype (proposed here): *Cuming 1124* [female specimen] (lecto K; iso BM).

Tree to 25 m tall. *Exudate* yellow. *Bole*: no information. *Twigs* angled, stout, longitudinally striate when dry; dark brown or chocolate to pale brownish yellow. *Petiole* finely striate horizontally, stout, with ligule-like appendages at the base, brown, yellowish, dark brown or dark maroon, 0.9-2.2 cm long. *Lamina* thickly or thinly leathery, pale brown or pale grey-brown to greenish, darker and shiny above, elliptic-oblong, broadly elliptic to ovate or obovate, 8.1-20.6 x 2.7-9.3 cm; apex acute, sometimes acuminate or attenuate; base acute to cuneate or decurrent; midrib yellowish, flattened to slightly raised above, raised and sharp below; margin entire and finely revolute; secondary veins brochidodromous, visible on both sides, closely arranged, slightly raised, occasionally with 2 intramarginal veins especially on female but these are very fine; tertiary veins inconspicuous below, fine, reticulate. *Glands* fine, closely arranged in dark grey-black to greenish interrupted wavy lines, running nearly parallel to midrib across secondary veins from midrib to margin. *Inflorescences* terminal, males with 1-3 (4) flowers in a cluster, females always solitary; bracts triangular, thickly leathery, to 1.0 cm long. *Male flower* with 4 sepals and petals, leathery, outer usually thicker; pedicel 5-10 mm long; sepals ovate; petals lanceolate to ovate; stamens in a massive, weakly 4-angled in central bundle; pistillode absent, anthers 2-thecous, sessile. *Female* flower not seen. *Fruit* globose, dark maroon-purple or dark chocolate, smooth and shiny, 1.4-5.0 x 1.6-5.5 cm, with thick leathery sepals; stigma sessile, with 8-12 crenate, nearly square lobes, black and hardened, to 0.8 cm across; seeds 4-10 with white aril.

Distribution – Luzon, Philippines.

Habitat & Ecology – Lowland and hill forest.

Notes – The fruits closely resemble *G. malaccensis* var. *pseudomangostana* but can be distinguished by the smoother and shiny fruit wall. The leaf also has 2-intramarginal veins but these are not as distinct as in *G. malaccensis.*

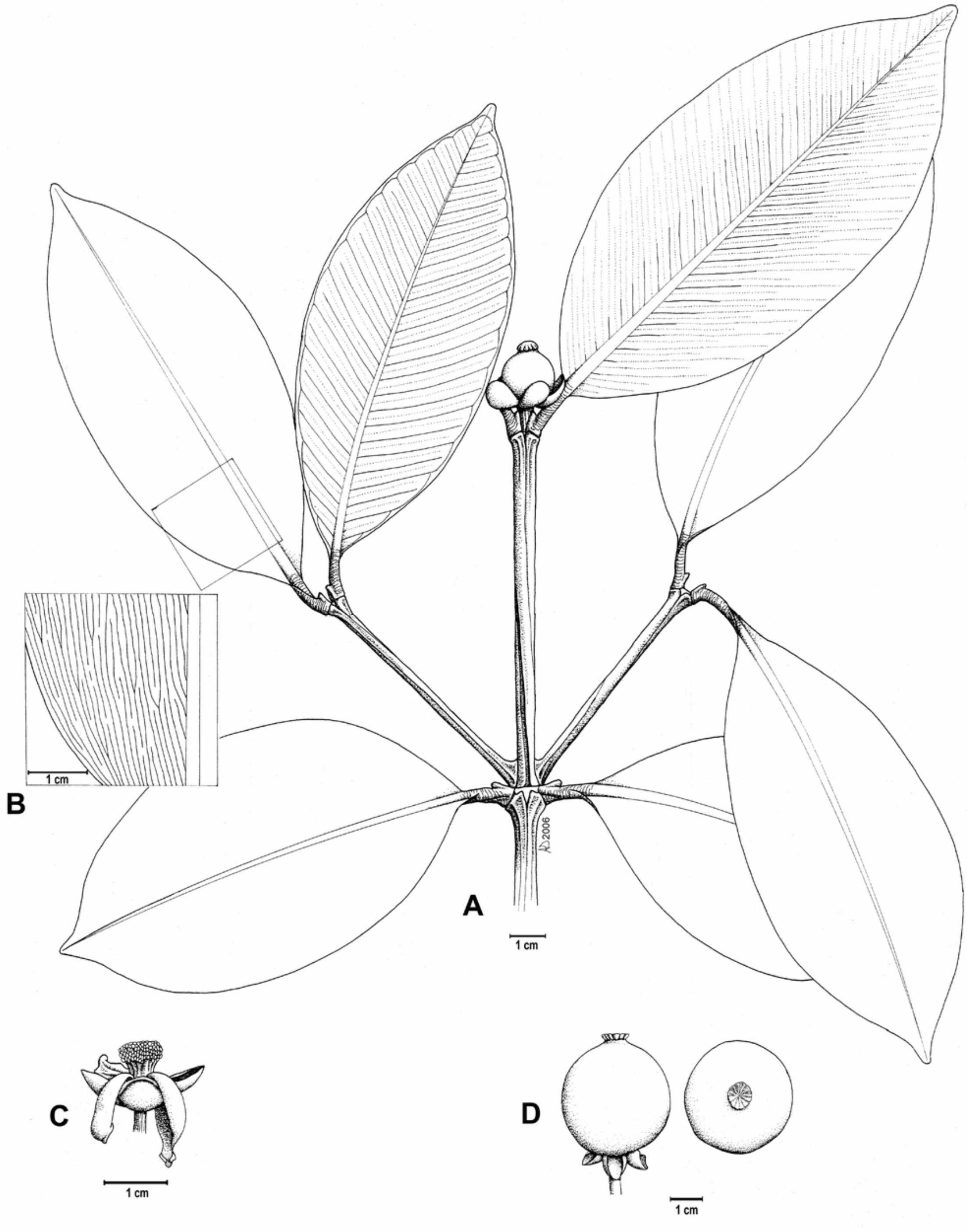
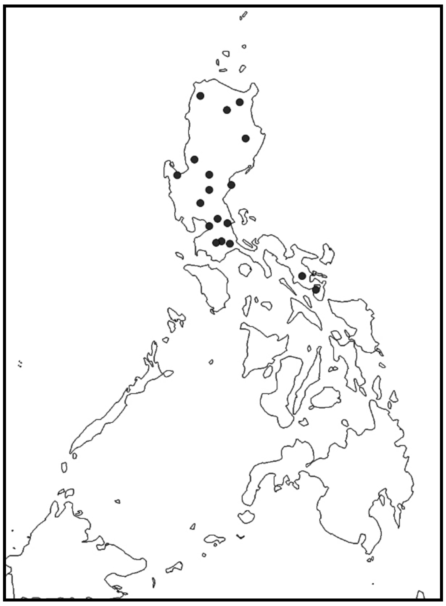


Figure 6.19. *Garcinia venulosa* (Blanco) Choisy. **A**. habit (female); **B**. glandular lines; **C**. male flower; **D**. fruit and stigma [(A, B: *Cuming 1124,* K); (C: *Alvarez 18513,* K); (D: *Curran 17827,* K)]. Drawn by Anna Dorward.



Map 6.17. Distribution of *Garcinia venulosa* (Blanco) Choisy.

6.8.1 Species with Unknown Status

The species listed here were originally listed by Jones (1980) as belonging to sect. *Garcinia.* Because of the scarcity and the poor state of the specimens of these species, it is impossible to determine whether they have the morphological characters that would assign them to sect. *Garcinia.* I am classifying them as of unknown status until more specimens can be obtained for study.

1. **Garcinia blancoi** Pierre

Garcinia blancoi Pierre, Fl. Forest. Cochinch. 1 (1882) 15 & loc. cit (1883) pl.79C. — Lectotype (proposed here): *Gaudichaud-Beaupre 226* (P) Manila, Philippines.

Garcinia calleryi Pierre, Fl. Forest. Cochinch. 1 (1882) 15 & loc. cit (1883) pl.79B. — Lectotype (proposed here): *Callery 56* (P), Palawan Island, Philippines.

Trees: no information on the size. *Exudate* yellow *Bole*: no information. *Twigs* 4-angled, longitudinally wrinkled when dry. *Petiole:* stout, 6-9 mm long. *Lamina* leathery, ovate-elliptic, 11-12 x 5 cm; apex acute to obtuse; base acute to acuminate; midrib slightly raised above and raised below; margin entire and finely revolute; secondary veins brochidodromous, fine but distinct, closely arranged, nearly parallel, visible above and slightly raised below. *Inflorescences* terminal, sepals and petals 4; female not found. *Male flower* [in bud] pedicel to 8 mm long; sepals unequal, outer larger than inner, concave, 7.5-8.0 x 5.0-6.0 mm; petals thicker and larger than sepals; stamens in an annular mass surrounding the pistillode; pistillode dwarf fungiform, tipped with a convex cap, 8-10 lobed; anthers sessile, 2-thecous. *Fruit:* unknown.

Distribution – Philippines.

Habitat & Ecology – Possibly in the lowlands.

Notes – Most of the description follows that of Pierre (1882). It is only known from two specimens in bud making it difficult to classify.

2. **Garcinia erythrosperma** Lauterb.

Garcinia erythrosperma Lauterb. in Bot. Jahrb. Syst. lviii. 26 (1922) — Type: *Lederman 11305*

Tree 10-12 m high, slender. *Exudate:* yellow. *Bole:* brown bark grey. *Twigs* subangular, longitudinally wrinkled when dry. *Petiole* 12-15 mm long; coarse towards lamina. *Leaves* lanceolate, 10-15 x 5-7 cm, coriaceous; apex acuminate and short; base acute; margin sub-revolute; secondary veins brochidodromous, c. 20 pairs, prominent. *Male flower* terminal, solitary, pedicel thick, as long as petiole; sepals 4, persistent, sub-coriaceous, 2 small, lanceolate, sub-acute, 2 larger, concave, widely ovate, subrotundate; staminodes c. 12, free, filament thread like; anthers elliptic, 2-thecous, dehiscent longitudinally. *Fruits* yellow, globose, 4.5 cm diameter; pedicel 15 mm long; sepals persistent 7-10 x 4-9 mm; stigma with 8-9 nearly free lobes, 10 mm across; pericarp fleshy; seeds ca. 8, lanceolate or crescent shaped, 12-17 x 4-8 mm long, covered by dark red aril with a reddish black seed when dry.

Distribution – North East New Guinea: Hunsteinspitze 1300 m.

Habitat & Ecology – Mossy montane forest.

Notes – The description of this species is taken from Lauterbach (1922) as I have not seen any specimens. The original type material in Berlin was destroyed during World War II. Duplicate material was traced in Wroclaw (WRSL) but the specimen was lost in the post to Edinburgh.

3. **Garcinia lucens** Pierre

Garcinia lucens Pierre, Fl. Forest. Cochinch. 1 (1882) 37. — Lectotype (proposed here): *Korthals s.n.* (lecto BO; iso L) East Kalimantan, Borneo.

Tree: size not known. *Exudate:* not known. *Twigs* slightly angled, pale brown to cream. *Petiole* stout, horizontally striate, angled, 1.6-2.0 cm long. *Lamina* thinly leathery, elliptic to ovate, 12.5-16.0 x 4.9-7.7 cm; apex acute with a blunt apex; base broadly acute to obtuse; midrib flattened to slightly raised above, raised and pointed below; margin entire and weakly revolute; secondary veins brochidodromous. *Glands* fine, in wavy longitudinal lines, running nearly parallel to the midrib. *Inflorescences* terminal, only males known, in cluster of 3-10 flowers; sepals and petals 4. *Male flower*: [in bud] pedicel longer than petiole, to 25 mm; sepals ovate to broadly elliptic, 3.6- 4.0 x 2.8-3.1 cm; petals oblong-elliptic, 3.0-3.5 x 5.5-6.2 cm; stamens in an annular mass, surrounding half of the pistillode; pistillode a slender fungiform shape, tipped by a 4-lobed cap; anthers 2-thecous. *Fruit* Unknown.

Distribution – East Kalimantan.

Habitat & Ecology – Lowland forest.

Notes – This species is represented by multiple collections of male and sterile specimens by Korthals, possibly from one locality in Kalimantan. No other specimens have been found. Although it has the distinct character of a long pedicel, the male flower is still in bud making it difficult to study.

4. **Garcinia moulmeinensis** Pierre ex Vesque

Garcinia moulmeinensis Pierre ex Vesque, Monogr. Phan. 8 (1893) 394. — Lectotype (proposed here): *Wallich 4852E* (P) Moulmein, Burma.

Size not known. *Exudate* not known. *Twigs* not known. *Petiole* short, 5-9 mm long. *Lamina* leathery, elliptic or oblong, 11.7-12.5 x 3.7-6.0 cm, pale brown; apex sharply acute or not; base broadly acute or nearly round; margin entire and revolute; midrib flattened above and raised below; secondary veins fine, visible below, a mixture of eucamptodromous and cladodromous, running nearly parallel, c.85° from the midrib; glandular lines faint but fine and inconspicuous below. *Inflorescences* possibly terminal, in cluster of 4-6 flowers; sepals and petals 4. *Male flower* not found. *Female flower* nearly sessile or with a short pedicel, to 3 mm long; sepals membranous, broadly ovate; petals concave, to 5 mm long; staminodes absent; ovary short, tipped by six locular, convex stigma. *Fruit* not found.

Distribution – Burma.

Habitat & Ecology – Lowland.

Notes – Represented only by the type specimen of two leaves without twigs. The flowers were detached and kept in a capsule.

5. **Garcinia squamata** Lauterb.

Garcinia squamata Lauterb., Bot. Jahrb. Syst. 58 (1923) 21. — Lectotype (proposed here): *Gjellerup 1167* (BO), Arfak Mountains, Papua, Indonesia.

Small tree to 4 m tall. *Exudate* yellow. *Twigs* round to slightly angled, pale grey-brown to brown. *Petiole* blackish, weakly channelled on the adaxial surface, to 1.0 cm long. *Lamina* thickly leathery, obovate, 3.0-5.0 x 1.8-3.0 cm; apex nearly round; base acute; margin entire and revolute; midrib flattened or weakly raised above and raised below, especially near the petiole; secondary veins very fine, inconspicuous below, camptodromous; tertiary veins inconspicuous. *Inflorescences* terminal or axillary, flowers solitary; sepals and petals 4. *Male flower* not seen. *Female flowers:* pedicel stout, to 9 mm long; sepals unequal in size, two outer larger, concave or nearly round, to 6 mm long; petals yellow, broadly elliptic, to 9 mm long; ovary 4-6 x 4-5 mm; stigma black, rugose; staminodes not present. *Fruit* Unknown.

Distribution – New Guinea.

Habitat & Ecology – Montane at 1900 m.

Notes – Represented only by female specimens in very young fruit which makes it difficult to classify.

6.8.2 Excluded Species

Listed here are species excluded from sect. *Garcinia* which were treated by Jones (1980) as belonging to the section. No description is given for each species except notes on the morphological characters that separate them from sect. *Garcinia* and, where appropriate, details are given of their phylogenetic position in the analysis of DNA sequence data (Chapter 5).

1. **Garcinia anomala** Planch. & Triana.

Garcinia anomala Planch. & Triana, Ann. Sci. Nat. ser. 4, 14 (1860) 329; Hook f., Fl. Brit. Ind. 1 (1872) 266; Kurz, J. Asiat. Soc. Bengal, Pt. 2., Nat. Hist. 43 (1874) 87; Kurz, Forest. Fl. Burma (1877) 89; Pierre, Fl. Forest. Cochinch. 1 (1882) 10, Fl. Forest Cochinch. 1 (1883) pl.79L; Vesque, Monogr. Phan. 8 (1893) 369; Engler, Nat. Pflanzenfam, ed. 2, 21 (1925) 223; Maheshwari, Bull. Bot. Surv. India 6 (1964) 117. — Lectotype (proposed here): *Hooker f. & Thomson 14* (lecto E; iso A, L), Khasia, India.

Distribution – Eastern India to northern Thailand.

Habitat & Ecology – Montane to 1500 m.

Notes – Differs from sect. *Garcinia* by the axillary inflorescences in thyrses and the male flowers having glomerate, more or less round bundles of stamens surrounding the pistillode.

2. **Garcinia chapelieri** (Planch & Triana) H. Perrier.

Garcinia chapelieri (Planch & Triana) H. Perrier, in Mem. Mus. Hist. Nat., Paris, 24 (1948) 97. — *Ochrocarpos chapelieri* Planch. & Triana in Ann. Sc. Nat. Bot. Ser. 4, 13 (1860) 366; Vesque, Monogr. Phan. 8 (1893) 522. — *Garcinia polyphlebia* Baker in Journ. Linn. Soc. 22 (1886) 447.

Distribution – Madagascar.

Habitat & Ecology – Lowland to hill forest.

Notes – No type specimens were available to study this species and the protologue only gave descriptions of the female specimens. However, other material obtained from P included a few male specimens. Differs from sect. *Garcinia* through the male flowers having 4 free bundles (vs. lobes) of stamens surrounding the pistillode. Pistillode slender, filament-like. The fruit wall has lobes and is tipped by small, 4 fused notch-like stigmas.

3. **Garcinia costata** Hemsl. ex King.

Garcinia costata Hemsl. ex King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 59 (1890) 161. — Lectotype (proposed here): *King's Collector 5375* (lecto K; iso L).

Distribution – Peninsular Malaysia.

Habitat & Ecology – Hill forest to 600 m.

Notes – Vegetatively, the large, cabbage-like and ribbed leaves are distinctly different from sect. *Garcinia.* The inflorescences are thyrses rather then in clusters as in sect. *Garcinia,* the male flower is similar to *G. anomala* by the mass of stamens surrounding the pistillode and the fruit has a lobed or segmented wall. Molecular analysis shows this species to be positioned outside the clade of sect. *Garcinia,* forming a monophyletic group together with *G. maingayi* and *G. trianii,* closely related to sect. *Brindonia.*

4. **Garcinia maingayi** Hook f.

Garcinia maingayi Hook f., Fl. Brit. India 1(1872) 267. — Lectotype (proposed here): *Cuming 161* (lecto K) Peninsular Malaysia.

Garcinia baillonii Pierre, Fl. Forest. Cochinch. 1 (1882) 18; loc. cit (1883) pl. 83. — Lectotype (proposed here): *Beccari 2498* (lecto K) Kuching, Sarawak.

Distribution – Sumatra, Peninsular Malaysia and Borneo.

Habitat & Ecology – Hill forest to lower montane 900 m

Notes – Closely related to *G. costata* but the leaf is smaller and the fruit wall not lobed but smooth with stripes of green and yellow. Molecular analysis positioned *G.*

maingayi outside the sect. *Garcinia* clade where it forms a monophyletic group together with *G. trianii* and *G. costata.*

5. **Garcinia propinqua** Craib, Kew Bull. 3(viii), 85 (1924).

Garcinia propinqua Craib, Bull. Misc. Inform. Kew (1924) 85. — Lectotype (proposed here): *Kerr 5611* (lecto K), Doi Chieng Dao, Thailand

Distribution – Northern Thailand.

Habitat & Ecology – Montane forest to 1200 m.

Notes – Represented only by a male type specimen. Morphologically it is similar to *G. anomala* but with a smaller stature, leaves and flowers.

6. **Garcinia pseudo-guttifera** Seem.

Garcinia pseudo-guttifera Seem., Fl. Vit. (1865) 11; A.C. Smith & S. Darwin, J. Arnold Arb., 55 (1974) 245; A.C. Smith, Fl. Vit. Nova (1981) 343-344. — Type: *Seeman 50* (holo K; iso BM) Navua River, Serua Province, Viti Levu (Fiji)

Distribution – New Hebrides, Fiji and Tonga.

Habitat & Ecology – From hill to lower montane forest.

Notes – Differs from sect. *Garcinia* by the inflorescences in thyrses which contain many flowers (to 40).

7. **Garcinia tonkinensis** Vesque.

Garcinia tonkinensis Vesque, Monogr. Phan. 8 (1891) 379. — Lectotype (proposed here): *Balansa 4359* (lecto P; iso K) Tonkin, Vietnam.

Distribution – Vietnam

Habitat & Ecology – Not known.

Notes – Poorly known with only two female specimens. Differs from sect. *Garcinia* by the thyrsoid inflorescences positioned terminally and axillary.

8. **Garcinia trianii** Pierre

Garcinia trianii Pierre, Fl. Forest. Cochinch. 1 (1882) 18; Fl. Forest Cochinch. 1 (1883) pl. 80L. — Lectotype (proposed here): *Beccari 360* (lecto K) Sarawak.

Distribution – Borneo.

Habitat & Ecology – Lower to upper montane forest 1900 m.

Notes – Similar morphologically to *G. maingayi* but has smaller leaves and flowers. Molecular analysis supports close relationship to *G. maingayi*.

9. **Garcinia vidua** Ridley.

Garcinia vidua Ridley, Kew Bull. 17 (1938) 115. — Lectotype (proposed here) *Haviland 2222* (lecto K; iso L, UC) Kuching, Sarawak.

Distribution – Sarawak.

Habitat & Ecology – Lowland to hill forest 600 m.

Notes – Differs from sect. *Garcinia* by having nearly sessile axillary inflorescences, with one to three flowers; stamens in the male flowers are very few in a central mass without a pistillode. The fruits are small and tipped with a sessile and rugose stigma. Both flower and fruit characters suggest *G. vidua* is a member of sect. *Brindonia* sensu Jones (1980).

6.9 List of Exsiccatae

1. *G. acuticosta* Nazre

Cockburn, P.F. FRI10559 (L ex. KEP) *Batu Biwa, Terengganu* — Henderson, M.R. 19654 (K) *Kelantan, Malaysia* — Loh, H.S. FRI13410 (L ex. KEP) *Gading Forest Reserve, Selangor* — Nazre, M. BB01 (E) *Bukit Bauk Forest Reserve, Terengganu.*

2. *G. cataractalis* Whitmore

Whitmore, T.C. FRI20350 (K ex. KEP) *Sungai Kerbat, Terengganu.*

3. *G. celebica* L.

Aban Gibot 54837 (L, SAN), *Pulau Sakar, Lahad Datu, Sabah* — Ag. Amin Sigun SAN104109 (E, SAN) *Membakut, Sabah*, SAN 126779 (E), SAN 98765 (E) — Ahmad Shukor AS107 (SING) *Kijal, Terengganu*, AS29 (SING) *Jason Bay, Johor* — Alvins, V.M. (SING) *Melaka* — Anderson, J.A.R. S30779 (L) & S30790 (E, L) *Gunung Api, Baram, Sarawak* — Anderson, M. 28 (P) *Calcutta, India.*

Backer, C.A. 27885 (L) *Pulau Kangean, Java* — Balgooy, M.M.J.v. 6818 (A) *Pulau Maikoor, Aru Is.* — Bayak 2150 (K) *Jesselton, Sabah* — Beguin 307 (L) *Bengkalis, Sumatra* — Bernard Lee S41863 (L) *Datu Protected Forest, Sarawak* — Blume, C.L. s.n. (L) *Java Island*; 1273 (L); 1669 (L) — Borssum Waalkes, J.v. 321 (L) *Pulau Panaitan, Java* — Boschbouwproefstation bb0945 (L), bb9316 (L ex. BO) *Lampung, Sumatra*; bb10104 (L) *Waai, Ambon Island*; bb5708 (L) *Nias Island, Sumatra* — Burghardt, C.P. bb5855 (L) *Boeton, Sulawesi* — Burkill, H.M. HMB259 (SING) *Pangkor Island, Perak;* HMB 999 (SING, L) *Pulau Angsa, Singapore.*

Castro & Melegrito 1499 (UC) *Banggi Island, Sabah* — Celestino & Ramos 23055 (L) *Sagpangan, Aborlan* — Cenabre, A.L. 29179 (A) & 29229 (A) *Puerto Princesa*

City, Palawan Islands — Chew, W.L. CWL1058 (A, L, SING) *Sungai Melinau, Baram* — Collins, D.J. s.n. (E, K, L), 1693 (L), 898 (L) *Sriracha, Thailand* — Congdon, G., Hamilton, C. 444 (A) *Haad Yai, Thailand.* — Coode, M.J.E., Wong, K.M. 6856 (A) *Tutong, Brunei* — Corner, E.J.H. s.n. (SING) *Sungai Sedili Kecil, Johor*; SFN 25766 (SING) *Kuala Bebar, Pahang* — Croft, G.W. 5684 (UC) *Indo-China* — Cuming, H. 2296 (K) Melaka — Curran, H.M. 3787 (K) *Palawan Islands* — Curtis, C. s.n. (SING) & 690 (SING) *Telok Bahang Forest, Pulau Pinang*; 2453 (SING) *Pulau Tengah, Pulau Pinang*; 3438 (SING) *Beruas, Perak.*

Diepenhorst HB2152 (L) *Priaman, Sumatra Barat.*

Eberhardt 3072 (P) *Tinh Thua Thien-Hue, Vietnam* — Edano, G. 77389 (SING) *Palawan Islands* — Elmer, A.D.E. 12617 (E, L), 12711 (A) *Addison Peak, Palawan*; 18480 (L, UC) *Puerto Princesa City, Palawan Islands.*

Falconer, H. (GH, L) *Molamyaing, Burma* — Flerry, F. 30203 (P) *Thu Dau Mot, Vietnam* — Forbes, H.O. 539 (L) *Sogeri Island*, *Papua New Guinea* — Foreman, D.B. LAE52091 (L) *Tavanatangir Harbour, Papua New Guinea*, LAE52129 (L) *Rabaul District, Papua New Guinea* — Foxworthy, F.W. 12577 (SING) *Telok Bahang Forest Reserve, Pulau Pinang*; 1741 (SING) *Pulau Pangkor, Perak*

Goodenough, J.S. (SING) *Changi, Singapore* — Griffith, W. s.n. (K), 857 (K, L, P) *Melaka*; s.n. (L) *Molamyaing, Burma*; Gwee, Paul, Samsuri Ahmad, Saifuddin, Jacky GAT141 (SING) *Tanjung Chek Java, Singapore.*

Hamilton, F.B. 1113 (E) *Calcutta, India* — Harmand 1074 (P) *Laos* — Harreveld, P.v. (L) Java — Haviland, G.D. 2329 (K, SING) *Bintulu, Sarawak* — Helfer, J.W. 21 (A, E, L) — Henderson, M.R. 18412 (SING), *Pulau Tioman, Pahang* — Holmberg, P.J. 868 (SING) *Malacca* — Holttum, R.E. (SING) *Singapore*; 17673 (SING) *Kuala Terengganu, Terengganu* — Hombron, J.B. (P) *Peninsular Malaysia* — Hoogerwerf, A. 132 (L) *Pulau Java* — Hooker, J.D., Thomson, T. s.n. (GH, L) — Huc., R. RH522 (A, L) *Wai Kambas, Palembang.*

Ilias Paie S36331 (L) Katibas, Kapit.

Kairo, A. NGF45063 (L) *New Guinea* — Karta 235 (L, BO), 380 (L) *Semarang, Pulau Karimunjawa* — Kerenga, K. LAE74243 (L) *New Britain, Bismarck Archipelago*; LAE74246 (L) *Papua New Guinea* — Kerr, A.F.G. 1073 (L), 8572 (K) *Thailand*; 11179 (K, L) *Kaw Tao Surat, Thailand*; 12752 (L) *Surat Thani, Thailand*; 14078 (L) *Adang Island, Thailand*; 20261 (K) *Chaiyapum, Thailand*; 8513 (K, UC) *Chaiyaburi, Thailand* — King's Collector s.n. (K) *Andaman Is.*; 483 (K) *Nicobar Is.* — Koelz, W. 24900 (UC) *Garo Hills Assam* — Koorders, S.H. 21958B (L), 30833 (L, BO), 33366B (L) *Banyumas Java*; 23646 (L), 2937B (L), S.H. 2960B (L, BO), 34266B (L) *Java Island* — Korthals, P.W. 1313a[4601] (P) *Banjarmasin Kalimantan* — Kostermans, A.J.G.H. 193A (L) *Manokwari, Irian Jaya*; 24028 (A) *Sri Lanka*; BW15509 (L) *Teluk Irian Jaya* — Kostermans, A.J.G.H., Kuswata Kartawinata 49 (A) *Ujung Kulon Nature Reserve Peutjang Is.* — Kostermans, A.J.G.H., Wirawan 661 (L) *Pergunungan Ruteng Lesser Sunda Is.*; 821 (A) *Flores Lesser Sunda Is.* — Kurz, W.S. 24 (P) *Andaman Is.*

Lace, J.H. 4675 (E) *Myanmar* — Lai, J. LJ154 (SING) *Pulau Ubin, Singapore*; Lai, J. LJ7 (SING) *Sentosa Island, Singapore* — Lam, H.J. (L) *Java Is.* — Laman, T., Ismail A Rachman, Edi Mirmanto TL545 (L) *Gunung Palung, West Kalimantan*;

TL559 (A ex. BO) *West Kalimantan* — Lesmy Tipot FRI33980 (L) *Pantai Aceh Forest Reserve, Pulau Pinang*; FRI34940 (L) *Pulau Pangkor Perak* — Liew, K.C. 168 (L ex. KLU) *Pulau Redang Terengganu.*

M.C. Lakshnakara 522 (L) Chantabun, Thailand — Mahamud 14983 (E) Rompin Pahang — Mahamud 14983 (SING) Rompin Pahang — Maingay, A.C. 150 (K) Melaka, Malaysia — Manalo, A. 7430 (K) — Palawan Islands —Maxwell, J.F. 85-167 (A) Songkhla, Thailand — Maxwell, J.F. 85-300 (A, L) Nakhon Si Thammarat Peninsular; 85-474 (E, A) Na Mom Songkhla; 86-68 (A) Songkhla; 88-190 (L) Chiang Mai Thailand — Mohamed Haniff, Mohd Noor 7570 (SING) Pulau Chupak, Kedah — Mohd Noor (UC ex. SING) Botanic Gardens Singapore — Mohd Noor, Samsuri Ahmad MN25 (E, A) Pulau Pemanggil, Johor — Muin Chai SAN29720 (L) Lahad Datu, Sabah.

N.G. Nair 3526 (L) *Sawai, Nicobar Is.* —Nengah Wirawan 392 (L), 394 (L) *Ujung Kulon Nature Reserve Peutjang Island* — Neth. Ind. For. Service bb30737 (L), bb30792 (L), bb30816 (L), bb30890 (L) *Serui, Irian Jaya*; bb30940 (L) *New Guinea*; bb32514 (L) *Sulawesi*; Cel./II-112 (L) *Malili, Sulawesi* — Noltee, A.C. 4022 (L ex. BO) *Pekalongan Java*.

P. Sirirugsa 1013 (A) *Songkhla Thailand* — Phuang van dier 36 (K ex. P) *Ba Ria Vietnam* — Pierre, J.B.L. 3633 (K ex. P) *Phuoc Le, Vietnam*; 3637 (P) *Laos*; 3695 (P); *Xa Phuoc Le, Vietnam*; 4607 (P) *Java Is*.; 700 (A) *Vietnam*; 700 (K) *Cochinchina*; 700 (P) *Ho Chi Minh City Vietnam* — Poilane, M.E. 14205 (K) *Cambodia*; 14781 (K ex. P) *Kampot, Cambodia*; 24088 (P) *Do Mai Vietnam*; 27208 (P) *Siemreab Cambodia*.

Rahim Ismail 97929 (L) *Kuantan Pahang* — Ramlanto, Zainal Fanani 721 (L) *Tolitoli Sulawesi* — Ridley, H.N. (SING) *Dinding Perak*; 1096B (SING) *Kuala Pahang, Pahang*; 1962 (SING) *Bukit Timah*, *Singapore*; 4791 (K, SING) *Pulau Ubin, Singapore*; 7966 (SING) *Pulau Pangkor, Perak*; 9023 (K, SING) — Ridsdale, C.E. SMHI188 (K, L, UC), SMHI195 (A, L) *Puerto Princesa City, Palawan Islands* — Rossum, H.I.P. 171 (L) *Pulau Belitung Sumatra* — Royen, P.v. 5464 (A) *Waigeo Island Irian Jaya*

Seidenfaden, G. 2585 (SING) *Tha Chang, Thailand* — Sidek bin Kiah S366 (SING) *Naka Kedah*; S77 (L) *Pulau Pawai, Singapore* — Sinclair, J. 5791 [SFN38548] (E ex. SING) *Machua Khali, Bangladesh* — Smith, J.E. (K) *Calcutta India* — Smythies, B.E. 14052 (L) *Sungai Satok Kuching* — Soepadmo, E. 311 (L) *Suaka Mergasatwa Ujungkulon Peutjang Island* — Steenis, C.G.G.J. bb28917 (L) *Papua New Guinea* — Stevens, P., Lelean, Y. LAE58551 (L) *Hoskins, Papua New Guinea* — Stone, B.C. 14477 (L ex. KLU) *Pantai Aceh Forest Reserve, Pulau Pinang* — Suppiah, T. FRI14761 (L) *Pahang, Malaysia.*

T & P KL2835 (SING) *Dungun Terengganu* — Teijsmann, J.E. s.n. (A, BO, A) *Hutumuri Ambon Island*; s.n. (L) *Tanjung Pandan Belitung*; 11843 (L) *Pangkadjene, Sulawesi*; 12392 (L) *Sulawesi*; 8045 (L) *Mampawah, Kalimantan*; 8960 (L ex. BO) *Timor Lesser Sunda Is* — Treub, M. 4169 (K) *Pulau Bangka, Sumatra*.

Vethevelu, P. 29696 (L) *Menchali Forest Reserve Pahang* — Vidal y Soler, S. 2152 (A, K) *Iwahig, Palawan* — Villamil, A. 342 (A) Sabah — Vogel, E.F. 1390 (L) *Suaka Mergasatwa, Ujungkulon Peutjang Island.*

Wallich, N. 4852 (K) *Penang, Malaysia*; 4854 (K) *Sylhet* — Whitmore, T.C. FRI 15746 (L ex. KEP) *Hulu Perak, Perak*; FRI 20509 (L) *Perlis, Malaysia* — Womersley, J.S. NGF24961 (L) *Morobe, Papua New Guinea* — Wood, D.D. 2451 (UC) *North Borneo* — Wyatt-Smith, J. 80555 (L) — *Pisang Is., Johor.*

Yahya SFN21419 (SING) Penang, Malaysia.

4. ***G. diospyrifolia*** Pierre

i. ***G. diospyrifolia*** Pierre **var.** ***diospyrifolia***

Burley, J.S., Tukirin 703 (A) *Sungai Kahayan, Central Kalimantan.* — Chan, Y.C. FRI19844 (L ex. KEP) *Lesong Forest Reserve, Pahang*; FRI25052 (KEP, K, L) *Bukit Bauk Forest Reserve, Terengganu.* — Clemens, J., Clemens, M.S. 22104 (K ex. SAR) *Sungai Rejang, Sarawak* — Cockburn, P.F. FRI 11066 (L ex. KEP) *Chini Forest Reserve, Pahang* — Corner, E.J.H. s.n. (K ex. SING) *Sedili, Mersing*; E.J.H. SFN28653 (L) *Johore, Malaysia.*

Jacobs, M. 5125 (K ex. L) *Kuching, Sarawak* — Kochummen, K.M. 77731 (L) *Mersing, Johor* — Korthals, P.W. s.n. (BO) *Borneo*; s.n. (L) *Banjarmasin, Kalimantan*; s.n. (L) *Sekubang, Kalimantan* — Laman, T., Ismail A Rachman, Edi Mirmanto TL1204 (A), TL987 (A) *Gunung Palung National Park, Kalimantan* — Laumonier, Y. YL6414 (L) *Siak, Sumatra.*

Maskuri 155 (L) *Tanah Merah, Kalimantan* — Mohamad Shah bin Mohamad Nur 1560 (SING) *Bukit Terom, Pahang* — Ridley, H.N. 9005 (K, SING) *Siak, Sumatra* — Samsuri Ahmad, Ahmad Shukor SA412 (A, SING) *Lesong Forest Reserve, Pahang* — Soegeng Reksodihardjo 47 (L ex. BO) *Samarinda, Kalimantan* — Soepadmo, E. 170 (E) *Pekanbaru, Riau* — Zainal Ariffin 914 (A, K) *Wain, Kalimantan.*

ii. ***G. diospyrifolia*** Pierre **var.** ***arborea*** Nazre

Aban Gibot SAN31195 (L) *Sungai Serudong, Tawau* — George Mikil SAN31886 (L ex. SAN) Tenom, Sabah — Ilias Paie S17017 (K) *Sabal Forest Reserve, Sarawak* — King's Collector 5460 (K, UC), 10958 (P, L), 7232 (K, KEP, P) *Larut, Perak.*

Majawat SAN102415 (K, SAN) *Kinabatangan, Sabah* — Kuswata Kartawinata 856 (L, BO), 942 (L) *Jaro, South Kalimantan* — Martin, P.J. S37905 (K, L) *Gunung Gading, Sarawak* — Pereira, J.T., A. Berhaman, J. Sugau, J., Madani, L., Baraham B JTP65 (E) *Penampang, Sabah* — Vogel, E.F. 2777 (L) *Sumatra Island.*

iii. ***G. diospyrifolia*** Pierre **var.** ***minor*** Nazre

Nazre, M. BB08 (E) *Bukit Bauk Forest Reserve, Terengganu* — Rosemary Gianno 541 (L) *Tasik Bera, Pahang* — Wong, K.M. 32216 (A ex. KEP) *Pasoh Forest Reserve, Negeri Sembilan.*

5. ***G. discoidea*** Nazre

Burkill, H.M. HMB1854 (L ex. SING) *Sedili, Mersing* — Chew, W.L. CWL843 (KEP, SING, UC) *Cameron Highlands, Pahang* — Corner, E.J.H. s.n. (SING), 34940 (E, L, SING) *Mawai, Johor*; SFN31499 (SING) *Kuala Nerang, Kedah.*

Kochummen, K.M. FRI2756 (A) *Bukit Arang, Selangor* — Nazre, M. BB02 (E) *Bukit Bauk Forest Reserve, Terengganu* — Ng, F. FRI5017 (L) *Bukit Fraser, Pahang* — Samsuri Ahmad, Ahmad Shukor SA462 (SING) *Pahang, Malaysia.*

6. ***G. exiguus*** Nazre

Coode, M.J.E., Dransfield, J., Kirkup, D., Idris M Said 7886 (A ex. BRUN) *Ulu Belalong, Brunei* — Paul Chai, P.P.K. S31750 (L) *Bintulu, Sarawak.*

7. ***G. harmandii*** Pierre

Harmand 349 (P) Laos — Pierre, J.B.L. 1371 (A, K) *Thanh Ho Bien Ho, Vietnam*; 776 (K, P) *Cambodia* — Poilane, M.E. 17388 (P) *Kampong Spoe, Cambodia* — Thorel, M. 1018 (K ex. P) *Mekong River*, *Cambodia.*

8. ***G. malaccensis*** Hk. f.

i. *G. malaccensis* var. *mangostana*

Alvins, V.M. 2742 (SING) *Merlimau, Melaka* — Ashton, P.S. BRUN3392 (SAR ex. BRUN) *Belalong*, *Brunei* — Chelliah, S. 104374 (KEP, L) *Bukit Bauk Forest Reserve, Terengganu* — Cockburn, P.F. FRI10887 (L) *Sungai Keliu, Pahang* — Cockburn, P.F. FRI8181 (KEP, L) *Sungai Kemia, Besut* — Kiah Hj. Salleh (SING) *Mandai Road Village*.

Kochummen, K.M. 76634 (L) *Sungai Menyala Forest Reserve, Negeri Sembilan* — Lindong, Santiago, A. KEP71525 (L) *Banang Forest Reserve, Johor* — Maingay, A.C. 149 (GH, K, L); 1643 (K) *Malacca*, *Malaysia* — Mohd Noor 1529 (SING) *Bukit Timah, Singapore*.

Neth. Ind. For. Service bb30045 (L) *Indragiri Hulu, Riau* — Nazre, M. BB 9 (E) *Bukit Bauk Forest Reserve*, *Terengganu* — Ridley, H.N. (SING) *Chua Chu Kang, Singapore* — Whitmore, T.C. FRI8682 (KEP, L) *Sungai Kahang, Kluang*; FRI8986 (L) *Sungai Loh, Terengganu.*

ii. *G. malaccensis* var. ***pseudomangostana*** Nazre

Arbainsyah AA1004 (BO) *Balikpapan, Kalimantan* — Elmer, A.D.E. 21113 (K, L, SING) *Tawau, Sabah* — Fidilis Krispinus, Sumbing SAN96472 (L) *Luasong, Kalabakan.*

James Ahwing 38173 (L) *Gomantong Forest Reserve, Sandakan* — Madani, L. 50574 (L) *Sandakan, Sabah* — Meijer, W. SAN19236 (L) *Tawau, Sabah* — Nazre, M. S1

(E) *Forest Research Centre, Sandakan* — Sigin, Joseph SAN97194 (L) *Kretam Forest Reserve, Sandakan.*

9. *G. mangostana* L.

Anon. 1667 (SING) *Malacca, Malaysia*; 7 (L) *Java.*

Anderson, J.A.R., Ilias Paie 15371 (L) *Gunung Gading, Sarawak* — Bakhhuizen van den Brink Sr., R.C. 3417 (L ex. BO) *Gunung Kembang, Java* — Blume, C.L. (L) *Java* — Bradley, M.C. (GH) *Thailand* — Brass, L.J. 32410 (A) *Kassam, Papua New Guinea*

Daud, Tachun bin Baba SFN36093 (L) *Gunung Gading, Sarawak* — Fidilis Krispinus, Sumbing SAN96472 (E) — *Luasong, Kalabakan* — Forest Department A1069 (SING) *Sandakan* — Fretes, d. (L) *Ambon Island*

Furtado, C.X.D.R. 34866 (A) *Botanic Gardens, Singapore* — Hasan Pukol 5726 (L, SING ex. BRUN) *Muara, Brunei* — Ilias Paie S15825 (L) *Labang Forest Reserve, Bintulu* — Junghuhn, F. (L) *Java* — Lai, S.T. S68180 (SAR) *Sungai Engkari, Sarawak*

Laman, T., Ismail A Rachman, Edi Mirmanto TL1300 (A) *West Kalimantan* — Maxwell, J.F. 86-499 (A) *Patalung, Thailand* — Mohamad Shah bin Mohamad Nur, Mohd Noor MS1782 (L, A, SING) *Pahang* — Mohamed Haniff 15649 (SING) *Teluk Intan, Perak* — Mohd Noor 146 (A) *Botanic Gardens, Singapore*

Nixon, A.B. 18690 & 18695 (A) *Tavoy, Burma* — Othman Ismawi S32968 (L) *Kuching*; S43603 (L) *Sungai Pakau, Belaga* — Sibat Luang S23041 (L) *Bukit Mentagai, Sarawak* — Sinclair, J. 6842 (E) *Jurong, Singapore* — Stevens, P., Streimann, H. LAE54735 (A, L) *Morobe, Papua New Guinea* — Stomps, T.J. (L) *Berastagi, Sumatra*

Telado 1922 (A) *Papar, Sabah* — Wong, K.M. WKM1597 (A) *Bukit Patoi, Temburong Brunei* — Wray , L. 5587 (SING) *Taiping, Perak* — Zollinger, H. 779 (L) *Java Island.*

10. *G. moselleyana* Pierre

Elmer, A.D.E. 7187 (K) *Leyte Island, Philippines* — Moseley, H.N. (K) *Basilan, Philippines* — Wenzel, C.A. 3036 (K, UC) *Placer, Philippines.*

11. *G. nitida* Pierre

Argent, G., Amiril Saridan 9318 (A, E, K) *Central Kalimantan* — Beccari, O. 1179 (A, K) *Sarawak*; 2104 (A) *Gunung Berumput, Sarawak* — Blicher, U. S59879 (L) *Kapit, Sarawak* — Church, A.C., Mahyar, U.W., Indah, Ismail, Hamzah 1299 (E ex. BO) *Central Kalimantan* — Clemens, J., Clemens, M.S. 40402 (UC); 40620 (A, K) *Kinabalu National Park*

Fidilis Krispinus, Sumbing SAN113356 (A) *Sungai Mantuluk, Keningau* — Haviland, G.D. 2339 (K) *Kuching* — Ilias Paie 13317 (L, SAR) *Perigi Mountain, Sarawak* — J.K. Lajangah 44731 (K, L SAN) *Kinabalu National Park, Sabah* — Sibat

Luang S22499 (A, K, SAR) *Anap Forest Reserve, Sarawak* — Zainal Ariffin AA914 (A) *Wain, Kalimantan.*

12. *G. ochraceus* Nazre

Streimann, H., Martin, N. LAE52886 (E); LAE52890 (E) *Amanab, New Guinea.*

13. *G. penangiana* Pierre

Brunig, E.F. S1142 (K ex. SAR) *Temburong, Brunei* — Burbidge, F.W. (K) *Borneo* — Burkill, I.H., Mohamed Haniff 15716 (SING) *Kuala Lipis, Pahang* — Chan, Y.C. FRI25061 (L ex. KEP) *Bukit Bauk, Terengganu* — Church, A.C., Mahyar, U.W., Afriastini 1762 (A, E, BO) *Sungai Serawai, Kalimantan*; 1840 (A) *West Kalimantan* — Church, A.C., Mahyar, U.W., Indah, Ismail, Hamzah 1216 (A) *Central Kalimantan* — Cockburn, P.F. FRI7877 (L ex. KEP) *Labis Forest Reserve, Johor*; FRI8242 (L ex. KEP) *Besut, Terengganu* — Corner, E.J.H. (SING) *Kemaman, Terengganu* — Curtis, C. s.n. (SING), 1549 (SING) *Telok Bahang Forest Reserve, Pulau Pinang*; 1430 (SING) *Prince of Wales, Malaysia.*

Daud, Tachun bin Baba SFN36067 (L, SING) *Sarawak* — de Wilde, W.J.J.O., de Wilde-Duyfjes, B.E.E. 12678 (K) *Aceh, Sumatra*; 18011 (K); 18028 (K) *North Sumatra* — Foxworthy, F.W. 1185 (SING) *Johor* — Galau S14977 (K ex. SAR) *Kuching* — Henderson, M.R. 21689 (K, SING) *Pulau Tioman, Pahang*; 24836 (SING) *Ketil, Kelantan* — Ilias Paie, James Dawos Mamit S28974 (E) *Banjaran Bungoh, Sarawak.*

Jacobs, M. 5444 (K) *Belaga, Sarawak* — Kadim, Mohd Noor KN591 (A, K, L, SING) *Pulau Tioman, Pahang* — King's Collector 3583 (L ex. KEP), 6769 (L ex. KEP), 7565 (SING) *Larut, Perak* — Kirkup, D., Wong, K.M., Dransfield, S., Niga 265 (K ex. BRUN) *Brunei* — Maurus, Heya, Suali SAN72470 (A) *Sook, Sabah* — Meijer, W. 2531 (A) *Pulau Tarakan, Kalimantan* — Othman Ismawi S29670 (E ex. SAR) *Kapit, Sarawak.*

Paul Chai, P.P.K., Wright, E. S32334 (L) *Sungai Medamit, Limbang* — Sibat Luang S23622 (K ex. SAR), S23667 (A) *Arip River, Sarawak*; Sibat Luang S25238 (K) *Semengoh, Sarawak* — Sidek bin Kiah, Maulod bin Elin SK533 (SING) *Pulau Tioman, Pahang* — Sidiyasa, K., Ambriansyah, Zainal Ariffin 1296 (A) *East Kalimantan* — Sinclair, J., Kiah Hj. Salleh SFN40794 (E, L, SING) *Gunung Tebu Forest Reserve, Terengganu.*

Teijsmann, J.E. (L ex. BO) *Pulau Bintan, Riau* — Vethevelu, P. FRI32926 (L ex. KEP) *Pasoh Forest, Negeri Sembilan* — Wallich, N. 4848 (E) *Singapore*; 4852D [Pierre4604] (P) *Prince of Wales, Malaysia* — Whitmore, T.C. FRI20282 (A, L, KEP), FRI20286 (L ex. KEP) *Trengan, Pahang*; FRI20347 (L) Sungai Kerbat, Terengganu; FRI8959 (L ex. KEP) *Sungai Loh, Terengganu* — Yeob 5839 (SING) *Johor, Malaysia* — Yii, P.C. S40775 (L ex. SAR) *Sabal Forest Reserve, Sarawak*; S53588 (SAR) *Batang Balui, Sarawak.*

14. *G. rigida* Miq.

Diepenhorst HB646 (L) *Priaman, Sumatra Barat* — Harmand 4012 (K) *Pulau Kondor, Vietnam* — Maskuri 193 (L) *Nias Island, Sumatra* — Poilane, M.E. 13735 (K) *Muang Saravane, Laos*; 17783 (K, P) *Cambodia.*

15. *G. sangudsangud* Nazre

A.Bakar, Meijer, W. SAN28681 (K, L) *Sungai Balung, Sabah* — Aban Gibot 60730 (L ex. SAN) *Ranau, Sabah*; SAN29564 (K, L, SAN), SAN32914 (L ex. SAN), SAN32977 (L, K) *Tawau, Sabah*; SAN30021 (K ex. SAN) Quoin Hill, Tawau; SAN34020 (L ex. SAN) *Merotai Besar, Sabah.*

Meijer, W. SAN22942 (L) *Sandakan, Sabah* — Muin Chai SAN29368 (K), SAN29720 (K, L, SAN), SAN33449 (K, L) *Lahad Datu, Sabah* — Wood, G.H.S., Wyatt-Smith, J. SANA4297 (L ex. SAN) *Mostyn estate, Lahad Datu.*

16. *G. venulosa* (Blanco) Choisy

Alvarez, R.J. 18513 (K) *Cagayan, Philippines* — Anon. 979 (L) *Arayat, Luzon* — Cuming, H. 1124 (K) — Curran, H.M. 10313 (K) *Tayabas, Luzon Island*; 17827 (E, K, L) *Cagayan, Philippines* — Edano, G. 5270 (A) *Nueva Ecija, Luzon Island* — Elmer, A.D.E. 18303 (L, UC) *Mount Makiling, Laguna*; 7308 (K) *Sorsogon, Luzon Island*; 8043 (E), 9151 (E) *Lucban, Luzon Island*; 8783 (E) *Baguio, Luzon Island.*

Fenix, E. 29968 (L) *Pangasinan* — Juliano, J.B. 23 (UC) *Laguna, Luzon Island* — Loher, A. 12655 (UC) *Montalban, Philippines*; 71 (K) Luzon Island — M. Azurin 29361 (A); 29361 (UC) *Isabela, Luzon Island* — Merrill, E.D. 4020 (K) *Tayabas, Luzon Island*

Quisumbing, E. 8065 (L) *Baler, Luzon Island* — Ramos, M. 33088 (L, SING) *Ilocos Norte, Luzon Island*; 77073 (SING) *Cagayan, Philippines* — Ramos, M., Edano, G. 47195 (SING) *Isabela, Luzon Island* — Teresita B. Banaga 33382 (L) *Mount Makiling, Laguna* — Vidal y Soler, S. 2110 (K), 2112 (K) *Manila, Philippines*; 2115 (K), 638 (K) *Tayabas, Luzon Island.*

CHAPTER 7
GENERAL CONCLUSIONS AND RECOMMENDATIONS

7.1 Delimitation and Taxonomy of Section *Garcinia*

From a total of 43 species distributed in Madagascar, and India to Fiji, originally listed by Jones (1980) in sect. *Garcinia,* 19 species are reduced to synonyms, nine species are found not to belong in the section and five species do not have enough characters to classify them to a section. *Garcinia celebica* is found to have the most synonyms (13) while one species, *G. cataractalis,* previously unlisted in Jones's (1980) classification is newly included in sect. *Garcinia.* Five species, *G. acuticosta, G. discoidea, G. exiguus, G. ochraceus* and *G. sangudsangud,* and three varieties, *G. diospyrifolia* var. *arborea, G. diospyrifolia* var. *minor* and *G. malaccensis* var. *pseudomangostana* are newly described, which makes a total of 16 species in sect. *Garcinia* (see Appendix I for a full listing). The distribution of sect. *Garcinia* is now centred in SE Asia, stretching from eastern India to Papua New Guinea.

In sectional delimitation, important morphological characters are from the inflorescence, the orientation of the male flower, and from the fruit and leaves. Section *Garcinia* has a terminal inflorescence (except *G. moselleyana*) in clusters of 2-14 flowers, and the male flowers have 4-lobed or 4-angled stamen bundles with 2-thecous anthers.

The fruits are berries, borne terminally, usually solitary, with a smooth and thick or thin wall when dry, and containing 2-12 seeds covered with a soft, edible translucent or white aril. The calyces are persistent and the stigmas are distinct with enough variation for species identification. For species circumscription, the inflorescence characters become less important, and characters from the male flower, fruit and leaf are most significant. Vegetative characters are usually sufficient for species identification.

7.2 Molecular Study of Sect. *Garcinia*

Parsimony and Bayesian analyses show that nuclear ITS data are more informative and provide better phylogenetic resolution in sect. *Garcinia* than the plastid *trn*S-G and *trn*D-T regions. Most of the sections of *Garcinia* delimited by Jones (1980) proved to be monophyletic but both ITS and plastid regions show that sect. *Garcinia* sensu Jones (1980) is not. This is because the clade consisting of *G. maingayi, G. costata* and *G. trianii* is nested outside of the clade of sect. *Garcinia* and is resolved as closely related to sect. *Brindonia* sensu Jones (1980). These three species differ from the species in sect. *Garcinia* and should be excluded from it on the basis of having thyrsoid inflorescences, stamen bundles without lobes, a ribbed fruit wall and stout secondary venation.

ITS phylogenetic trees allow sect. *Garcinia* to be divided into four groups of which all, except one of *G. nitida, G. cataractalis* and *G. diospyrifolia,* are monophyletic.

Characters that support these groups are the shape of stamen bundles, the shape of the fruit and stigma, and the fruit wall. Within sect. *Garcinia,* however, there is striking incongruence in the tree topology between the ITS and plastid trees. The main source of incongruence is due to the placement of *G. rigida.* In the ITS tree, *G. rigida* is nested within the sect. *Garcinia* clade but in the plastid trees, especially those based upon *trn*S-G data, *G. rigida* is placed outside sect. *Garcinia*. *Garcinia rigida* is believed to be of hybrid origin resulting in chloroplast capture, an introgression of the cytoplasmic genome of one species into the nuclear background of another. Plastid data from the species sampled are insufficient, however, to determine the maternal parent species of *G. rigida.*

Another species, *G. mangostana* (mangosteen)*,* a widely cultivated fruit species in South East Asia that is thought to be of hybrid origin (Richards, 1990c), does not show any discordance between the placement of accessions in ITS and plastid trees. The phylogenies indicate that mangosteen arose from crosses between varieties of *G. malaccensis* if it is confirmed as an obligate agamosperm. However, if mangosteen is a facultative agamosperm, beside *G. malaccensis*, another *Garcinia* species could be involved in its parentage.

Most species of sect. *Garcinia* sampled in this study are distributed to the west side of Wallace's Line. Species from the eastern side of Wallace's Line are found nested within species from the west which suggests an origin on the western side of the line. Age estimation shows that the crown of *Garcinia* is 61.26+/-1.58 MY while accessions of *G. rigida* from east of Wallace's Line split from their most common recent ancestor on the west no later than 21.58+/-2.90 MY. This is consistent with the theory of dispersal of species across this biogeographic division from west to east after the Sahul and Sunda shelves converged c. 20 MY ago (Morley, 1998).

7.3 Future Work and Recommendations

Future work is needed to clarify several areas of uncertainty raised by the research presented in this thesis:

1. The most morphologically heterogeneous and agamospermous species, *G. celebica,* needs additional study at the population level, especially from some islands (e.g. Andaman, Nicobar and Indonesia) and Indo-china where few collections have been made. Study of breeding systems (embryology, sex ratio, whether multiple seedlings emerge from a single seed) as outlined by Richards (1990a) needs to be carried out on these populations to determine if they are agamospermous, and if so whether this agamospermy is obligate or facultative. To investigate the correlation between breeding system and morphological variation, morphometric study could be carried out using herbarium specimens and compared with studies of genetic variation. Genotypic variation throughout a wide geographical range of *G. celebica* could be investigated by DNA fingerprinting (e.g. AFLP & RAF) techniques as used by Yapwattanaphun et al. (2003) and Ramage et al. (2004). Both AFLP and RAF might give sufficient intraspecific resolution to determine if morphologically distinct populations are genetically different, and therefore whether they represent distinct agamospermous lines.

2. Taxonomic placement of a group of species omitted from sect. *Garcinia* (*G. maingayi*, *G. trianii* and *G. costata*), needs to be considered relative to sect. *Brindonia* (sensu Jones). It is not currently clear whether this clade of *G. maingayi, G. trianii* and *G. costata* should stand as a new section or part of sect. *Brindonia.* To investigate this further, more detailed molecular phylogenetic study of sect. *Brindonia* (77 species) is needed with greater sampling of representative species. DNA sequence data from the regions used in this study of ITS, *trn*S-G and *trn*D-T could be used to see if the phylogenetic placement of the *G. maingayi, G. trianii* and *G. costata* clade is within sect. *Brindonia.* If they nest within the clade of sect. *Brindonia,* they should be considered as part of the section. If the group is placed outside of sect. *Brindonia*, morphological investigation, especially focusing on type of inflorescence, shape of stamens and fruit characters, needs to be made to determine whether *G. maingayi, G. trianii* and *G. costata* might be justifiably described as a new section.
3. Many more herbarium collections are needed to determine the placement of species not currently assigned to a section of *Garcinia*. Collection of specimens with male flowers is especially important. However, because finding male flowers is difficult, specimens with mature fruit could be sufficient because as proven in this study, fruit characters (e.g. fruit wall and stigma in *G. acutiscosta* and *G. cataractalis*) could give enough characters for sectional placement. Future field collection should prioritise poorly collected areas where unassigned species are found: Myanmar (*G. moulmienensis*), Kalimantan (*G. lucens*), the Philippines (*G.*

blancoi), and eastern and western parts of Papua (*G. squamata* and *G. erythrosperma*).

4. Any future molecular phylogenetic analysis in sect. *Garcinia* should sample more species with multiple accessions because it will give a clearer understanding of species relationships and possible hybrid origins. Apart from the ITS region, other nuclear markers such as the ribosomal external transcribed spacer (ETS), or perhaps low copy number nuclear genes (e.g. *PgiC, Adh*, GBSSI, G3PDH, PHY) that are less subject to concerted evolution, could be used to infer phylogeny because they may give additional phylogenetic resolution, and provide species-specific markers to enable the identification of parents of hybrid species. For plastid regions, additional potentially more variable markers such as *rpo*B-*trn*C, *trn*T-*trn*L and *trn*S-*trnf*M will allow better identification of the source of conflicting phylogenetic signal between plastid and nuclear phylogenetic trees as shown for example in *G. rigida,* and may provide species-specific markers to identify the maternal parents of hybrids.
5. Further research on breeding systems is required to confirm the nature of agamospermy in mangosteen throughout its range and especially in the Southeast Asian region. In order to do this, it will be necessary to investigate more detailed aspects of the embryology of populations, particularly of those from Borneo and east Indonesia because few studies have been carried out in this area. More field investigation in Southeast Asia is needed to locate male trees which will enable studies of pollination biology and the potential viability of the male flowers. Such

studies may indicate that outbreeding in mangosteen is occurring and that it is therefore not an obligate agamospermous species.

6. a) Undoubtedly the nature of agamospermy in mangosteen (as outlined in 5 above) is important to unravel its hybrid origin, but more data are needed especially on the ploidy level and the possible existence of cytological variation to understand its parentage. At present, cytological information of mangosteen has a range of published chromosome numbers from 56 to 96 (Chapter 3), but it is not certain whether this simply reflects difficulties in making cytological preparations of *Garcinia*'s tiny chromosomes. Establishing the true variation in chromosome number in mangosteen is important because although it is conceivable that an obligate agamosperm might have a variable chromosome number, such variation might also reflect multiple origins through hybridisation or perhaps a facultatively agamospermous breeding system.

   b) A more resolved phylogeny is needed to pinpoint parental species, and whether mangosteen has originated once or multiple times. These phylogenetic studies will need multiple mangosteen accessions, multiple samples of *G. malaccensis* that this study implicates as a possible parent, and other species closely related to mangosteen (*G. penangiana* and *G. venulosa*). It will also be necessary to sample other species of sect. *Garcinia* not included in this study (e.g. *G. exiguus, G. harmandii, G. moselleyana, G. ochraceus, G. sangudsangud* and *G. venulosa*) as any could be a parent of mangosteen. Sampling should concentrate in Malesia, particularly in Indo-china, Peninsular Malaysia, Sumatra, Borneo, Philippines, Sulawesi and Papua where these species are found.

c) More variable nuclear and plastid regions are needed to give species-specific markers to enable the identification of possible parental species in mangosteen. The markers indicated in (4) above could be variable enough, but fingerprinting techniques such as AFLPs might be another promising means of generating species-specific markers given their greater potential variability.

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APPENDIX I

Scientific names of sect. *Garcinia* in IPNI plus new names described in this study; names in bold currently belong to sect. *Garcinia* as defined in this thesis (Chapter 6) and asterisks denote those originally listed by Jones (1980) including invalid names.

Species	Taxonomic Status	Taxonomic Notes
1. *G. acuticosta* Nazre	**Sect. *Garcinia*/Sp. nov**	Newly described species based on the fruit and evidence from molecular data.
2. *G. affinis* Wall. ex Pierre*	Illegitimate use	Wallich 4854 in Pierre (1882) identified as *G. celebica* L.
3. *G. affinis* Wight & Arn.	Syn. *G. cambogia* Desr.	Wallich 4866 in Wight & Arn. (1834) identified as *G. cambogia* Desr.
4. *G. anomala* Planch. & Triana*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* from inflorescences & male flower.
5. *G. baillonii* Pierre*	Non sect. *Garcinia*/Syn. *G. maingayi* Hk. f.	Differ from sect. *Garcinia* from the inflorescences, male flower, fruit & leaves.
6. *G. basacensis* Pierre*	**Syn. *G. celebica* L.**	Shared the same male flower & leaves with *G. celebica* L.
7. *G. benthami* Pierre*	**Syn. *G. celebica* L.**	Shared the same male flower, leaves & fruit with *G. celebica* L.
8. *G. blancoi* Pierre*	Unknown	Insufficient material (male specimen in bud).
9. *G. calleryi* Pierre*	Syn. *G. blancoi* Pierre	Insufficient material (male specimen in bud).
10. *G. cataractalis* Whitmore	**Sect. *Garcinia***	Newly included members based on the fruit & evidence from molecular data.
11. *G. celebica* L.*	**Sect. *Garcinia***	The earliest valid name (1754) of many synonyms.
12. *G. chapelieri* (Planch. & Triana) H.Perrier*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* from male flower, fruit & stigma.
13. *G. cornea* L.*	**Syn. *G. celebica* L.**	Described in 1774; similar fruit & male flower as *G. celebica* L.
14. *G. cornea* Roxb. ex Sm.	Illegitimate use	= *G. cornea* L. (Roxburgh, 1832).
15. *G. costata* Hemsl.ex King*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* from the inflorescences, male

		flower & fruit.
16. *G. cumingiana* Pierre*	**Syn. *G. venulosa* (Blanco) Choisy**	Similar male flower in Cumming 2114 with *G. venulosa.*
17. *G. diospyrifolia* Pierre var. *diospyrifolia**	**Sect. *Garcinia***	Slender small tree variety.
18. *G. diospyrifolia* var. *arborea*	**Sect. *Garcinia* /Var. nov.**	New variety – medium sized tree.
19. *G. diospyrfolia* var. *minor*	**Sect. *Garcinia* /Var. nov**.	New variety – bushy small tree.
20. *G. discoidea* Nazre	**Sect. *Garcinia*/Sp. nov.**	Newly described species; previously known as *G. hombroniana* var. A Whitmore.
21. *G. erythrosperma* Lauterb.*	Unknown	Insufficient material & no type specimen available.
22. *G. exiguus* Nazre	**Sect. *Garcinia*/Sp. nov.**	Newly described species; share similar fruit & leaves.
23. *G. fabrilis* Miq.*	**Syn. *G. celebica* L.**	Described by Miquel (1861) found in Sumatra.
24. *G. fascicularis* Wall*	**Syn. *G. penangiana* L**	Collected by Wallich (1831) in Penang.
25. *G. ferrea* Pierre*	**Syn. *G. celebica* L.**	Described by Pierre (1882) found in Cambodia.
26. *G. harmandii* Pierre*	**Sect. *Garcinia***	Belongs to sect. *Garcinia* from the male flowers.
27. *G. hombroniana* Pierre*	**Syn. *G. celebica* l.**	Described by Pierre (1882) found in Peninsular Malaysia.
28. *G. jawoera* Pierre*	**Syn. *G. celebica* L.**	Described by Pierre (1882) found in Java.
29. *G. kingii* Pierre *ex* Vesque*	**Syn. *G. celebica* L.**	Described by Vesque (1891) found in Andaman.
30. *G. krawang* Pierre*	**Syn. *G. celebica* L.**	Described by Pierre (1882) found in Kalimantan.
31. *G. kurzii* Pierre*	**Syn. *G. celebica* L.**	Described by Pierre (1882) found in Nicobar.
32. *G. lucens* Pierre*	Unknown	Insufficient material (male in buds).
33. *G. macrophylla* Miq.*	Illegitimate /Non Sect. *Garcinia*	Name was used earlier by Martius (1841)/ identified as *G. griffithii* T. Anders.
34. *G. macrophylla* T.Anders. *ex* Hook.*f.*	Illegitimate/ Non Sect. *Garcinia*	Name was used earlier by Martius (1841)/ /identified as *G. griffithii* T. Anders.
35. *G. maingayi* Hook.*f.**	Non Sect. *Garcinia*	Differ from sect. *Garcinia* from the inflorescences, male flower & fruit.
36. *G. malaccensis* Hook. *f.* var. *malaccensis**	**Sect. *Garcinia***	Varieties based on male flower and fruit.
37. *G. malaccensis* var. *pseudomangostana* Nazre	**Sect. *Garcinia*/var. nov.**	A new varieties based on male flower and fruit.
38. *G. mangostana* L.*	**Sect. *Garcinia***	Type for genus and for the section.
39. *G. moselleyana* Pierre*	**Sect. *Garcinia***	Belongs to sect. *Garcinia* from the male flowers.
40. *G. moulmienensis* Pierre ex Vesque*	Unknown	Insufficient material (female flower).
41. *G. nitida* Pierre*	**Sect. *Garcinia***	Belongs to sect. *Garcinia* from male flowers, fruit and leaves.

42. *G. ochraceus* Nazre	**Sect. *Garcinia*/Sp. nov.**	Newly described species & members of sect. *Garcinia* based on male flowers & fruit.
43. *G. opaca* King*	**Syn. *G. diospyrifolia* Pierre**	Described by King (1890) found in Peninsular Malaysia.
44. *G. opaca var. dumosa* Whitmore	**Syn. *G. diospyrifolia* var. *diospyrifolia***	Described by Whitmore (1973) found in Peninsular Malaysia.
45. *G. penangiana* Pierre*	**Sect. *Garcinia***	Belongs to sect. *Garcinia* from male flowers, fruit and leaves.
46. *G. porrecta* Laness.	Invalid/Syn. *G. cornea* L.	Used by Lanessan (1872) for synonym of *G. cornea* L.
47. *G. porrecta* Wall.*	Nom. nudum	Used by Wallich (1831); cultivated tree in BO.
48. *G. porrecta* var. *schizogyna* Boerl.	Invalid/Syn. *G. rigida*	Used by Boerlage (1901); cultivated tree in BO.
49. *G. propinqua* Craib*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* from inflorescences & male flower.
50. *G. pseudo-guttifera* Seem.*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* from inflorescences & male flower.
51. *G. riedeliana* Pierre*	**Syn. *G. celebica* L.**	Described by Pierre (1882) found in Sulawesi.
52. *G. rigida* Miq.*	**Sect. *Garcinia***	Belongs to sect. *Garcinia* from fruit and molecular evidence.
53. *G. rumphii* Pierre*	**Syn. *G. celebica* L.**	Described by Pierre (1882) found in Bangka Is., Java.
54. *G. schefferi* Pierre*	**Syn. *G. rigida* Pierre**	Shared the same fruit with *G. rigida* Pierre.
55. *G. speciosa* Wall.*	**Syn. *G. celebica* L.**	Described by Wallich (1832) found in Burma.
56. *G. sangudsangud* Nazre	**Sect. *Garcinia*/Sp. nov.**	Newly described species & members of sect. *Garcinia* based on male flowers & fruit.
57. *G. squamata* Lauterb.*	Unknown	Insufficient material (female flower).
58. *G. tonkinensis* Vesque*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* based on the inflorescences, male flower & fruit.
59. *G. trianii* Pierre*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* based on the inflorescences, male flower & fruit.
60. *G. venulosa* Choisy*	**Sect. *Garcinia***	Belongs to sect. *Garcinia* from inflorescences, fruits & male flowers.
61. *G. vidua* Ridl.*	Non Sect. *Garcinia*	Differ from sect. *Garcinia* based on the inflorescences, male flower & fruit.

APPENDIX II

Species, accessions and origin of samples used in molecular analysis for this study.

	Species (synonym)	Accession No.	Collectors	Voucher	Locality Collected [Origin]	Sequence		
						ITS	*trn*S-G	*trn*D-T
1	*G. acutacosta*	BB01	M. Nazre et al.	BB01	Bkt. Bauk Fst. Res., Compt. 22	▨	▨	▥
2	*G. balica*	021	M. Nazre et al.	VI.C.365	Bogor Bot. Gdns., Java [Maluku Is.]	▨	▨	-
3	*G. cataractalis*	077	M. Nazre et al.	FRIM01	FRIM Kepong	▨	▨	▥
4	*G. celebica*	002	M. Nazre et al.	CR01	Cape Rechado, Melaka, Malaysia.	▨	▨	▥
5	*G. celebica (G. hombroniana)*	003	M. Nazre et al.	Nur03	Kepong, Malaysia	▨	▨	-
6	*G. celebica (G. hombroniana)*	005	M. Nazre et al.	Nur01	Kepong, Malaysia.	▨	-	-
7	*G. celebica (G. hombroniana)*	009	M. Nazre et al.	Mardi01	MARDI, Selangor, Malaysia.	▨	▨	-
8	*G. celebica*	023	M. Nazre et al.	VI.C.18	Bogor Bot. Gdns., Java [Borneo Is.:Kalimantan]	▨	▨	▥
9	*G. celebica (G. benthami)*	027	M. Nazre et al.	IV.C.106	Bogor Bot. Gdns., Java [Vietnam]	▨	▨	-
10	*G. celebica*	028	M. Nazre et al.	VI.C.273	Bogor Bot. Gdns., Java [W. Java]	▨	▨	-
11	*G. celebica*	033	M. Nazre et al.	VI.C.335	Bogor Bot. Gdns., Java[Borneo]	▨	▨	▥
12	*G. celebica*	038	M. Nazre et al.	VI.A.16	Bogor Botanic Gdns, Java [Sulawesi]	▨	-	-
13	*G. celebica*	043	M. Nazre et al.	-	Bogor Botanic Gdns, Java [Java]	▨	-	-
14	*G. celebica*	053	M. Nazre et al.	VI.A.153	Bogor Botanic Gdns, Java [Sumatra]	▨	-	-
15	*G. celebica*	054	M. Nazre et al.	VI.C.335a	Bogor Bot. Gdns., Java [Borneo]	▨	-	-
16	*G. celebica (G. hombroniana)*	059	M. Nazre et al.	CR02	Cape Rechado, Melaka, Malaysia.	▨	▨	-
17	*G. celebica*	062	M. Nazre et al.	VI.A.4	Bogor Bot. Gdns., Java [P. Malaysia]	▨	▨	-
18	*G. costata*	BL03	M. Nazre et al.	BL03	Bkt. Larut, behind Rumah Delima	▨	▨	-
19	*G. costata*	BL06	M. Nazre et al.	BL06	Bkt Larut, 900m besides main road.	▨	-	-
20	*G. cowa*	004	M. Nazre et al.	Nur02	Kepong, Malaysia	▨	-	-
21	*G. cowa (misid. as G. dulcis)*	013	M. Nazre et al.	Nur04	Kepong, Malaysia	▨	-	-
22	*G. cymosa*	037	M. Nazre et al.	XXIV.A.16	Bogor Botanic Gdns, Java [Irian]	▨	▨	▥
23	*G. cymosa aff.*	042	M. Nazre et al.	VI.C.338	Bogor Botanic Gdns, Java [Maluku]	▨	▨	-
24	*G. diospyrifolia var. arborea*	BB02	M. Nazre et al.	BB02	Bkt. Bauk Fst. Res.	▨	-	-
25	*G. diospyrifolia var. arborea (G.*	BB05	M. Nazre et al.	BB05	Bkt. Bauk Fst. Res., Compt. 22	▨	-	-

	opaca)					▧		
26	*G. diospyrifolia* var. *diospyrifolia* *(G. opaca* var. *dumosa)*	078	M. Nazre et al.	MN78	Rompin, Pahang	▧	▨	▥
27	*G. diospyrifolia var. minor*	BB06	M. Nazre et al.	BB06	Bkt. Bauk Fst. Res., Compt. 22	▧	▨	▥
28	*G. discoidea*	SL01	M. Nazre et al.	SL01	Sg. Loh, near logging camp	▧	▨	▥
29	*G. discoidea*	SL02	M. Nazre et al.	SL02	Sg. Loh, main logging road to Compt 33	▧	-	-
30	*G. dulcis*	050	M. Nazre et al.	IV.C.114	Bogor Bot. Gdns., Java [Sumatra]	▧	▨	-
31	*G. echinocarpa*	035	M. Nazre et al.	VI.A.36	Bogor Botanic Gdns, Java [Sri Lanka]	▧	-	-
32	*G. forbesii*	024	M. Nazre et al.	VI.A.58	Bogor Botanic Gdns, Java [Kalimantan]	-	▨	-
33	*G. lateriflora*	040	M. Nazre et al.	VI.A.17	Bogor Botanic Gdns, Java [Java]	▧	▨	-
34	*G. latissima*	026	M. Nazre et al.	VI.C.54	Bogor Bot. Gdns., Java [South Papua]	▧	-	-
35	*G. maingayi*	098	Latiff. et. al	ALM 6120	Rompin, Pahang	▧	-	-
36	*G. malaccensis*	BB04	M. Nazre et al.	BB04	Bkt. Bauk Fst. Res.	▧	-	-
37	*G. malaccensis*	BB08	M. Nazre et al.	BB08	Bkt. Bauk Fst. Res., Compt. 22	▧	▨	▥
38	*G. malaccensis*	BB09	M. Nazre et al.	BB09	Bkt. Bauk Fst. Res., Compt. 22	▧	▨	▥
39	*G. malaccensis var. pseudomangostana*	SP01	M. Nazre et al.	SP01	Sepilok Fst. Reserve, Behind	▧	▨	▥
40	*G. mangostana*	096	Shamsul et al.	SK-MY-10	Universiti Putra Malaysia.	▧	-	-
41	*G. mangostana*	LAO	Newman s.n.	LAO	Laos	▧	▨	▥
42	*G. megaphylla*	030	M. Nazre et al.	VI.C.275	Bogor Bot. Gdns., Java [South America]	▧	-	-
43	*G. megaphylla*	041	M. Nazre et al.	VI.C.277	Bogor Bot. Gdns., Java [South America]	▧	-	▥
44	*G. penangiana*	006	M. Nazre et al.	KT01	Kota Tinggi, Johor, Malaysia.	▧	▨	▥
45	*G. penangiana*	BB07	M. Nazre et al.	BB07	Bkt. Bauk Fst. Res., Compt. 22	▧	-	-
46	*G. picrorhiza*	039	M. Nazre et al.	VI.A.27	Bogor Botanic Gdns, Java [Maluku] Ambon	▧	▨	-
47	*G. rigida*	029	M. Nazre et al.	VI.C.235	Bogor Bot. Gdns., Java [Maluku]	▧	▨	▥
48	*G. rigida*	045	M. Nazre et al.	XXIII.A.122	Bogor Bot. Gdns., Java [S. Sulawesi]	▧	▨	▥
49	*G. rigida*	049	M. Nazre et al.	VI.A.50	Bogor Bot. Gdns., Java [Maluku]	▧	▨	▥
50	*G. rigida*	057	M. Nazre et al.	VI.C.145	Bogor Bot. Gdns., Java [Maluku]	▧	▨	▥
51	*G. rostrata*	091	Shamsul et al.	SK-MY-05	Menchali FR, Rompin Pahang	▧	▨	-
52	*G. rostrata*	BL05-1	M. Nazre et al.	BL05-1	Bkt. Larut, Perak.	▧	-	-

53	*G. rostrata*	007	M. Nazre et al.	KT02	Kota Tinggi, Johor, Malaysia.	▩	▨	▥
54	*G. scortechinii*	012	M. Nazre et al.	Fraser05	Fraser's Hill, Pahang, Malaysia.	▩	-	-
55	*G. scortechinii*	089	Shamsul et al.	SK-MY-09	Gunung Nuang, Selangor	▩	▨	-
56	*G. scortechinii*	K04	M. Nazre et al.	K04	Kinabalu Park, Bundu Tuhan Trail	▩	▨	▥
57	G. sp. B1	008	M. Nazre et al.	Fraser02	Fraser's Hill, Pahang, Malaysia.	▩	-	-
58	*G. sp. B1*	011	M. Nazre et al.	Fraser04	Fraser's Hill, Pahang, Malaysia.	▩	▨	-
59	*G. sp. D1*	064	M. Nazre et al.	SULTENG03	Sulawesi Tengah	▩	▨	-
60	*G. sp. D1*	070	M. Nazre et al.	SULTENG09	G. Hek, Sulawesi Tengah	▩	▨	-
61	*G. sp. D2*	P01	M. Nazre et al.	P01	Poring Hotspring, trail to canopy walkaway	▩	-	-
62	*G. sp. D3*	P02	M. Nazre et al.	P02	Poring Hotspring, trail to waterfalll	▩	▨	▥
63	*G. sp. D4*	BL04	M. Nazre et al.	BL04	Bkt. Larut, behind Rumah Delima	▩	-	-
64	*G. sp. D5*	BL05-2	M. Nazre et al.	BL05-2	Bkt Larut, 900m besides main road.	▩	-	-
65	*G. sp. D6*	K12	M. Nazre et al.	K12	Kinabalu Park, Bundu Tuhan Trail	▩	-	-
66	*G. sp. M1*	025	M. Nazre et al.	-	Bogor Bot. Gdns., Java	▩	-	-
67	*G. sp. M2*	068	M. Nazre et al.	SULTENG07	G. Hek, Sulawesi Tengah	▩	-	-
68	*G. sp. M3*	072	M. Nazre et al.	SULTENG11	G. Hek, Sulawesi Tengah	▩	-	-
69	*G. sp. M4*	022	M. Nazre et al.	IV.C.378	Bogor Bot. Gdns., Java [Sulawesi]	▩	-	▥
70	*G. sp. M5*	069	M. Nazre et al.	SULTENG08	G. Hek, Sulawesi Tengah	▩	▨	-
71	*G. sp. M5*	073	M. Nazre et al.	SULTENG12	G. Hek, Sulawesi Tengah	▩	▨	-
72	*G. sp. M6*	093	Shamsul et al.	SK-MY-06	Menchali FR, Rompin Pahang	▩	▨	-
73	*G. sp. M6*	094	Shamsul et al.	SK-MY-08	Apau FR, K. Kelawang NS	▩	▨	-
74	*G. sp. X1*	052	M. Nazre et al.	VI.C.373	Bogor Botanic Gdns, Java	▩	▨	-
75	G. sp. X2	080	M. Nazre et al.	22B	Sg. Dusun, Selangor	▩	▨	▥
76	*G. spicata*	019	M. Nazre et al.	VI.C.111	Bogor Bot. Gdns., Java [Sri Lanka]	▩	▨	-
77	*G. trianii*	K02	M. Nazre et al.	K02	Kinabalu Park, Bundu Tuhan Trail	▩	▨	▥
78	*G. urophylla*	001	M. Nazre et al.	Fraser01	Fraser's Hill, Pahang, Malaysia.	▩	▨	-
79	*G. urophylla*	081	M. Nazre et al.	14B	Sg. Dusun, Selangor	▩	▨	-
80	*G. xanthochymus*	034	M. Nazre et al.	VI.A.52	Bogor Botanic Gdns, Java	▩	-	-
81	*G. xanthochymus*	BB03	M. Nazre et al.	BB03	Bkt. Bauk Fst. Res.	▩	-	-
82	*G. xanthochymus cf.*	032	M. Nazre et al.	VI.A.42	Bogor Bot. Gdns., Java Sumatera Is.	▩	▨	-
83	*G. xanthochymus?*	092	Shamsul et al.	SK-MY-07	Menchali FR, Rompin Pahang	▩	-	-

APPENDIX III

List of sequences taken from GENBANK used in this study.

	Species [synonym]	Author	Origin	GenBank Accession
1	*G. acuminata*	Yapwattanaphun et al.	Thailand	AB 110796
2	*G. atroviridis*	Yapwattanaphun et al.	Thailand	AB 110797
3	*G. atroviridis*	M. Nazre et al.	P. Malaysia	AF 367211
4	*G. celebica [G. hombroniana]*	Yapwattanaphun et al.	Thailand	AB 110803
5	*G. celebica [G. hombroniana]*	Yapwattanaphun et al.	Thailand	AB 110804
6	*G. celebica [G. hombroniana]*	M. Nazre et al.	P. Malaysia	AF 367214
7	*G. celebica [G. speciosa]*	Yapwattanaphun et al.	Thailand	AB 110816
8	*G. costata*	Yapwattanaphun et al.	Thailand	AB 110798
9	*G. cowa*	Yapwattanaphun et al.	Thailand	AB 110799
10	*G. diospyrifolia* var. *minor [G. opaca* var. *minor]*	M. Nazre et al.	P. Malaysia	AF 367227
11	*G. dulcis*	Yapwattanaphun et al.	Thailand	AB 110800
12	*G. dulcis*	Yapwattanaphun et al.	Thailand	AB 110801
13	*G. forbesii*	M. Nazre et al.	P. Malaysia	AF 367224
14	*G. globulosa*	M. Nazre et al.	P. Malaysia	AF 367221
15	*G. hanburyi*	Yapwattanaphun et al.	Thailand	AB 110802
16	*G. latissima*	Abdul-Salim,K. and Dick	P. Malaysia	AF 479789
17	*G. madruno*	Gehrig et al.	S. America	AJ 509215
18	*G. malaccensis*	Yapwattanaphun et al.	Java, Indonesia	AB 110805
19	*G. malaccensis*	Yapwattanaphun et al.	Java, Indonesia	AB 110806
20	*G. mangostana*	Yapwattanaphun et al.	Java, Indonesia	AB 110807
21	*G. mangostana*	Yapwattanaphun et al.	P. Malaysia	AB 110808
22	*G. mangostana*	Yapwattanaphun et al.	Thailand	AB 110809
23	*G. mangostana*	Yapwattanaphun et al.	Thailand	AB 110810
24	*G. mangostana*	Yapwattanaphun et al.	Thailand	AB 110811
25	*G. mangostana*	Gehrig et al.	S. America	AJ 509214
26	*G. nervosa*	M. Nazre et al.	P. Malaysia	AF 367222
27	*G. penangiana (misid. as G. malaccensis)*	M. Nazre et al.	P. Malaysia	AF 367226
28	*G. prainiana*	M. Nazre et al.	P. Malaysia	AF 367218
29	*G. rostrata*	M. Nazre et al.	P. Malaysia	AF 367225

30	*G. rostrata (*misidentification of *G. celebica)*	Yapwattanaphun et al.	Thailand	AB 110813
31	*G. schomburgkiana*	Yapwattanaphun et al.	Thailand	AB 110814
32	*G. scortechinii*	M. Nazre et al.	P. Malaysia	AF 367219
33	*G. sp.*	Gehrig et al.	S. America	AJ 312607
34	*G. syzygifolia (*misidentification of *G. rigida)*	Yapwattanaphun et al.	Java, Indonesia	AB 110815
35	*G. tinctoria*	Yapwattanaphun et al.	Australia	AB 110817
36	*G. vilersiana*	Yapwattanaphun et al.	Thailand	AB 110818
37	*G. xanthochymus*	Yapwattanaphun et al.	Thailand	AB 110819
38	*G.bancana*	M. Nazre et al.	P. Malaysia	AF 367212
39	*Symphonia globulifera*	Gustafsson & Bittrich	-	AY 682919
40	*Tripetalum cymosum*	Gustafsson & Bittrich	-	AY 145206
41	*Clusia rosea*	Gehrig et al.	S. America	AJ 509230

APPENDIX IV

Molecular Lab Protocol

A. DNA extraction (Doyle and Doyle, 1990)

1. Preheat 1ml CTAB (Cetyltriammonium bromide) mixed with 2µl 2-mercaptoethanol per sample at 65°C in the waterbath.
2. Harvest approximately 0.50g of leaf material into the 1.5ml eppendorf tube and add 2 spatulas of sand.
3. With the eppendorf lid open, immerse the tube into liquid nitrogen with long handled forceps, being careful not to let any leaf material out of the tube. Hold the tube until it stops making a bubbling noise.
4. Carefully macerate the leaf tissue with a plastic pestle until the material is finely graved. The sample can be re-chilled in liquid nitrogen if difficult.
5. Add 500µl of the pre-heated CTAB buffer and continue to gently grind the sample.
6. Add further 500µl of CTAB buffer with a pinch of PVPP (polyvinylpolypyrrolidone) and mix the contents by flicking the tube.
7. Incubate the mixture for 30 minute at 65°C in the heated block.
8. Remove the mixture from the heated block and allow to cool to ambient temperature.
9. Add 500µl of wet chloroform (24 chloroform : 1 isoamyl alcohol) and mix gently by hand to obtain a momentary single phase. Transfer the mixture to the orbital shaker and shake on minimum speed for 10-20 minutes.
10. Centrifuge the mixture for 10 minutes at 13,000 rpm.
11. Remove the supernatant (upper aqueous layer) to a clean 1.5ml eppendorf tube and repeat the chloroform extraction (step 9 and 10).
12. Transfer the supernatant to a clean 1.5ml eppendorf tube and precipitate the DNA by adding 2/3 volume of cold isopropanol (-20°C) and mix gently. The mixture can be left overnight to increase the amount of DNA.
13. Centrifuge the mixture for 10 minutes at 13,000 rpm to pellet out the DNA.
14. Remove the supernatant and wash the DNA by adding 1ml wash buffer (76% ethanol, 10mM NH_4 Ac). Leave the DNA for at least 30 minutes.
15. Centrifuge the tube for 5 minutes at 13,000 rpm and discard the supernatant being careful not to dislodge the DNA pellet. Dry the pellet in the vacuum centrifuge for 5 minutes or until the pellet is dry.
16. Dissolve the pellet in 50µl of TE (10mM Tris HCl ph 8.0, 1mM EDTA ph 8.0) buffer.
17. To determine the quality of the DNA, 1% agarose gel electrophoresis was run and DNA concentrated was compared with 1kb+ marker.

B. DNA Extraction - DNeasy® Plant Mini (Qiagen, USA)

1. Preheat a water bath or heating block to 65°C.
2. Grind plant or fungal tissue under liquid nitrogen to a fine powder using a mortar and pestle. Transfer the tissue powder and liquid nitrogen to an appropriately sized tube and allow the liquid nitrogen to evaporate. Do not allow the sample to thaw.

3. Add 400 µl of Buffer AP1 and 4 µl of RNase A stock solution (100 mg/ml) to a maximum of 100 mg of ground (wet weight) or 20 mg (dried) plant or fungal tissue and vortex vigorously. No tissue clumps should be visible. Vortex or pipet further to remove any clumps. Clumped tissue will not lyse properly and will therefore result in a lower yield of DNA. In the rare case where clumps cannot be removed by pipetting and vortexing, a disposable micropestle may be used. Note: Do not mix Buffer AP1 and RNase A before use.
4. Incubate the mixture for 10 min at 65°C. Mix 2–3 times during incubation by inverting tube. This step lyses the cells.
5. Add 130 µl of Buffer AP2 to the lysate, mix, and incubate for 5 min on ice. This step precipitates detergent, proteins, and polysaccharides. Optional: Centrifuge the lysate for 5 min at 20,000 x g (14,000 rpm). After centrifugation, apply supernatant to QIAshredder Mini Spin Column.
6. Apply the lysate to the QIAshredder Mini Spin Column (lilac) placed in a 2 ml collection tube and centrifuge for 2 min at 20,000 x g (14,000 rpm). It may be necessary to cut the end off the pipet tip to apply the lysate to the QIAshredder Mini Column. The QIAshredder Mini Column removes most precipitates and cell debris, but a small amount will pass through and form a pellet in the collection tube.
7. Transfer flow-through fraction from step 4 to a new tube (not supplied) without disturbing the cell-debris pellet. Typically 450 µl of lysate is recovered. For some plant species less lysate is recovered.
8. Add 1.5 volumes of Buffer AP3/E to the cleared lysate and mix by pipetting. Buffer AP3/E. Reduce the amount of Buffer AP3/E accordingly if less lysate is recovered. A precipitate may form after the addition of ethanol but this will not affect the DNeasy procedure. Note: It is important to pipet Buffer AP3/E directly onto the cleared lysate and to mix immediately.
9. Apply 650 µl of the mixture from step 6, including any precipitate which may have formed, to the DNeasy Mini Spin Column sitting in a 2 ml collection tube (supplied). Centrifuge for 1 min at ≥6000 x g (corresponds to ≥8000 rpm for most microcentrifuges) and discard flow-through.* Reuse the collection tube in step 9.
10. Repeat step 8 with remaining sample. Discard flow-through* and collection tube.
11. Place DNeasy Mini Spin Column in a new 2 ml collection tube (supplied), add 500 µl Buffer AW to the DNeasy Mini Spin Column and centrifuge for 1 min at ≥6000 x g (≥8000 rpm). Discard flow-through and reuse the collection tube in step 11 Note: Ensure ethanol is added to Buffer AW.
12. Add 500 µl Buffer AW to the DNeasy Mini Spin Column and centrifuge for 2 min at 20,000 x g (14,000 rpm) to dry the membrane.
13. Transfer the DNeasy Mini Spin Column to a 1.5 ml or 2 ml microcentrifuge tube and pipet 100 µl of Buffer AE directly onto the DNeasy membrane. Incubate for 5 min at room temperature (15–25°C) and then centrifuge for 1 min at ≥6000 x g (≥8000 rpm) to elute. Elution with 50 µl (instead of 100 µl) increases the final DNA concentration in the eluate significantly, but also reduces overall DNA yield. If larger amounts of DNA (>20 µg) are loaded, eluting with 200 µl (instead of 100 µl) increases yield.
14. Repeat step 12 once.

C. Ethanol Clean Up

1. Make each reaction to 20µl by adding deionised water and transfer to the 0.5ml microfuge tubes.

2. Add 5µl of stop solution (stock B) for each reaction.
   stock B;
   i. 0.5M EDTA - 0.4µl
   ii. Sigma Water - 1.6µl
   iii.3M NaOAc pH 5.2 - 2.0µl
   iv.Glycogen (DTCS kit) - 1.0µl
3. Add 60µl of 95-100% ethanol (-20°C).
4. Mix the reactions thoroughly.
5. Centrifuge the reactions at 13,000 rpm for 15 minutes at 4°C.
6. Carefully remove the supernatant with the pipette.
7. Gently add 200µl of 70% ethanol (-20°C).
8. Centrifuge at 13,000 rpm for 5 minutes at 4°C.
9. Carefully remove the supernatant.
10. Repeat the steps 7 – 9.
11. Vacuum dry the pellet for 2-5 minutes until no trace of ethanol remains.
12. Re-suspend each pellet in 35-40µl of Sample Loading Solution (SLS) and mix well.

APPENDIX V

Matrix of internal transcribed spacer (ITS) sequences. Asterices indicate excluded characters in the analysis.

ITS1

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                                         ***********************
                                                 10        20        30        40        50        60        70        80        90       100
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuminata AB110796                    TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-GGCGTG--TTGTCATTCA---TTGGATTGGCAACACGC-CCTT
G. acuticosta BB01                       TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. atroviridis AF367211                   TCGCAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTAA--CACAT-TCACAGG-GGTGTG--TGGTCAGTCG---TTGGATTGGCAACATGC-CACT
G. atroviridis AB110797                   TCGCAACCTGCCC-AATA-GCACGACCCGTGAACTCGTTTAA-CACAT-TCACAGG-GGTGTG--TGGTCAGTCG---TTGGATTGGCAACATGC-CACT
G. balica 021                            TCGAAACCTGCCC-AATA-GCACG-CCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. bancana AF367212                      TCGAAACTTGCCAAAATA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATGC-CCCT
G. cataractalis 077                      TCGAAACCTGCCC-AACA-GCATGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. celebica 002                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 003                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 005                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 009                          TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCAACATGC-CCTT
G. celebica 023                          TCGAATCCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 027                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 028                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 033                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 038                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 043                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 054                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 059                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica 062                          TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica AB110816                     TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCAACATGC-CCTT
G. celebica AB110813                     TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica AB110814                     TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. celebica AF367214                     TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCAGTCA---CTAGATTGGCAACACGC-CTTT
G. costata BL03                          TCGAAACCTGCCC-AACA-GCACGACCTGCGAACTCGTTTAA-CACAT-TGACAAG-GGTGTG--TGGTCAGTCG---CTGGATTGGCAACACGC-CCTT
G. costata BL06                          TCGAAACCTGCCC-AACA-GCACGACCTGCGAACTCGTTTAA-CACAT-TGACAAG-GGTGTG--TGGTCAGTCG---CTGGATTGGCAACACGC-CCTT
G. costata AB110798                      TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. cowa 004                              TCGAAACTCGCCA-AATA-GCACGACTCGTGAACTCGTTTAA-CACAT-CGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATAC-CTCT
G. cowa 013                              TCGAAACTCGCCA-AATA-GCACGACTCGTGAACTCGTTTAA-CACAT-CGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATAC-CCCT
G. cowa AB110799                         TCGAAACTCGCCA-AATA-GCACGACTCGTGAACTCGTTTAA-CACAT-CGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATAC-CCCT
G. cowa AF367216                         TCGAAACTCGCCA-AATA-GCACGACTCGTGAACTCGTTTA--CACAT-CGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATAC-CTCT
G. cymosa 037                            TCGAAACCTGCCC-AGCCAGAACGACCCGTGAACTCGTCTAAACACATACGACGAG-TGCGTGGTGGGTCAGTCG---GGGGATTGGCAACATGC-CCTC
G. cymosa 042                            TCGAAACCTGCCT-AGCA-GAACTACCCGTGAACTCGTTTAAACACAT-CGACAAG-TGTGTG--TGGTCAATCC---TTGGATTGGCAACACGC-CCTT
G. diospyrifolia var. arborea BB02       TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. diospyrifolia var. arborea BB05       TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. diospyrifolia var. diospyrifolia 078  TCGAAACCTGCCC-AACA-GCATGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. diospyrifolia var. minor AF36         TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. diospyrifolia var. minor BB06         TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. discoidea SL01                        ???AAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CATT
G. discoidea SL02                        ?????????????????????????????TGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
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G. dulcis 050                            TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTAAC-CACAT-TGACAAG-CGCGTG--TCGTCGGTCC---TCGGATTGGCAACATGC-CCTT
G. dulcis AB110800                       TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-TGCATG--TGGCCATTCC---TCGGATTGGCGACATGC-CCTT
G. dulcis AB110801                       TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-TGCATG--TGGCCATTCC---TCGGATTGGCGACATGC-CCTT
G. echinocarpa 035                       TCGAAACCTGCCC-AACA-GCATGACCTGTGAACTAGTTTAA-CAAAT-TGACAAG-GGTGTG--TGGTCAATCA---CTGGATTGGCAACATTC-CCTT
G. forbesii AF367224                     TCGAAACTCGCCA-AATA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATGC-CCCT
G. forbesii AF67223                      TCGAAACTCGCCA-AATA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATGC-CCCT
G. globulosa AF367221                    TCGAAACTCGCAA-AATA-GCACGACTCGTGAACTCGTTTAA-CACAT-TGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACCTGC-CCCT
G. hanburyi AB110802                     TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-GGCGTG--TTGTCATTCA---TTGGATTGGCAACACGC-CCTT
G. laterifolia 040                       TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-GGCGTG--TTGTCAGTCA---TTGGATTGGTAACACGC-CCTT
G. latissima 026                         TCGAAACCTGCCC-AACA-GCACGACCTGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. latissima AF479789                    TCGAAACCTGCCC-AGCA-GCATGACCTGTGAACTCGTTTAA-CACAC-TGACAAG-TGTGTG--TGCCCAGTCC---TTGGATTGGAGACATGC-ACTA
G. madruno AJ509215                      TCAAAACCTGCCC-AGCA-GCACGACCTGTGAACTTGTTTAA-CACAC-TGACCAG-TGTGTG--TGGCCAGTCC---TTGGATTGGCAACATGC-ACTA
G. maingayi 098                          TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGTGTG--TGGTCAGTCG---CTGGATTGGCAACACCC-CCTT
G. malaccensis AB110810                  TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. malaccensis AB110811                  TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. malaccensis var. malaccensis BB04     TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. malaccensis var. malaccensis BB08     TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. malaccensis var. malaccensis BB09     TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGAcGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. malaccensis var. pseudomangostana SP01TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana 096                        TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana AB110807                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana AB110808                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana AB110809                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana AB110810                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana AB110811                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana AF367215                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana AJ509214                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. mangostana LAO                        TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTG--TTGTCGGTCA---CTAGATTGGCAACACGC-CCTT
G. megaphylla 030                        TCGAAACCTGCCC-AGCA-GCACAACCTGTGAACTTGTTTAA-CACAC-TGACAAG-TGTGTG--TGGCCAGTCC---TTGGATTGGAAACATGC-ACTA
G. megaphylla 041                        -----ACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACATTCGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. nervosa AF367222                      TCAAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTT-AA-CCCAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. nigrolineata AF367216                 TCGAAACTCGCCA-AATA-GCACGACTCGTGAACTCGTTTA--CACAT-CGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATA--CCTT
G. nitida 119                            TCGAAACCTGCCC-AACA-GCATGACCCGTGAACTTGTTTAA-CCCAT-TGACGAG-GGTGTT--TTGTTGGTCA---TTAGATTGGCGACACGC-CCTT
G. penangiana 006                        TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGATGAG-GGTGTG--TTGTCTATCA---CTAGATTGGCAACACGC-CCTT
G. penangiana AF367226                   TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGATGAG-GGTGTG--TTGTCGATCA---CTAGATTGGCAACACGC-CCTT
G. penangiana BB07                       TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGTAGAG-GGTGTG--TTGTCGATCA---CTACATTGGCAACACGC-CCTT
G. picrorhiza 039                        TTGAAACCTACCA-AATA-GTTAGACTTGCGAACTTGTTTTA-CACAT-TGACAAG-TGCGTG--TTGTCAGTCG---TTTGACTTCTAACATGC-CCTT
G. porrecta AB110812                     TCGAAACTCGCCA-AATA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATGC-CCCT
G. prainiana AF367218                    TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTCGTTTAA-CACAT-CAACAAG-TGTGTG--TGGTCAGTCT---TTCGATTGGCAACATGC-CCTT
G. rigida 029                            TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-AGACAAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. rigida 045                            TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACAAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. rigida 049                            TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACAAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. rigida 057                            TCAAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACAAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. rostrata 007                          TCGAAACCTGCCC-CACA-GCACCACACGCGAACCCGTTTAA-CACAT-TTGCAAG-TGTGTG--TGGTCAGTCG---TTGCATTGACAACATGC-CCTT
G. rostrata 091                          TCGAAACCTGCCC-AACA-GCACGACACGCGAACCTGTTTAT-CACAT-GCGCAAG-TGTGTG--TGGTCAGTTG---TTGGATTGACAACATGC-CCTT
G. rostrata AB110813                     TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-CGACGAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCAACATGC-CCTT
G. rostrata AF367225                     TCGAAACCTGCCC-AACA-GCACGACACGCGAACCTGTTTAT-CACAT-GCGCAAG-TGTGTG--TGGTCAGTTG---TTGGATTGACAACATGC-CCTT
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G. rostrata BL051               TCGAAACCTGCCC-CACA-GCACCACATGCGAACCCGTTTAA-TACAT-TTGCAAG-TGTGTG--TGGTCAGTCG---TTGCATTGACAACATGC-CCTT
G. schomburgkiana AB110814      TCGAAACTCGCTA-AATA-GCACAACTCGTGAACTCGTTTAA-CACAT-CGACAGA-GGTGTG--TGGTCAGTCA---TTGGATTGGCAACATAC-CCCT
G. scortechinii AF367219        TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-GGCGTG--TTGTCAGTCA---TTGGATTGGTAACACGC-CCTT
G. scortechinii 012             ------CCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-GGCGTG--TCGTCAGTCA---TTGGATTGGTAACACGC-CCTT
G. scortechinii 089             TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-GGCGTG--TCGTCAGTCA---TTGGATTGGTAACACGC-CCTT
G. scortechinii K04             TCAAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-CGCGTG--TGGTCAGTCA---TTCGATTGGCAACACGC-CCTT
G. sp. AJ312607                 TCAAAACCTGCCC-AGCA-GCACGACCTGTGAACTTGTTTAA-CACAC-TGACCAG-TGTGTG--TGGCCAGTCC---TTGGATTGGCAACATGC-ACTA
G. sp.B1 008                    ---------GCAA-AATA-GCACGACTCGTGAACTCGTTTAA-CACAT-CGACAGA-GGTGTG--TGGTCGGTCA---TTGGATTGGCCACCTGC-CCCT
G. sp.B2 011                    TCGAAACTCGC-A-AATA-GCACGACTCGTGAACTCGTTTAA-CACAT-CGACAGA-GGTGTG--TGGTCGGTCA---TTGGATTGGCCACCTGC-CCCT
G. sp.D1 064                    TCGAAACCTGCCC-AACA-GCACGACACGCGAACCTGTTTAT-CACAT-GCGCAAG-TGTGTG--TGGTCAGTCG---TCGGATTGACAACATGC-CCTT
G. sp.D1 070                    TCGAAACCTGCCC-AACA-GCACGACACGCGAACCTGTTTAT-CACAT-GCGCAAG-TGTGTG--TGGTCAGTCG---TTGGATTGACAACATGC-CCTT
G. sp.D2 P01                    ------------------------------------GTTTAA-CACATGCGCAAGCGTGCGTG----GTCAGTCG---TCGTATTGACAACATGC-CCTT
G. sp.D3 P02                    TCGAAACCTGCCC-GACA-GCACGACGCGCGAACCCGTTTAA-CACATGCGCAAGCGTGTGTG----GTCAGTCG---TCGGATTGACAACATGC-CCTT
G. sp.D4 BL04                   TCGAAACCTGCCC-AACA-GCACGACACGCGGACCTGTTTAA-CACA--TGCCA-G-TGTGTG--TGGTCAGTCG---TTGGACTGACAACATGC-CCTT
G. sp.D5 BL052                  TCGTAACCTGCCC-CACA-GCACGACACGCGAACCTGTTTAA-CACAT-GTGCGAG-TGTGTGTGTGGTCAGTCG---TTGGATTGACGGCATGC-CCTC
G. sp.D6 K12                    TCGAAACCTGCCC-AACA-GCACGACACGCGAACCTGTTTAA-CACAT-GTGCA-G-TGTGTGTGTGGTCAGTCG---TTGGATTGACGGCATGC-CCTT
G. spicata 019                  TCGAAACCTGCCC-AGCA-GCACGACCTGTGAACTTGTTTAC-CACAT-TTACAAG-TGCGTG--TGGTCGGTCC---TCGGATTGGCAACATGC-CCTT
G. sp.M1 025                    TCGAAACCTGCCC-AACA-GCACGACCTGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. sp.M2 068                    TCGA---CTGCCC--ACA-GCACGACCCGTGAACTCGTTTA--CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. sp.M3 072                    TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. sp.M4 022                    TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. sp.M5 069                    TCGAAACCTGCCC-AACA-GCATGACCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. sp.M5 073                    TCGAAACCTGCCC-AACA-GCATGACCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TGGTCAGTCA---TTGGATTGGCAACACGC-CCTT
G. sp.M6 093                    TCGAAACTTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAC-TGACAAG-GGCGTG--TGGTCAGACA---TTGAATTGGCAACACGC-CCTT
G. sp.M6 094                    TCGAAACTTGCCC-AACA-GCACGACCCGTGAACTCGTTTAA-CACAC-TGACAAG-GGCGTG--TGGTCAGACA---TTGAATTGGCAACACGC-CCTT
G. sp.X1 052                    TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. sp.X2 080                    TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTAAC-CACAT-TGACAAG-CGCGTG--TGGTCGATCC---TCGGATTGGCAACATGC-CCTT
G. syzygifolia AB110815         TCGAAACCTGCCC-AACA-GCACGACCCGTGAACTTGTTTAA-CCCAT-TGACAAG-GGTGTT--TTGTCGGTCA---CTAGATTGGCGACACGC-CCTT
G. tinctoria AB110817           TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. trianii K02                  TCGAAACCTGCCC-AATA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGTGTG--TGGTCAGTCG---CTGGATTGGCAACACGC-CCTT
G. urophylla 001                TCGAAACCTGCCCCAACA-GCACGACCCGTGAACTCGTTTAA-CACAT-CGACAAG-GGTGTG--TCGTCATTCA---TTGGATTGGCAACACGC-CCTT
G. urophylla 081                TCGAAACCTGCCCCAACA-GCACGACCCGTGAACTCGTTTAA-CACAT-TGACAAG-GGCGTG--TCGTCATTCA---TTGGATTGGCAACACGC-CCTT
G. vilersiana AB110818          TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. xanthochymus AB110819        TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. xanthochymus 034             TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CACAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
G. xanthochymus 092             TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTAAC-CACAT-TGACAAG-CGCGTG--TGGTCGATCC---TCGGATTGGCAACATGC-CCTT
G. xanthochymus BB03            -------------------------CCCGTGAACTTGTTTAA-CCCAT-TAC--AG-GGTGTG----GTCGATCC---TCGGATTGGCAACATGC-CCTT
G. xanthochymuscf 032           TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTAAC-CACAT-TGACAAG-CGCGTG--TGGTCGGTCC---TCGGATTGGCAACATGC-CCTT
Symphonia globulifera AY682919  TCGAAACCTGCCC-AGCA-GCACGACCTGTGAACTCGTTTAA-CATAT-GGACGAG-GGCGTG--CGGCCAATCCTCATCGGGTTGGAAACACGC-CGTT
Tripetalum cymosum AY145206     TCGAAACCTGCCC-AGCA-GCACGACCCGTGAACTTGTTTAC-CGCAT-TGACAAG-CGCGTG--TGGCCAGTCC---TCGGATTGGCAACATGC-CCTT
Clusia rosea                    TCGAAACCTGCCC-AGCA-ACACAACCCGTGAACCCGTTCAT-TGTAT-CGACGGGGGTTCTG--TTGTAAATCC---TTGGATTGACGACATTCCCCGA
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                                                110       120       130       140       150       160       170       180       190       200
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuminata AB110796                    GTAAGTC-AAGGGGTG--CCCATCGCTCATGTAGCGTATGGCTCCTCAAGACG-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TGTTG
G. acuticosta BB01                       GTAAGTC-AAGAGGTG--CCCATTGCTCCTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCG
G. atroviridis AF367211                  GTAAGTC-GTGGGGTG--CCCATTGCTCTAGTGGCATATGGCTCCTCAAGACC-CAACA-AACCAA-TCTCGGCGCGGGATGCGCCAAGGAAC--TATTG
G. atroviridis AB110797                  GTAAGTC-GTGGGGTG--CCCATTGCTCTAGTGGCATATGGCTCCTCAAGACC-CAACA-AACCAA-TCTCGGCGCGGGATGCGCCAAGGAAC--TATTG
G. balica 021                            GTAAGTC-GAGGGGTG--CCCATTGCTCATGTAGCGTATGGCTCCTCAAGACG-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TGTTG
G. bancana AF367212                      GTAAGTC-GAGGGGTG--ACCATTGCTCCTGTAGCACATGGCTCCTCAAGACA-TAACA-CACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TATTG
G. cataractalis 077                      GTAAGTC-AAGGGGTG--CCCATCGCTCATGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCG
G. celebica 002                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 003                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 005                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 009                          GTAAGTC-AAGAGGTG--CCCATCGCTCCTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 023                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 027                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 028                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 033                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
G. celebica 038                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
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G. celebica 054                          GTAAGTC-AAGAGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCAAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
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G. celebica 062                          GTAAGTC-AAGGGGTG--CCCATTGCTCTTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCA
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G. cowa 013                              GTAAGTC-GAGGGGTG--CCCATTGCTCTTGTAGCACATGGCTCCTCAAGACG-TAACA-CACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TATTG
G. cowa AB110799                         GTAAGTC-GAGGGGTG--CCCATTGCTCTTGTAGCACATGGCTCcTCAAGACG-TAACA-CACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TATTG
G. cowa AF367216                         GTAAGTC-GAGGGGTG--CCCATTGCTCTTGTAGCACATGGCTCCTCAAGACG-TAACA-CACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TAATG
G. cymosa 037                            GTAAGTC-GAGGGGTG--CCAATTGCTCACGTGGCATTTGGCTCTCCAAGACG-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TGTCG
G. cymosa 042                            GTAAGTC-GAGGGGTG--CCCATTGCTCACGTGGCATTTGGCTTTCCAAGACG-CAACA-AACCAA-TCCCGGCGCGGGATGCGCCAAGGAAT--TGTTT
G. diospyrifolia var. arborea BB02       GTAAGTC-AAGGGGTG--CCCATCGCTCATGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCG
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G. diospyrifolia var. minor AF36         GTAAGTC-AAGGGGTG--CCCA-CGCTCATGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TATCGGCGCGGGTTGCGCCAAGGAAC--TATCG
G. diospyrifolia var. minor BB06         GTAAGTC-AAGGGGTG--CCCATCGCTCATGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCG
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G. discoidea SL02                        GTAAGTC-AAGAGGTG--CCCATTGCTCCTGTAGCATGTGGCTCCTCGAGATG-CAACA-AACCAA-TCTCGGCGCGGGTTGCGCCAAGGAAC--TATCG
G. dulcis 050                            GTAAGTC-GAGGGGTG--CCAATCGCTCATGCAGCCTTTGGCTCCTCAAGACAACAACA-AACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCG
G. dulcis AB110800                       GTAAGTC-GAGGGGTG--CCAATGGCTCATGCAGCCTTCGGCTCCTCAAGACAACAACA-AACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCA
G. dulcis AB110801                       GTAAGTC-GAGGGGTG--CCAATGGCTCATGCAGCCTTCGGCTCCTCAAGACAACAACA-AACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCA
G. echinocarpa 035                       GTAAGTC-TAGGGGTG--CCCACTGCTCATGTGACACTGGGCTCCTCAAGACG-CAACA-AACCAA-TTTGGGCGCGGGTTGCGCCAAGGAAC--TATCG
G. forbesii AF367224                     GTAAGTC-GAGGGGTG--CCCATTGCTCTTGTAGCACATGGCTCCTCAAGACG-TAATAACACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TATTA
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G. hanburyi AB110802                     GTAAGTC-AAGGGGTG--CCCATCGCTCATGTAGCGTATGGCTCCTCAAGACG-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TGTTG
G. laterifolia 040                       GTAAGTC-GAGGGGTGTGCCCATCGCTCATGTAGCGTATGGCTCCTCAAGATG-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TATTG
G. latissima 026                         GTAAGTC-GAGGGGTG--CCCATCGCTCATGTAGCGTATGGCTCCTCAAGACG-CAACA-AACAAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TGTTG
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G. madruno AJ509215                      GTGAGTC-GAGGGGTG--TCGATTGCTCATGCAGCAT-TGGCTCCTCAAGACA-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAG--AATAA
G. maingayi 098                          GTAAGTC-GAGGGGTG--GCCGTCGCTCTCGTAGCATATGGCTCCCCAAGACG-TAACA-AACCAA-TCTCGGCGCGGGATGCGCCAAGGAAC--TATCG
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G. megaphylla 030                        GTGAGTC-GAGAGGTG--TCGATTGCTCAGGAAGCAT-TGGCTCCTCAAGACA-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAG--AATAA
G. megaphylla 041                        GTAAGTC-GAGGGGTG--CCAATGGCTCATGCAGCCTTTGGCTCCTCAAGACAACAACA-AACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCA
G. nervosa AF367222                      GTAAGTC-GAGGGGTG--CCAATCGCTCATGCAGC-TTTGGCTCCTCAAGACA-CAACAACACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCG
G. nigrolineata AF367216                 GTAAGTC-GAGGGGTG--CCCATTGCTCTTGTAGCACATGGCTCCTCAAGACG-TAACA-CACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TAATG
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G. porrecta AB110812                     GTAAGTC-GAGGGGTG--CCCATTGCTCTTGTAGCACATGGCTCCTCAAGACG-TAATAACACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TATTG
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G. rostrata AF367225                     GTAAGTC-GAGGGGTG--TCGAGTGCTCGCTTGGCATTCGGCTCCTCGAGACA-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAACC-TATTA
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G. scortechinii 012                      GTAAGTC-CAGGGGTG--CCCATCGCTCATGTAGCGTATGGCTCCTCAAGACG-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TATTG
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G. sp.B1 008                    GTAAGTC-GAGGGGTG--ACCATTGCTCTGGTAACACATGGCTCCTCAAGACG-TAACA-CACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TATTG
G. sp.B2 011                    GTAAGTCGGAGGGGTG--CCCATTGCTCTTGTAGCACATGGCTCCTCAAGACG-TAACA-CACCAA-TCCCGGCGCGGGATGCGCCAAGGAAC--TATTG
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G. sp.D1 070                    GTAAGTC-GAGGGGTG--TCGAGTGCTTGCTTGGCATTCGGCTCCTCGAGACG-CAACA-AACCAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TATTA
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G. sp.M1 025                    GTAAGTC-GAGGGGTG--CCCATCGCTCATGTAGCGTATGGCTCCTCAAGACG-CAACA-AACAAA-TCCCGGCGCGGGTTGCGCCAAGGAAC--TGTTG
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G. sp.X2 080                    GTAAGTC-GAGGGGTG--CCAGTCGCTCATGCAGCCTTTGGCTCCCTAAGACAACAACA-AACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCG
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G. xanthochymus 092             GTAAGTC-GAGGGGTG--CCAGTCGCTCATGCAGCCTTTGGCTCCCTAAGACAACAACA-AACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCG
G. xanthochymus BB03            GTAAGTC-GAGGGGTG--CCAGTCGCTCATGCAGCCTTTGGCTCCCTAAGACAACAACA-AACCAAATCCCGGCGCGGGTTGCGCCAAGGAAC--AATCG
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                                                                                                                          5.8S
                                                210       220       230       240       250       260       270       280       290       300
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G. cataractalis 077                      TAAATGTAA--GGAACCCCTCCC-CGTCTT-GGAAACAAGGTAGGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. celebica 002                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 003                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 005                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 009                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 023                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 027                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 028                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 033                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 038                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 043                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 054                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 059                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica 062                          TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica AB110816                     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica AB110813                     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica AB110814                     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACTTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. celebica AF367214                     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. costata BL03                          TAAATGTAAAAGGAACTCCTCTC-CATCTt-GGAAACAACGTATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGACAACGG
G. costata BL06                          TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAACGTATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGACAACGG
G. costata AB110798                      AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AATCAAAACGACTCTCGGCAACGG
G. cowa 004                              TAAATGTAA--GGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. cowa 013                              TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. cowa AB110799                         TAAATGTAAAAGGAACTcCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. cowa AF367216                         TAAATTTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. cymosa 037                            TAAATGTGA--GGAACTCCTCTC-CGTCCT-GGAAACAGTGTATGTGACGAGGGCCTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. cymosa 042                            TAAATGTGA--GGAACTCCTCTC-CGTCCT-GGAGACAGTGTACGTGATGAGGGCCTGTT---CCTTTTAGTCGT-AAACAAAATGACTCTCGGCAACGG
G. diospyrifolia var. arborea BB02       TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. diospyrifolia var. arborea BB05       TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. diospyrifolia var. diospyrifolia 078  TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGTTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. diospyrifolia var. minor AF36         TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. diospyrifolia var. minor BB06         TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. discoidea SL01                        TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. discoidea SL02                        TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. dulcis 050                            AAAACGCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. dulcis AB110800                       AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. dulcis AB110801                       AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. echinocarpa 035                       TAAATGTAA--GGAACTCCTCTC-CGTCTT-GGAAACAATGTACGTGACGAGGGCTAGTT---CTTTCCAGTTTT-AAACAAAACGACTCTCGGCAACGG
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G. forbesii AF367224                     TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. forbesii AF67223                      TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. globulosa AF367221                    TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. hanburyi AB110802                     TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAATGACTCTCGGCAACGG
G. laterifolia 040                       TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---TCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. latissima 026                         AAAATGTGA--GGAACTCCTATC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. latissima AF479789                    AAAATATGG--GGAACTCCTCTC-CATCCT-GGAAACAGTGTATGCGACGAGGGATTGTT---CCTTTTAGTCGT-AAATAGAACGACTCTCGGCAACGG
G. madruno AJ509215                      AAAATATGA--GGAACTCCTCTC-CATCCT-GGAAACAGTGTATGCGACGAGGGATTGTT---CCTTTTAGTCGT-AAATAAAACGACTCTCGGCAACGG
G. maingayi 098                          TAAATGTAAAAGGAACTCCTCTC-CGTCTT-GGAAACAGTGTACGTGACGAGGTCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. malaccensis AB110810                  TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. malaccensis AB110811                  TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. malaccensis var. malaccensis BB04     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. malaccensis var. malaccensis BB08     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. malaccensis var. malaccensis BB09     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. malaccensis var. pseudomangostana SP01TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. mangostana 096                        TAAATGTAA--GGAACTCCTTCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. mangostana AB110807                   TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. mangostana AB110808                   TAAATGTAA--GGAACTCCTTCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
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G. mangostana AB110811                   TAAATGTAA--GGAACTCCTTCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. mangostana AF367215                   TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. mangostana AJ509214                   TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. mangostana LAO                        TAAATGTAA--GGAACTCCTTCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. megaphylla030                         AAAATATGA--GGAACTCCTCTC-CATCCT-GGAAACAGTGTATGCGACGAGGGATTGTT---CCTTTTAGTCGT-AAATAGAACGACTCTCGGCAACGG
G. megaphylla041                         AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AATCAAAACGACTCTCGGCAACGG
G. nervosaAF367222                       AAAACGCAA--GGAACTCCTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCCTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. nigrolineataAF367216                  TAAATTTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. nitida119                             TAAATGTAA--GGAACTCCTCTC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. penangiana006                         TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCATT---CCTTTCAGTTGTTAAACAAAACGACTCTCGGCAACGG
G. penangiana AF367226                   TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCATT---CCTTTCAGTTGTTAAACAAAACGACTCTCGGCAACGG
G. penangianaBB07                        TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAATGTACGTGATGAGGGCTCATT---CCTTTCAGTTGTTAAACAAAACGACTCTCGGCAACGG
G. picrorhiza039                         TAGAAGTAA--GGAACTCCTTTA-TGTCCT-GGAAACAGTGTACATGATGAGGGCCTGTT---CCTTTTACTGGT-AAACGAAATGACTCTCGGCAACGG
G. porrecta AB110812                     TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. prainiana AF367218                    TAAATGTGA--GGAACTCCTCTC-CGTCCT-GGAAACAGAGTACGCGATGAGGGTATGTC---CCTTTTAGTCAT-AAACAAAACGACTCTCGGCAACGG
G. rigida 029                            TAAATGTAA--GGAACTCCTCCC-CGTCTTTGGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. rigida 045                            TAAATGTAA--GGAACTCCTCCC-CGTCTTTGGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. rigida 049                            TAAATGTAA--GGAACTCCTCCC-CGTCTTTGGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. rigida 057                            TAAATGTAA--GGAACTCCTCCC-CGTCTTTGGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. rostrata 007                          TAAA-GTGAAAGGAACTCCTCTCCTGTCTT-GGAAACAATGAACGCGACGAGGGCATGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. rostrata 091                          TAA--GTGAAAGGAACTCCTCTCTCGTCTT-GGAAACAATGAACGTGATGAGGGCATGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. rostrata AB110813                     TAAATGTAA--GGAACTCCTCCC-CGTCTT-GGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAATGACTCTCGGCAACGG
G. rostrata AF367225                     TAAGTGAAA--GGAACTCCTCTCTCGTCTT-GGAAACAATGAACGTGATGAGGGCATGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. rostrata BL051                        TAAA-GTGAAAGGAACTCCTCTCCTGTCTT-GGAAACAATGAACACGACGAGGTCATGTT---CCTTTTAATCGT-AAACAAAACGACTCTCGGCAACGG
G. schomburgkiana AB110814               TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. scortechinii AF367219                 TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---TCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. scortechinii 012                      TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
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G. scortechinii 089             TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. scortechinii K04             TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCATGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp. AJ312607                 AAAATATGA--GGAACTCCTCTC-CATCCT-GGAAACAGTGTATGCGACGAGGGATTGTT---CCTTTTAGTCGT-AAATAAAACGACTCTCGGCAACGG
G. sp.B1 008                    TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.B2 011                    TAAATGTAAAAGGAACTCCTCTC-CATCTT-GGAAACAATGAATGTGACGAGGGCTTGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.D1 064                    TAAGTGAAA--GGAACTCCTCTCCCGTCTT-GGAAACAATGAATGTGATGAGGGCATGCT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.D1 070                    TAAGTGAAA--GGAACTCCTCTCCCGTCTT-GGAAACAATGAACGTGATGAGGGCATGCT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.D2 P01                    TAAA-GCGGAAGGAACTCCTCTCCCGCTTT-GGAAACAATGAACGCGGTGAGGGCACGTT---CCTTTCGGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.D3 P02                    TAAGTGAAA--GGAACTCCTCTCCCGTGTT-GGAAACAATGAACGTGATGAGGGCATGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.D4 BL04                   TAAGTGAAA--GGAACTCCTCTCCCGTGTT-GGAAACAATGAACGTGATGAGGGCATGTT---CCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.D5 BL052                  TAAGTGAAA--GGAACTCCTCTCCCGTGTT-GGAAACAATGAACGTGATGAGGGCGTGTT---CCTTTTAGTCGTAAAACAAAACGACTCTCGGCAACGG
G. sp.D6 K12                    TAAGTGAAA--GGAACTCCTCTCCCGTGTT-GGAAACAATGAACGTGATGAGGGCGTGTT---CCTTTTAGTCGTAAAACAAAACGACTCTCGGCAACGG
G. spicata 019                  AAAACGTGA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. sp.M1 025                    AAAATGTGA--GGAACTCCTATC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.M2 068                    AAA-TGTGA--GGAACTCCTCTC-CGTCTT-GGAACCA-TGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAATACGACTCTCGGCAACGG
G. sp.M3 072                    AAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.M4 022                    AAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCAT-AAACAAAACGACTCTCGGCAACGG
G. sp.M5 069                    AAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.M5 073                    AAAATGTGA--GGAACTCCTCAC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. sp.M6 093                    TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGA-AAACAAAACGACTCTCGGCAACGG
G. sp.M6 094                    TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGA-AAACAAAACGACTCTCGGCAACGG
G. sp.X1 052                    AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AATCAAAACGACTCTCGGCAACGG
G. sp.X2 080                    AAAACGCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. syzygifolia AB110815         TAAATGTAA--GGAACTCCTCCC-CGTCTTTGGAAACAAAGTACGTGATGAGGGCTGGTT---CCTTTCAGTCGTTAAACAAAACGACTCTCGGCAACGG
G. tinctoria AB110817           AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AATCAAAACGACTCTCGGCAACGG
G. trianii K02                  TAAATGTAAAAGGAACTCCTCTC-CGTCTT-GGAAACAACGTACGTGACGAGGTCTTGTTGTTCCTTTTAGTCGT-AAACAAAACGACTCTCGGCAACGG
G. urophylla 001                TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAATGACTCTCGGCAACGG
G. urophylla 081                TAAATGTGA--GGAACTCCTCTC-CGTCTT-GGAAACAATGCACGTGATGAGGGCTTGTT---CCTTTCAGTCGT-AAACAAAATGACTCTCGGCAACGG
G. vilersiana AB110818          AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AATCAAAACGACTCTCGGCAACGG
G. xanthochymus AB110819        AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AATCAAAACGACTCTCGGCAACGG
G. xanthochymus 034             AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AATCAAAACGACTCTCGGCAACGG
G. xanthochymus 092             AAAACGCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. xanthochymus BB03            AAAACGCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
G. xanthochymuscf 032           AAAACGCGA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
Symphonia globulifera AY682919  TAAACGTAA--GGAACTCCTCTC-CATCCC-GAACATGGCGTATGCGACGAGGCCTCGTT---CCTTTCAGTTGC-AAACAAAACGACTCTCGGCAACGG
Tripetalum cymosum AY145206     AAAACTCAA--GGAACCCTTCTC-CATCCT-GGAAACAGTGTGTGCGACGAGGGCTTGTT---CCTTTTAGTTGT-AAACAAAACGACTCTCGGCAACGG
Clusia rosea                    AAAACTAAA--GGAACTCCCTGC-CATCCC-GGAAACGGTGCATGCGTCGGGGATCGGTT---CCTTGTGGTCAT-AAACAAAACGACTCTCGGCAACGG
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                                                 310       320       330       340       350       360       370       380       390       400
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G. acuminata AB110796                    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. acuticosta BB01                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. atroviridis AF367211                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. atroviridis AB110797                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. balica 021                            ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. bancana AF367212                      ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
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G. celebica 002                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 003                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 005                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 009                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 023                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 027                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 028                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 033                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 038                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 043                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 054                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 059                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica 062                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica AB110816                     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica AB110813                     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica AB110814                     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. celebica AF367214                     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. costata BL03                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. costata BL06                          ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGaATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. costata AB110798                      ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. cowa 004                              ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. cowa 013                              ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. cowa AB110799                         ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. cowa AF367216                         ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. cymosa 037                            ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. cymosa 042                            ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. diospyrifolia var. arborea BB02       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. diospyrifolia var. arborea BB05       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. diospyrifolia var. diospyrifolia 078  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. diospyrifolia var. minor AF367227     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. diospyrifolia var. minor BB06         ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. discoidea SL01                        ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. discoidea SL02                        ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. dulcis 050                            ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. dulcis AB110800                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. dulcis AB110801                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. echinocarpa 035                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. forbesii AF367224                     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
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G. forbesii AF67223                     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. globulosa AF367221                   ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. hanburyi AB110802                    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. laterifolia 040                      ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. latissima 026                        ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. latissima AF479789                   ATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. madruno AJ509215                     ATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. maingayi 098                         ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. malaccensis AB110810                 ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. malaccensis AB110811                 ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. malaccensis var. malaccensis BB04    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. malaccensis var. malaccensis BB08    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. malaccensis var. malaccensis BB09    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. malaccensis var. pseudomangostana SP01ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana 096                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana AB110807                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana AB110808                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana AB110809                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana AB110810                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana AB110811                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana AF367215                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana AJ509214                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. mangostana LAO                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. megaphylla 030                       ATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. megaphylla 041                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. nervosa AF367222                     ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. nigrolineata AF367216                ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. nitida 119                           ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. penangiana 006                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. penangiana AF367226                  ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. penangianaBB07                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. picrorhiza039                        ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. porrecta AB110812                    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. prainiana AF367218                   ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG


G. rigida 029                           ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rigida 045                           ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rigida 049                           ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rigida 057                           ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rostrata 007                         ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rostrata 091                         ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rostrata AB110813                    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rostrata AF367225                    ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. rostrata BL051                       ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
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G. schomburgkiana AB110814	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. scortechinii AF367219	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. scortechinii 012	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. scortechinii 089	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. scortechinii K04	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp. AJ312607	ATATCTCAGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTACG
G. sp.B1 008	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.B2 011	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.D1 064	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.D1 070	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.D2 P01	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.D3 P02	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.D4 BL04	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.D5 BL052	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.D6 K12	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. spicata 019	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.M1 025	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.M2 068	ATATCTCGGCTCTTGCATCGATGAAGTACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCATGTTGCG
G. sp.M3 072	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.M4 022	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.M5 069	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.M5 073	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.M6 093	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.M6 094	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.X1 052	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. sp.X2 080	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. syzygifolia AB110815	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. tinctoria AB110817	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. trianii K02	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. urophylla 001	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. urophylla 081	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. vilersiana AB110818	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. xanthochymus AB110819	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. xanthochymus 034	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. xanthochymus 092	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. xanthochymus BB03	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
G. xanthochymuscf 032	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
Symphonia globulifera AY682919	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTTTTTGAACGCAAGTTGCG
Tripetalum cymosum AY145206	ATATCTCGGCTCTTGCATCGATGAAGAACGTAGCGAAATGCGATACGTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCG
Clusia rosea	ATATCTCGGCTCTCGCATCGATGAAGAACGTAGCGAAATGCGATACTTGGTGTGAATTGCAGAATCCCGTGAACCATCGAGTCTTTGAACGCAAGTTGCG

ITS2

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                                                410       420       430       440       450       460       470       480       490       500
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G. acuminata AB110796                    CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCGAA----------TTGTTA-TGGA-ATTTGGGCG
G. acuticosta BB01                       CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTTCTA-CGGT-GTTTGGGCG
G. atroviridis AF367211                  CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-GCCCAAAAC--CACAA----------TTGTCA-GGGT-ATTTGGGTG
G. atroviridis AB110797                  CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-GCCCAAAAC--CACAA----------TTGTCG-GGGT-ATTTGGGCG
G. balica 021                            CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. bancana AF367212                      CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-ATTTGGGCG
G. cataractalis 077                      CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. celebica 002                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 003                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 005                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 009                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--ACCAA----------TTGCTA-TGGT-GTTTGGGCG
G. celebica 023                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 027                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 028                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 033                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 038                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 043                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 054                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica 059                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-TGGT-GTTTGGGCG
G. celebica 062                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica AB110816                     CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--ACCAA----------TTGCTA-TGGT-GTTTGGGCG
G. celebica AB110813                     CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica AB110814                     CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACATAATGT--TGCCCAAAC--CCCAA----------TTGTTA-TGGT-GTTTGGGCG
G. celebica AF367214                     CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--ACCAA----------TTGCTA-TGGT-GTTTGGGCG
G. costata BL03                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TTCCCAAAC--CACAG----------TTGCTA-TGGT-ATTTGGGAG
G. costata BL06                          CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TTCCCAAAC--CACAG----------TTGtTA-TGGT-ATTTGGGAG
G. costata AB110798                      CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGT-ATAAGGGCG
G. cowa 004                              CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGTTG-TGGT-ATTTGGGCG
G. cowa 013                              CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGTTG-TGGT-ATTTGGGCG
G. cowa AB110799                         CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGTTG-TGGT-ATTTGGGCG
G. cowa AF367216                         CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-ATTTGGGCG
G. cymosa 037                            CCCAAAGCCTTATGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAA-C--CCAAA----------ATGCAA-GGGG-ATTTGGGCG
G. cymosa 042                            CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCAAA----------ATGCAA-GGGA-ATTTGGGCG
G. diospyrifolia var. arborea BB02       CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCGAA----------TTGCTA-TGGT-GTTTGGGCG
G. diospyrifolia var. arborea BB05       CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCGAA----------TTGCTA-TGGT-GTTTGGGCG
G. diospyrifolia var. diospyrifolia 078  CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCGAA----------TTGCTA-TGGT-GTTTGAGCG
G. diospyrifolia var. minor AF367227     CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. diospyrifolia var. minor BB06         CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. discoidea SL01                        CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCATGGGTGTCACACAATGT--TGCCCAAAC--CCCAT----------TTTCTA-CGGT-GTTTGGGCG
G. discoidea SL02                        CCCAAAGCATTTTGG--TTGAGGGCACGTCTGCATGGGTGTCACACAATGT--TGCCCAAAC--CCCAT----------TTTCTA-CGGT-GTTTGGGCG
G. dulcis 050                            CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAGA----------TTGTGG-TGGG-GTGAGGGCG
G. dulcis AB110800                       CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGG-ATAAGGGCG
G. dulcis AB110801                       CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGG-ATAAGGGCG
G. echinocarpa 035                       CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACA-TGT--TGCCCAAAT--TCCAA----------TTGCTA-TGGG-ATATGGGCG
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G. forbesii AF367224	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTG-TG-TGGT-GTTTGGGCG
G. forbesii AF67223	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-GTTTGGGCG
G. globulosa AF367221	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-ATTTGGGCG
G. hanburyi AB110802	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCGAA----------TTGTTA-TGGA-ATTTGGGCG
G. laterifolia 040	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCAAA----------TTGTTG-TGGA-ATTTGGGTG
G. latissima 026	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. latissima AF479789	CCCGAAGCCTTCAGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAG--CCCAA----------CTGGTA-TTGG-ATTTGGGCG
G. madruno AJ509215	CCCGAAGCCTTCAGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAG--CCCAA----------CTGGTA-TTGG-ATATGGGCG
G. maingayi 098	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TGCCCAAACC-CCCAG----------TTGCTTATGGT-ATTTGGGCG
G. malaccensis AB110810	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-cGGT-GTTTGGGCG
G. malaccensis AB110811	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. malaccensis var. malaccensis BB04	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. malaccensis var. malaccensis BB08	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. malaccensis var. malaccensis BB09	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. malaccensis var. pseudomangostana SP01	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana 096	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana AB110807	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana AB110808	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana AB110809	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana AB110810	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana AB110811	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana AF367215	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana AJ509214	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. mangostana LAO	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. megaphylla 030	CCCGAAGCCTTGAGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------CTGGTA-TTGG-ATATGGGCG
G. megaphylla 041	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGG-ATAAGGGCG
G. nervosa AF367222	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAA-----------TTGTCG-TGGG-ATAAGGGCG
G. nigrolineata AF367216	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-ATTTGGGCG
G. nitida 119	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-CGGT-GTTTGGGCG
G. penangiana 006	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCTAA----------TTGCTA-CGGT-GTTTGGGCG
G. penangiana AF367226	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCTAA----------TTGCTA-CGGT-GTTTGGGCG
G. penangiana BB07	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCTAA----------TTGCTA-CGGT-GTTTGGGCG
G. picrorhiza 039	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCGCACAATGT--TGGCCAAAC--CCAAG----------TCATAA-TGGG-ATTTTGGCG
G. porrecta AB110812	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-GTTTGGGCG
G. prainiana AF367218	CCCAAAGCCTTATGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCTAAACC-CCAAA----------TTGCAA-GGGG-ATTTGGGCG
G. rigida 029	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-TGGT-GTTTGGGTG
G. rigida 045	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-TGGT-GTTTGGGTG
G. rigida 049	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-TGGT-GTTTGGGTG
G. rigida 057	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-TGGT-GTTTGGGTG
G. rostrata 007	CCCGAAGCCTTTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-AGCCCAAAC--CCAAA----------ACGCAAAAGGGGATTTGGGCA
G. rostrata 091	CCCGAAGCCTCTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------ATGCAAATGGG-ATTTGGGCG
G. rostrata AB110813	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--ACCAA----------TTGCTA-TGGT-GTTTGGGCG
G. rostrata AF367225	CCCGAAGCCTCTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------ATGCAAATGGG-ATTTGGGCG
G. rostrata BL051	CCCGAAGCCTTTAGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------ACGCAAAAGGGGATTTGGGCG
G. schomburgkiana AB110814	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-ATTTGGGCG
G. scortechinii AF367219	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTAT--TGCCCAAATT-CCAAA----------TTGTTA-TGGA-ATTTGGGTG
G. scortechinii 012	CCCAAAGCCTTT-GG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--AGCCCAAAT--CCAAA----------T-GTTA-TGGA-ATTTGGGCG

G. scortechinii 089	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCAAA----------TTGTTA-TGGA-ATTTGGGCG
G. scortechinii K04	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTAGGCG
G. sp. AJ312607	CCCGAAGCCTTCAGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAG--CCCAA----------CTGGTA-TTGG-ATATGGGCG
G. sp.B1 008	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-ATTTGGGCG
G. sp.B2 011	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGTT-TGCCCAAAC--CCCAA----------TTGCTG-TGGT-ATTTGGGCG
G. sp.D1 064	CCCGAAGCCTCTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCGAAC--CCAAA----------ATGCAAATGGG-ATTTGGGCG
G. sp.D1 070	CCCGAAGCCTCTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCGAAC--CCAAA----------ATGCAAATGGG-ATTTGGGCG
G. sp.D2 P01	CCCGAAGCCTTTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCGCACAATGTT-TGCCCAAAC--CCAAA----------TTGCAAATGGG-ATTTGGGCG
G. sp.D3 P02	CCCGAAGCCTTTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------ATGCAAATGGG-ATTTGGGCG
G. sp.D4 BL04	CCCGAAGCCTTTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------ATGCAAATGGG-ATTTGGGCG
G. sp.D5 BL052	CCCGAAGCCTTTCGGGGTTGAGGGCACGTCTGCCTGGGTGTCACACAATGTTTTGCCCAAAC--CCAAA----------ATGCAAATGGG-ATTCGGGCG
G. sp.D6 K12	CCCGAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TTCCCACAC--CACAG----------TTGATA-TGGT-ATTTGGGAG
G. spicata 019	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATATT-TGCCCAAAC--CCAAA----------TCGTTG-TGGG-ATAAGGGCG
G. sp.M1 025	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.M2 068	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.M3 072	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.M4 022	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.M5 069	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.M5 073	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.M6 093	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.M6 094	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCCAA----------TTGTTA-TGGA-ATTTGGGCG
G. sp.X1 052	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGG-ATAAGGGCG
G. sp.X2 080	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTGTCG-TGGG-ACAAGGGCG
G. syzygifolia AB110815	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGT--TGCCCAAAC--CCCAA----------TTGCTA-TGGT-GTTTGGGTG
G. tinctoria AB110817	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGG-ATAAGGGCG
G. trianii K02	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACATTGT--TGCCCAAACCCCCCAG----------TTGCTA-TGGT-ATTTGGGCG
G. urophylla 001	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCAAA----------TTGTTA-TGGA-ATTTGGGCA
G. urophylla 081	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACACTGT--TGCCCAAAT--CCAAA----------TTGTTA-TGGA-ATTTGGGCA
G. vilersiana AB110818	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATtG-TGGT-ATAAGGGCG
G. xanthochymus AB110819	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGG-ATAAGGGCG
G. xanthochymus 034	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCG-TGGG-ATAAGGGCG
G. xanthochymus 092	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTGTCG-TGGG-ACAAGGGCG
G. xanthochymus BB03	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTGTCG-TGGG-ACAAGGGCG
G. xanthochymuscf 032	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAGA----------TTGTTG-TGGG-ATAAGGGCG
Symphonia globuliera AY682919	CCCAAAGCCTTTTCGG-TTGAGGGCACGTCTGCCTGGGTGTCACGCAATGT--CGCCCAAATA-CCAAACGGCTACGAATTGCTACTGG--ATTTGGGCG
Tripetalum_cymosum AY145206	CCCAAGGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAATGTT-TGCCCAAAC--CCAAA----------TTATCGTTGG--ACAAGGGCG
Clusia_rosea	CCCAAAGCCTTTTGG--TTGAGGGCACGTCTGCCTGGGTGTCACACAAAGT--CGCCCAA-G--CCCAA----------CATCCAGTGGG-AATAGGGCG

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                                                510       520       530       540       550       560       570       580       590       600
                                         ...|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuminata AB110796                    GATGTTGGTCTCCCGTGTGCCCCT-CAGTTGCGGTTGGCCTAAAT-GCGAGCCTTGTTGACGTTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. acuticosta BB01                       GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTC-ACAGACCCTCG
G. atroviridis AF367211                  GATGTTGGTCTCCCGTGCGCCCCG-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCTTCG
G. atroviridis AB110797                  GATGTTGGTCTCCCGTGCGCCCTG-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCTTCG
G. balica 021                            GATGTTGGTCTCCCGTGTGCCCTT-CGGTTGCGGTTGGCCCAAAT-ACGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTAT
G. bancana AF367212                      GTTGTTGGCCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTATAGACCCTCG
G. cataractalis 077                      GATGTTGGTCTCCCGTGCGCCCC--GGCTCGCGGTTGGCCCAAAA-ACCAGCCCTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. celebica 002                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 003                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 005                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGT-G--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 009                          GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. celebica 023                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACATGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 027                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 028                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 033                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 038                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 043                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 054                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica 059                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. celebica 062                          GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica AB110816                     GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. celebica AB110813                     GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica AB110814                     GATGTTGGTCTCCCGTGTGCCTCT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. celebica AF367214                     GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. costata BL03                          GATGTTGGTCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ACGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. costata BL06                          GATGTTGGTCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ACGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. costata AB110798                      GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTTTGATGTTG--TACACGGC-AATCGGTGGTTT-TAAGACCCTCG
G. cowa 004                              GTTGTTGGCCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. cowa 013                              GTTGTTGGCCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. cowa AB110799                         GTTGTTGGCCTCCCGTGtGCCCCT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. cowa AF367216                         GTTGTTGGCCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. cymosa 037                            GATGTTGGTCTCCCGTGTGCCCTT-CGCCCGCGGTTGGCCCAAAT-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-TAAGACCCTCG
G. cymosa 042                            GATGTTGGTCTCCCGTGTGCCCTT-CGCCCATGGTTGGCCCAAAT-ACGAGCCTTGTTGATGTCG--TACATGGC-AATCGGTGGTTT-AAAGACCCTCG
G. diospyrifolia var. arborea BB02       GATGTTGGTCTCCCGTGTGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACATGGC-AATCGGTGGTTT-ACAGACCCTCG
G. diospyrifolia var. arborea BB05       GATGTTGGTCTCCCGTGTGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACATGGC-AATCGGTGGTTT-ACAGACCCTCG
G. diospyrifolia var. diospyrifolia 078  GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-AGGAGCCTTGTTGATGTTG--TACATGGC-AATCGGTGGTTT-ACAGACCCTCG
G. diospyrifolia var. minor AF367227     GATGTTGGTCTCCCGTGCGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. diospyrifolia var. minor BB06         GATGTTGGTCTCCCGTGCGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. discoidea SL01                        GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTC-ACAGACCTTCG
G. discoidea SL02                        GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTC-ACAGACCTTCG
G. dulcis 050                            GATGTTGGTCTCCCGTGTGTCGTT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTCG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. dulcis AB110800                       GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTtG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCg
G. dulcis AB110801                       GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTtG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCg
G. echinocarpa 035                       GATGCTGGTCTCCCGTGTG-CACC-CGCTCGCGGTTGGCCCAAAT-ACGAGCCATGTTGATGTTG--TTCACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. forbesii AF367224                     GTTGTTGGCCTCCCATGCGCCCCT-CGCTCGTGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
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G. forbesii AF67223                      GTTGTTGGCCTCCCATGCGCCCCT-TGCTCGTGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. globulosa AF367221                    GTTGTTGGCCTCCCGTGCGCCCTT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTGGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. hanburyi AB110802                     GATGTTGGTCTCCCGTGTGCCCCT-CAGTTGCGGTTGGCCTAAAT-GCGAGCCTTGTTGACGTTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. laterifolia 040                       GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCTAAAT-GCAAGCCTTGTTGATGATG--TGCACGAC-AATCGGTGGTTT-ACAGATCCTCT
G. latissima 026                         GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCCAAAT-ACGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. latissima AF479789                    GATGTTGGCCTCCCGTGTGCCCTG-GGCTCGCGGTTGGCCCAAAT-ACGAGTCGCGTTGATGTTG--TACACGAC-AATCGGTGGTTT-AAAGACCTTCG
G. madruno AJ509215                      GATGTTGGCCTCCCGTGTGCCCTG-TGCTCGCGGTTGGCCCAAAT-ATGAGTCGCGTTGATGTTG--TACACGAC-AATCGGTGGTTT-AAAGACCTTCG
G. maingayi 098                          GATGTTGGTCTCCCGTGTGCCCCT-TGCTCGCGGTTGGCCAAAAT-ACGTGCCTCGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. malaccensis AB110810                  GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. malaccensis AB110811                  GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. malaccensis var. malaccensis BB04     GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. malaccensis var. malaccensis BB08     GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. malaccensis var. malaccensis BB09     GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTcG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. malaccensis var. pseudomangostana SP01GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGTTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana 096                        GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana AB110807                   GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana AB110808                   GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana AB110809                   GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana AB110810                   GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana AB110811                   GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana AF367215                   GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGCTAATCGGTGGTTT-ATAGACCCTCG
G. mangostana AJ509214                   GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. mangostana LAO                        GATGTTGGTCTCCCGTGCGCCCCT-AGCTCGCGGCTGGCCTAAAA-ACGAGCCTTGTTGATGTCG--TACACGGC-AATCGGTGGTTT-ATAGACCCTCG
G. megaphylla 030                        GATGTTGGCCTCCCGTGTGCTCTG-TGCTCGCGGTTGGCCCAAAT-ACGAGTCGCGTTGATGTTG--TACACGAC-AATCGGTGGTTT-AAAGACCTTCG
G. megaphylla 041                        GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. nervosa AF367222                      GATATTGGTCTCCCGTGTGCCATT-TGCTCCCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TGCACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. nigrolineata AF367216                 GTTGTTGGCCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. nitida 119                            GATGTTGGTCTCCCGTGCGCCCCT-GGCTTGCGGTTGGCCCAAAA-ATGAGCCTTGTTGATGTTG--TACACGGC-AATTGGTGGTTT-ACAGACCCTCG
G. penangiana 006                        GATGTTGGTCTCCCGTGCGCCCTT-GGCTCACGGTTGGCCTAAAA-ACGAGCCTTGTTGATGTTG--TACATGGC-AATCGGTGGTTT-ATAGACCCTCG
G. penangiana AF367226                   GATGTTGGTCTCCCGTGCGCCCTT-GGCTCACGGTTGGCCTAAAA-ACGAGCCTTGTTGATGTTG--TACATGGC-AATCGGTGGTTT-ATAGACCCTCG
G. penangianaBB07                        GATGTTGGTCTCCCGTGCGCCCTT-GGCTCACGGTTGGCCTAAAA-ACGAGCCTTGTTGATGTTG--TACATGGC-AATCGGTGGTTT-ATAGACCCTCG
G. picrorhiza039                         GATGTTGGTCTCCCGTGTGTCTTT-TGCTCACGGTTGGCCCAAAT-GTGAGTCTCGTTGATGTTGTGTACATGGC-AATCGGTGGTGT-AAAGACCCTCG
G. porrecta AB110812                     GTTGTTGGCCTCCCATGCGCCCCT-TGCTCGTGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. prainiana AF367218                    GATGTTGGTCTCCCGTGTGCCCTT-CGCTCGCGGTTGGCCTAAAT-ATGAGCCTTTTTGATGTCG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. rigida 029                            GATGTTGGTCTCCCGTGCGCCCCT-GGCTCGCGGTTGGCCCAAAA-AC-AGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. rigida 045                            GATGTTGGTCTCCCGTGCGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. rigida 049                            GATGTTGGTCTCCCGTGCGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. rigida 057                            GATGTTGGTCTCCCGTGCGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. rostrata 007                          GATGTTGGTCTCCCGTGAGCCCTC-TGCTCGCGGTTGGCCCAAAA-ATGAGCCCAGTTGATGTTG--AACACGGC-AATCGGTGGTGT-AAAGACCCTCG
G. rostrata 091                          GATGTTGGTCTCCCGTGAGCCCCC-TGCTTGCGGTTGGCCCAAAA-TTGAGCCCTGTTGATGTTG--TACACGGC-AATCGGTGGTGT-AAAGACCCTCG
G. rostrata AB110813                     GATGTTGGTCTCCCGTGCGCCCTT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. rostrata AF367225                     GATGTTGGTCTCCCGTGAGCCCCC-TGCTTGCGGTTGGCCCAAAA-TTGAGCCCTGTTGATGTTG--TACACGGC-AATCGGTGGTGT-AAAGACCCTCG
G. rostrata BL051                        GATGTTGGTCTCCCGTGAGTCCTC-TGCTCGCGGTTGGCCCAAAA-ATCAGCCCAGTTGATGTTG--AACACGGC-AATCGGTGGTGT-AAAGACCCTCG
G. schomburgkiana AB110814               GTTGTTGGCCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. scortechinii AF367219                 GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCTAAAT-GCAAGCCTTGTTGATGATG--TGCACGAC-AATCGGTGGTTT-ACAGATCCTCT
G. scortechinii 012                      GATGTTGGTCTCCCGTGTGCCC-T-CGGTTGCGGTTGGCATAAAT-GCGAGCCTTGT-GATG-TG--TGCACGAC-AATCGGTGGTTT-ACAGACCCTCT
G. scortechinii 089                      GATGTTGGTCTCCCGTGTGCCC-T-CGGTTGCGGTTGGCCTAAAT-GCGAGCCTTGTTGATGTTG--TGCACGAC-AATCGGTGGTTT-ACAGACCCTCT
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G. scortechinii K04	GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCTAAAT-ACGAGCCTTGTTGACGTTG--TGCACGAC-AATTGGTGGTTT-ACAGACCTTCT
G. sp. AJ312607	GATGTTGGCCTCCCGTGTGCCCTG-TGCTCGTGGTTGGCCCAAAT-ATGAGTCGCGTTGATGTTG--TACACGAC-AATCGGTGGTTT-AAAGACCTTCG
G. sp.B1 008	GTTGTTGGCCTCCCGTGCGCCCTT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. sp.B2 011	GTTGTTGGCCTCCCGTGCGCCCTT-TGCTCGCGGTTGGCCCAAAT-ATGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. sp.D1 064	GATGTTGGTCTCCCGTGAGCCCCT-TGCTCGCGGTTGGCCCAAAA-ATGAGCCCTGTTGATGTTG--TACACGGC-AATCGGTGGTGT-AAAGACCCTCG
G. sp.D1 070	GATGTTGGTCTCCCGTGAGCCCCC-TGCTCGCGGTTGGCCAAAAA-ATGAGCCCTGTTGATGTTG--TACACGGC-AATCGGTGGTGT-AAAGACCCTCG
G. sp.D2 P01	GGTGTTGGTCTCCCGTGAGCCCCCCCGCTTGCGGTTGGCCCAAAA-ATGAGCCCCGTTGATGTTG--TACACGGC-AATCGGTGGTGT-GGAGACCCTCA
G. sp.D3 P02	GATGTTGGTCTCCCGTGAGCCCCC-TGCTTGCGGTTGGCCCAAAA-ATGAGCCCTGTTGATGTTG--TACACGGC-AATCGGTGGTGT-CAAGACCCTCG
G. sp.D4 BL04	GATGTTGGTCTCCCGTGAGCCCCC-TGCTTGCGGTTGGCCCAAAA-ATGAGCCCTGTTGATGTTG--TACACGGC-AATCGGTGGTGT-CAAGACCCTCG
G. sp.D5 BL052	GATGTTGGTCTCCCGTGAGCCCCC-TGCTTGCGGTTGGCCCAAAA-ATGAGCCCTGTTGATGTCG--TACACGGC-AATCGGTGGTGT-AAAGACCCTCG
G. sp.D6 K12	GATGTTGGTCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCCAAAT-ACGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. spicata 019	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTT-TTGATGCTG--TACACGAA-AATCGGTGGTTT-AAAGACCCTCG
G. sp.M1 025	GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCCAAAT-ACGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. sp.M2 068	GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCCAAAT-ACGAGCTTTGTTGACATTG--TGCAGGAC-AATCGGTGGTTT-ATAGACCCTCT
G. sp.M3 072	GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCCAAAT-ACGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. sp.M4 022	GATGTTGGTCTCCCGTGTGCCCCT-CGGTTGCGGTTGGCCCAAAT-ACGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. sp.M5 069	GATGTTGGTCTCCCGTGTACCCCT-CGGTTGCGGTTGGCCCAAAT-ACGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. sp.M5 073	GATGTTGGTCTCCCGTGTACCCCT-CGGTTGCGGTTGGCCCAAAT-ACGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATAGACCCTCT
G. sp.M6 093	GATGTTGGCCTCCCGTGTGCCCCT-TGGTTGCGGTTGGCCCAAAT-AAGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATTAACCCTCT
G. sp.M6 094	GATGTTGGCCTCCCGTGTGCCCCT-TGGTTGCGGTTGGCCCAAAT-AAGAGCCTTGTTGACATTG--TGCACGAC-AATCGGTGGTTT-ATTAACCCTCT
G. sp.X1 052	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. sp.X2 080	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. syzygifolia AB110815	GATGTTGGTCTCCCGTGCGCCCCT-GGCTCGCGGTTGGCCCAAAA-ACGAGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTT-ACAGACCCTCG
G. tinctoria AB110817	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. trianii K02	GATGTTGGTCTCCCGTGCGCCCCT-TGCTCGCGGTTGGCCAAAAT-ACGTGCCTTGTTGATGTTG--TACACGGC-AATCGGTGGTTTTACAGACCCTCG
G. urophylla 001	GATGTTGGTCTCCCGTGTGCCCCT-CAGTTGCGGTTGGCCTAAAT-GCGAGCCTTGTTGACGTTG--TGCACGAC-AATCGGTGGTTT-ACAGACCCTCT
G. urophylla 081	GATGTTGGTCTCCCGTGTGCCCCT-CAGTTGCGGTTGGCCTAAAT-GCGAGCCTTGTTGACGTTG--TGCACGAC-AATCGGTGGTTT-ACAGACCCTCT
G. vilersiana AB110818	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTTTGATGTTG--TACACGGC-AATCGGTGGTTT-TAAGACCCTCG
G. xanthochymus AB110819	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. xanthochymus 034	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. xanthochymus 092	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. xanthochymus BB03	GATGTTGGTCTCCCGTGTGCCATC-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
G. xanthochymuscf 032	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGAC-AATCGGTGGTTT-AAAGACCCTCG
Symphonia globulifera AY682919	GACGTTGGTCTCCCGTGTGCCCCT--CGTCGCGGTTGGCCCAAAT-ACGAGCCCTGTTGATGATA--TGCACGGT-GATCGGTGGTTT-AAGGACCCTCG
Tripetalum cymosum AY145206	GATGTTGGTCTCCCGTGTGCCATT-TGCTCGCGGTTGGCCCAAAC-ACAAGCCTCTCTGATGTTG--TACACGGC-AATCGGTGGTTT-AAAGACCCTCG
Clusia rosea	GATATTGGTCTCCCGTGTGCCCTT--GATCGCGGTTGGCCCAAAATATGAGCCTCGATGACTCTG--GTCACGAC-GATCGGTGGTTT-GTAGACCCTAG

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                                                610       620       630       640       650       660       670       680
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G. acuminata AB110796                    GACAATGTC-GTGAACTC-CTGTCGTATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAGAA???????
G. acuticosta BB01                       GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCC-ATGCAT-TCTTTGCATGATCGAAAAGCGACCCC
G. atroviridis AF367211                  GATAGTGTC-GTGCACTC-TCGTCGCATT-GGCATTAAAGGCCCCA-ATGCAA-TTATTGCATGATCTTCAAACAA????
G. atroviridis AB110797                  GATAGTGTC-GTGCACTC-TCGTCGCATT-GGCATTAAAGGCCCCA-ATGCAA-TTATTGCATGATCTTCAAA???????
G. balica 021                            GACAATGTC-GTGCATTC-CTGTCGCATC-GGTGTTAATGGCCCCA-GTGCAA-TCATTGCATGATCACAGAGCGACCCC
G. bancana AF367212                      GATAGTGTT-GTGCACTC-TCGTCTCATT-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATACTATCGTAAACAA???
G. cataractalis 077                      GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAACGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 002                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 003                          GACAATGTC-GTGCACTC-TCATCGAAT--GGCATTAATGGCCCCA--TGCAT-TCTTTGCATGATC-CAA-GC-ACCCC
G. celebica 005                          GACAATGTC-GTGCACTC-TCATCGAAT--GGCATTAATGGCCCCA--TGCAT-TCTTGGCAT-ATCCCAAC-CAACCC?
G. celebica 009                          GACAATGTT-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAAGCGACCC
G. celebica 023                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCC-ATGCAT-TCTTTGCATGATCGCAAAGCGACCTC
G. celebica 027                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 028                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAA-GCGACCC
G. celebica 033                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 038                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 043                          GACAATGTC-GTGCACTC-TCATTGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 054                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 059                          GACAATGTT-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCA--TCTTTGCATGATCGCAAAGCGACCCC
G. celebica 062                          GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. celebica AB110816                     GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAA???????
G. celebica AB110813                     GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAA???????
G. celebica AB110814                     GACAATGTC-GTGCACTC-TCATCGAATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAA???????
G. celebica AF367214                     GACAATGTT-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAAA??????
G. costata BL03                          GACAATGTC-GTGCACTC-TCGTCGCATT-GGCATCAATGGCCCCG-ATGCAA-TCATTGCATGATCTCGAAGCGACCCC
G. costata BL06                          GACAATGTC-GTGCACTC-TCGTCGCATT-GGCATCAATGGCCCCG-ATGCAA-TCATTGCATGATCTCGAAGCGACCCC
G. costata AB110798                      GACAACGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAA????????
G. cowa 004                              GATAGTGTT-GTGCACTC-TCGTCTCATT-GGCATTAATGGCCCCTAATGCAA-TCATTGCATACTATCGTAGCGACCCC
G. cowa 013                              GATAGTGTT-GTGCACTC-TCGTCTCACCTGGCATTAATGGCCCCA-ATGCAA-TCATTGCATACTATCGTAGCGACCCC
G. cowa AB110799                         GATAGTGTT-GTGCACTC-TCGTCTCACT-GGCATTAATGGCCCCA-ATGCAA-TCATTGCATACTATCGTAGA??????
G. cowa AF367216                         GATAGTGTT-GTGCACTC-TCGTCTCATT-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATACTATCGTAGACAA???
G. cymosa 037                            GACAATGTC-GTGCACTC-GCGTCACCTT-GGCATT--TGGCCCCA-ATGCGG-T--TCGCATGATCTCAA-GCGACCCC
G. cymosa 042                            GACTGTGCC-GTGCACTC-TCGTCACCTT-GGCCCT--TGGCCCCA-ATGCGG-TCGCTGCATGATATTGAAGCGACCCC
G. diospyrifolia var. arborea BB02       GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAACGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. diospyrifolia var. arborea BB05       GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAACGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. diospyrifolia var. diospyrifolia 078  GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAACGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. diospyrifolia var. minor AF367227     GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAACGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGA??????
G. diospyrifolia var. minor BB06         GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAACGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. discoidea SL01                        GACAATGTC-GTGCACTC-TCATAGCATT-GGCA??????????????????????????????????????????????
G. discoidea SL02                        GACAATGTC-GTGCACTC-TCATCGCATT-GGCATT????????????????????????????????????????????
G. dulcis 050                            AACAACGTC-GTGCACTC-TCGTCACATT-GGCACCAGTACCCCCA-GAGCAA-TCGTTGCATGCTCATAA-GCGACCCC
G. dulcis AB110800                       GATAGCGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAA????????
G. dulcis AB110801                       GATAGCGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAA????????
G. echinocarpa 035                       GACAATGTC-GTGCACTC-TCATCGCATC-GGCATTAATGGCCCCA-ATGCAA-TCATTGCA-GATCA????????????
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G. forbesii AF367224	GATAGTGTT-GTGCACTC-TCGTCTCATT-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATACTATCGTAAACAA???
G. forbesii AF67223	GATAGTGTT-GTGCACTC-TCGTCTCATT-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATACTATCGTAAAACAA??
G. globulosa AF367221	GATAGTGTT-GTGCACTC-TCGTCTCACT-GGCATTAATGGCCCCA-ATGCAA-TCATTGCATACTATCGTAA???????
G. hanburyi AB110802	GACAATGTC-GTGAACTC-CTGTCGTATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAGAA???????
G. laterifolia 040	GACAATGTC-GTGAACTC-CTATCGCATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAAAGCGACCC?
G. latissima 026	GACAATGTC-GTGCACTC-CTGTCGCATC-GGTGTTAATGGCCCCA-GTGCAA-TCATTGCATGATCACAGAGCGACCCC
G. latissima AF479789	GACAATGTC-GTGCACTCCTCATCGCTTT-GGCACCAATGGGCCCA-AAGCAAATCATTGCAAGCTCAG???????????
G. madruno AJ509215	GACAATGTC-GTGCACTC-TCATCGCTTT-GGCACCAATGGACCCA-AAGCAAATCATTGCAAGCTCACAAAGCGACCCC
G. maingayi 098	GACAATGTC-GTGCACTC-TCTTCTCATT-GGCGTTAATGGCCCCG-ATGCAA-TCATTGCATGATCTCGATGCGACCCC
G. malaccensis AB110810	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAA???????
G. malaccensis AB110811	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAA???????
G. malaccensis var. malaccensis BB04	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. malaccensis var. malaccensis BB08	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. malaccensis var. malaccensis BB09	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. malaccensis var. pseudomangostana SP01	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. mangostana 096	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. mangostana AB110807	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAA???????
G. mangostanaAB110808	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAA????????
G. mangostanaAB110809	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAA????????
G. mangostanaAB110810	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAA????????
G. mangostanaAB110811	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAA????????
G. mangostanaAF367215	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAAA??????
G. mangostanaAJ509214	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCATAGCGACCCC
G. mangostanaLAO	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCT-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. megaphylla030	GACAATGTC-GTGCACTC-TCATCGGTTT-GGCACCAATGGGCCCA-AAGCAAATCATTGCAAGCTCACAAAGCGACCCC
G. megaphylla041	GACGACGTC-GTGCACTC-TCGTCACATT-GGCACTGATACCCCCA-AAGCAA-TCGTTGCATGCTCATAA-GCGACCCC
G. nervosaAF367222	GACAACGTC-GTGCACCC-TCGTCACATT-GGCACTAATACCCCCA-A-GCAA-TCGTTGCATGCTCATAAAACA?????
G. nigrolineataAF367216	GATAGTGTT-GTGCACTC-TCGTCTCATT-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATACTATCGTA-ACAA???
G. nitida119	GACAATGTC-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. penangiana006	GACAATGTT-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATTGCAAAGCGACCCC
G. penangiana AF367226	GACAATGTT-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATTGCAAAA???????
G. penangianaBB07	GACAATGTT-GTGCACTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAGCGACCCC
G. picrorhiza039	GATAGTGTC-GTGCACTC-TTATCACCTT-GGCTCTCCTG-CCCCA-ATGCAA-TCATTGCATGATCTTGAAGTGACCCC
G. porrecta AB110812	GATAGTGTT-GTGCACTC-TCGTCTCATT-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATACTATCGTAA???????
G. prainiana AF367218	GACAATGCT-GTGCACCC-TTGTCACATC-GGCGCT--TGGCCCCA-ATGCAAATGA-TGCATGATCCCAAACACAA???
G. rigida 029	GACAATGTC-GTGTACTC-TCATCGCACT-GGCATTAACGGCCTCA-ATGCAT-TCTTTACATGATCGCAAAGCGACCCC
G. rigida 045	GACAATGTC-GTGTACTC-TCATCGCACT-GGCATTAACGGCCTCA-ATGCAT-TCTTTACATGATCGCAAAGCGACCCC
G. rigida 049	GACAATGTC-GTGTACTC-TCATCGCACT-GGCATTAACGGCCTCC-ATGCAT-TCTTTACATGATCGCAAAGCGACCCC
G. rigida 057	GACAATGTC-GTGTACTC-TCATCGCACT-GGCATTAACGGCCTCC-ATGCAT-TCTTTACATGATCGCAAAGCGACCCC
G. rostrata 007	GACAATGTC-GTGCACTC-ATGTCACGCC-GGAGCTAATGGCCCTA-ATGCAA-TCATTGCATGATATCGAAGCGACCCC
G. rostrata 091	GACAATGTC-GTGCGCTC-ATGTCACATC-GGTGCTAATGGCCCTA-ATGCAA-TCATTGCATGATATTGAAGCGACCCC
G. rostrata AB110813	GACAATGTC-GTGCAcTC-TCATCGCATT-GGCATTAATGGCCCCA-ATGCAT-TCTTTGCATGATCGCAAAAA??????
G. rostrata AF367225	GACAATGTC-GTGCGCTC-ATGTCACATC-GGTGCTAATGGCCCTA-ATGCAA-TCATTGCATGATATTGAAA???????

G. rostrata BL051	GACAATGTC-GTGCCCTC-ATGTCACGTC-GGAGCTAATGGCCTTA-ATGCAA-TCATTGCATTATATCGAAGCGACCCC
G. schomburgkiana AB110814	GATAGTGTT-GTGCACTC-TCGTCTCACT-GGCATTAATGGGCCTA-ATGCAA-TCATCGCATACTATCATAA???????
G. scortechinii AF367219	GACAATGTC-GTGAACTC-CTATCGCATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAAAA???????
G. scortechinii 012	GACAATGTC-GTGAACTC-CTATCGCATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAGAGCGACCCC
G. scortechinii 089	GACAATGTC-GTGAACTC-CTATCGCATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAGAGCGACCCC
G. scortechinii K04	GACAATGTCCGTGCACTC-CTGTCGCATC-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATGATCACAGAGCGACCCC
G. sp. AJ312607	GACAATGTC-GTGCACTC-TCATCGCTTT-GGCACCAATGGACCCA-AAGCAAATCATTGCAAGCTCACAAAGCGACCCC
G. sp.B1 008	GATAGTGTT-GTGCACTC-TCGTCTCACT-GGCATTAATGGCCCTG-ATGCAA-TCATTGCATACTATCGTAGCGACCCC
G. sp.B2 011	GATAGTGTT-GTGCACTC-TCGTCTCACT-GGCATTAATGGCCCTA-ATGCAA-TCATTGCATACTATCGTAGCGACCCC
G. sp.D1 064	GACGATGTC-GTGCGCTCATGTCCACATC-GGTGCTAATGGCCCTC-ATGCAA-TCATTGCATCATATTGAAGCAACCCC
G. sp.D1 070	GACGATGTC-GTGCGCTCATGTCAC-ATC-GGTGCTAATGGCCCTA-ATGCAA-TCATTGCATGATATTGAAGCGACCCC
G. sp.D2 P01	GACGATGCC-GTGCGCTC-ATGTCACATC-GGTGGTAGTGGCCCCG-ATGCAG-TCTTTGCATGAT??????????????
G. sp.D3 P02	GACAATGCC-GTGTGCTC-ATGTCACCTC-GGTGCTAATGGCCCTA-ATGCAA-TCATTGCATGATATTAAAGCGACCCC
G. sp.D4 BL04	GACAATGTC-GTGTGCTC-ATGTCACGTC-GGTGGTGGTGGCCTTG-ATGCAA-TCATTGCA-CATAT????????????
G. sp.D5 BL052	GATAATGTC-GTGCGCTC-GTGTCACATC-GGTGCTAATGGCCCTA-ATGCAA-TCATTGCATGATATTGAAGCGACCCC
G. sp.D6 K12	GACAATGTC-GTGCACTC-TCGTCGCATT-GGCATCAATGGCCCCG-ATGCAA-TCATTGCATGATCTCGAAGCGACCCC
G. spicata 019	GACAACGTC-GTGCATTC-TCGTCACATT-GGCAGTAATGCCCCCA-GAGCAA-TCGTTGCATGCTCATAAAGCGACCTC
G. sp.M1 025	GACAATGTC-GTGCACTC-CTGTCGCATC-GGTGTTAATGGCCCCA-GTGCA--TCATTGCATGATCACAGAGCGACCCC
G. sp.M2 068	GACAATGTC-GTGCACTC-CTGTCGCATC-GGTGTTAATGGCCCCA-GTGCAA-TCATTGCATGATCACAGAGTGACCTC
G. sp.M3 072	GACAATGTC-GTGCACTC-CTGTCGCATC-GGTGTTAATGGCCCCA-GTGCAA-TCATTGCATGATCACAGAGCGACCCC
G. sp.M4 022	GACAATGTC-GTGCACTC-CTGTCGCATC-GGTGTTAATGGCCCCA-GTGCCA-TCATTGCATGATCACAGAGCGACCCC
G. sp.M5 069	GACAATGTC-GTGCACTC-CTGTCGCATC-GGTGTTAATGGCCCTA-GTGCAA-TCATTGCATGATCACAGAGCGACCCC
G. sp.M5 073	GACAATGTC-GTGCACTC-CTGTCGCATC-GGTGTTAATGGCCCTA-GTGCAA-TCATTGCATGATCACAGAGCGACCCC
G. sp.M6 093	GACAATGTC-GTGCACTC-TTGTCGCATC-GGGGTT-ATGGCCC---ATGCAA-TCATTGCATGATCACAGA????????
G. sp.M6 094	GACAATGTC-GTGCACTC-TTGTCGCATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAGAGCGACCCC
G. sp.X1 052	GACGACGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAAGCGACCCC
G. sp.X2 080	GACAATGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAAGCGACCCC
G. syzygifolia AB110815	GACAATGTC-GTGTACTC-TCATCGCACT-GGCATTAACGGCCTCA-ATGCAT-TCTTTACATGATCGCAAAA???????
G. tinctoria AB110817	GACAACGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAA????????
G. trianii K02	GACAATGTC-GTGCACTC-TCGTCTCATT-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCTTGATGCGACCCC
G. urophylla 001	GACAATGTC-GTGAACTC-CTGTCGCATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAGAGCGACCCC
G. urophylla 081	GACAATGTC-GTGAACTC-CTGTCGCATC-GGCGTTAATGGCCCCA-ATGCAA-TCATTGCATGATCACAGAA???????
G. vilersiana AB110818	GACAACGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAA????????
G. xanthochymus AB110819	GACAACGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAA????????
G. xanthochymus 034	GACAACGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAAGCGACCCC
G. xanthochymus 092	GACAATGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAAGCGACCCC
G. xanthochymus BB03	GACAATGTC-GTGCACTC-TCGTCACATT-GGCACTAATACCCCCA-AAGCAA-TCGTTGCATGCTCATAAAGCGACCCC
G. Xanthochymus cf. 032	GACAACGTC-GTGCATTC-TCGTCACATT-GGCACTAATACCCCCA-GAGCAA-TCGTTGCATGCTCATAA?????????
Symphonia globulifra AY682919	GAATATGTC-GTGCACTC-TCGTCACCTC-GGCACTGACGTCCTCA-GGGCA-TCATAACGCGACCCCAG??????????
Tripetalum cymosum AY145206	GACGACGTC-GTGCGC??
Clusia rosea	GACATCGTC-GTGCGCCG-CTGTCTCTTG-GTCACCGACGGCCCGA-AAAAGCATAACTGCTTGCTCCTAATGCGACCCC

Matrix of *trn*S-*trn*G sequences and binary gap coded characters. Asterices indicate excluded characters in the phylogenetic analysis.

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                                                  10        20        30        40        50        60        70        80        90       100
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                         TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_balica 021                              TGTCTATGA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_cataractalis 077                        TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_celebica 002                            TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATT-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_celebica 003                            ??????????????????????????????????????????????TA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTTCAATATAT
G_celebica 009                            TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATT-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_celebica 023                            TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_celebica 027                            GGTCTATAA-ATAACCCTATT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTC-AATATAT
G_celebica 033                            TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATT-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_celebica 059                            TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_celebica 28                             TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_costata BL03                            TCTTATCACAATAATTACCCTCTGTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAAAAGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_cymosa 037                              TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTA-CGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_cymosa 042                              TGTCTATAA-ATAACCCTATT--GTC-GAGTAAGAGTATG-A-GGATA-AGATCCTAAA-AGAATCATA------ATCAAAATTACAGTGTT-AATATAT
G_diospyrifolia var. minor BB06           GGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATACTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_diospyrifolia var. diospyrifolia 078    TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_discoidea SL01                          TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_dulcis 050                              GGTCTATAA-ATAACCCTATT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATAAAAATTACAGTGTT-AATATAT
G_forbesii 024                            GGATTATCG-ATTACCCTATT--GTC-GAGTAAGAGTATGGA-GTATA-AGATCCAAAA-AGAATCATC------ATCAAAATTATAGTGTT-AATATAT
G_lateriflora 040                         TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGAGAGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_magostana LAO                           TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_malaccensis var. malaccensis BB08       TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_malaccensis var. malaccensis BB09       TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_malaccensis var pseudomangostana SP01   TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATTCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_mangostana 096                          TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_megaphylla 041                          GGTCTATAA-ATAACCCTTTT--GTC-GAGGAAGAGTATGGA-GGATA-GGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_nitida 119                              AGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_penangiana 006                          TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_picrorhiza 039                          TGTCTATAA-ATAACCCTATT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_rigida 029                              ??TCTATAG-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------AWCAAAATTACAGTGTT-AATATAT
G_rigida 045                              GGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_rigida 049                              ????????A-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_rigida 057                              TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_rostrata 007                            ???????????????????????????????????????????????????????????????ATCATCGACGAAATCACAATTACAGTGTT-AATATAT
G_rostrata 09091                          TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATAGGATACCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_scortechinii 089                        ???????????????????????????????????????????????????????????????????????????ATCAAAATTACAGTGTT-AATATAT
G_sp. B1 011                              ?????????????????????????????????????????????????AGGAAAAAAA-AGAATCATC------ATCAAAAATATAGTGTC-AATATAT
G_sp. D1 064                              GGACTATAG-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-GGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_sp. D1 07071                            ????????????TCAACATTT--GTA-GAGTAAGAGTATCCCAGGATAGCGATAATAAACAGAATCATC------ATCCAAATTACTGTGTT-AATATAT
G_sp. D3 P02                              TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-GGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_sp. M4 022                              GGTCTATGA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
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G_sp. M5 069                             TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_sp. M6 093                             TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATAGAGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_sp. M6 094                             ???????????????????????GTC-CAGTAAGAGTATGGA-CGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_sp. X1 052                             GGACTATGA-ATAACCCTTTT--GTC-GAGGAAGAGTATGGGAGGATA-GGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_sp. X2 080                             GGACTATGA-ATAACCCTTTT--GTC-GAGGAAGAGTATGGGAGGATA-GGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_trianii K02                            TGTCTATAA-ATAACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-AGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT
G_urophylla 001                          GCATGATCG-ATTACCCTTTT--GTC-GAGTAAGAGTATGGA-GGATA-GGATCCTAAA-AGAATCATC------AACAAAATTACAGTGTT-AATATAT
G_urophylla 081                          ????????????????????????????????????????????????????????????????????????????????????????????????????
G_xanthochymuscf 032                     GGTCTATAA-ATAACCCTTTT--GTC-GAGGAAGAGTATGGA-GGATA-GGATCCTAAA-AGAATCATC------ATCAAAATTACAGTGTT-AATATAT


                                            110       120       130       140       150       160       170       180       190       200
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_balica 021                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_cataractalis 077                       -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_celebica 002                           -TGTATCTCTT-CAGGGAACCCAACGAGATTCG-AAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_celebica 003                           -TGTATCTCTT-CAGGGAACCCTACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_celebica 009                           -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_celebica 023                           -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_celebica 027                           -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAAAATTGGATTCTCTACCA
G_celebica 033                           -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_celebica 059                           -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_celebica 28                            -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_costata BL03                           -TGTATCTCTTACAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_cymosa 037                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTTTATATCATTCGTATAGAATTTGATTCTCTATCA
G_cymosa 042                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTTATTTCTATATCATTCGTATAAAATTGGATTCTCTATCA
G_diospyrifolia var. minor BB06          -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_diospyrifolia var. diospyrifolia 078   -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_discoidea SL01                         -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_dulcis 050                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_forbesii 024                           -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_lateriflora 040                        -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_magostana LAO                          -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_malaccensis var. malaccensis BB08      -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_malaccensis var. malaccensis BB09      -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_malaccensis var. pseudomangostana SP01 -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_mangostana 096                         -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_megaphylla 041                         -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCATTAATTGTTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_nitida 119                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_penangiana 006                         -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTACCA
G_picrorhiza 039                         ATGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_rigida 029                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_rigida 045                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_rigida 049                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
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G_rigida 057                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_rostrata 007                           -TGTATCTCTT-CAGGGAACCCAACGAAATTCG-AAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_rostrata 09091                         -TGTATCTCTT-CAGGGAACCCAACGAGATTCG-AAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_scortechinii 089                       -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. B1 011                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAAAATTTGATTCTCTATCA
G_sp. D1 064                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCG-AAAAGGAAGACTCA-------TTAATGGAATACTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. D1 07071                           -TGTATCTCGC-TCAGGGACCCAACGAGATTCCGAAAAGGAAGACTCA-------TAACTGGAATACTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. D3 P02                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCG-AAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. M4 022                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. M5 069                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. M6 093                             -TGTATCTCTT-CAGGGAACCCAAC--AATTC-AAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. M6 094                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. X1 052                             -TGTATCTCTT-CCGGGAACCCAACGAGATTCGAAAAAGGAAGACTCATTAATTGTTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_sp. X2 080                             -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCATTAATTGTTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA
G_trianii K02                            -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGATTCA-------TTAATTGAATTCTATATCATTCGTATATAATTTGATTCTCTATCA
G_urophylla 001                          -TGTATCTCTT-CGGGGAACCCAACGAGATTCGAAAAAGGAAGACTCA-------TTAATTGAATTCTATATCATTCGTATAGAATTTGATTTTCTATCA
G_urophylla 081                          ????????????????????????????????????????????????????????????????????????????????????????????????????
G_xanthochymus cf. 032                   -TGTATCTCTT-CAGGGAACCCAACGAGATTCGAAAAAGGAAGACTCATTAATTGTTAATTGAATTCTATATCATTCGTATAGAATTTGATTCTCTATCA

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                                            210       220       230       240       250       260       270       280       290       300
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_balica 021                             TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_cataractalis 077                       TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 002                           TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 003                           TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 009                           TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 023                           TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 027                           TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 033                           TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 059                           TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_celebica 28                            TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_costata BL03                           TACTCGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_cymosa 037                             TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTC------TTTTTGATTCA
G_cymosa 042                             TACGCGTGGAAATAGTTCTAC--------------------TTAA-AATTG----------TTTTGA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_diospyrifolia var. minor BB06          TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_diospyrifoliavardios 078               TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_discoidea SL01                         TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_dulcis 050                             TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_forbesii 024                           TACGCGTGGAAATAGTTCTACTTAGAATTGTTTTTTTCTACTTAG-AATTG----------TTTTTATTTTCAATAAGAACTC------TTTTTGATTCA
G_lateriflora 040                        TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG---------TTTT-TA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_magostana LAO                          TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB08       TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB09       TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_malaccensis var. pseudomangostana SP01 TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
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G_mangostana 096                        TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_megaphylla 041                        TACACGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTC-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_nitida 119                            TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_penangiana 006                        TACGCGTGGAAATAGTTCTAC-------------------------------------------------------------------------------
G_picrorhiza 039                        TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTG---------TTTT-TA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_rigida 029                            TACGCGTGGAAATAGTTCTAC--------------------TTAGAATTGTTTTTTTTTTTTTTTTTTTCACATTAAAAACTCTTTTGGTTTTAAATTCA
G_rigida 045                            TACGCGTGGAAATAGTTCTAC--------------------TTAGAAATTG----------TTTTTT---------------------------------
G_rigida 049                            TACGCGTGGAAATAGTTCTAC--------------------TTAGAAATTG----------TTTTTTTTTTCAATAAGAACTCGTTTTGTTTTTGATTCA
G_rigida 057                            TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTGTTTTTTTTTTTTTTTTTTTTCAATTAAAACCCCTTTTGTTTTTGATTCA
G_rostrata 007                          TACGCGTGGAAATAGTTCTACTTAGAA--------------TTAG-AATTG----------TTTTTC-TTTCAATA------CGTTTTGTTTTTGAATCA
G_rostrata 09091                        TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTC-TTTCAATA------CGTTTTGTTTTTGAATCA
G_scortechinii 089                      TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTGTGAATCA
G_sp. B1 011                            TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCTTTTTG------ATTCA
G_sp. D1 064                            TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTG-----------TTTTC-TTTCAATA------CGTTTTGTTTTTGAATCA
G_sp. D1 07071                          TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTC-TTTCAATA------CGTTTTGTTTTTGAATCA
G_sp. D3 P02                            TACGCGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTC-TTTCAATA------CGTTTTGTTTTTGAATCA
G_sp. M4 022                            TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_sp. M5 069                            TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_sp. M6 093                            TACGTGTGGAAATAGTTTCAC--------------------TTAG-AATTG---------TTTTTAA-TTTCAATAAGAAACTCTTTTGTTTTTGAATCA
G_sp. M6 094                            TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_sp. X1 052                            TACACGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTC-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_sp. X2 080                            TACACGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTC-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_trianii K02                           TACGCGTGGAAATAGTTCTACTTAGAATTG--------------G-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_urophylla 001                         TACGTGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTA-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA
G_urophylla 081                         ????????????????????????????????????????????????????????????????????????????????????????????????????
G_xanthochymuscf 032                    TACACGTGGAAATAGTTCTAC--------------------TTAG-AATTG----------TTTTTC-TTTCAATAAGAACTCGTTTTGTTTTTGAATCA

                                           310       320       330       340       350       360       370       380       390       400
                                        ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                       ----------------------------------------------------------------------------------------------------
G_balica 021                            AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_cataractalis 077                      ----------------------------------------------------------------------------------------------------
G_celebica 002                          ----------------------------------------------------------------------------------------------------
G_celebica 003                          ----------------------------------------------------------------------------------------------------
G_celebica 009                          ----------------------------------------------------------------------------------------------------
G_celebica 023                          ----------------------------------------------------------------------------------------------------
G_celebica 027                          ----------------------------------------------------------------------------------------------------
G_celebica 033                          ----------------------------------------------------------------------------------------------------
G_celebica 059                          ----------------------------------------------------------------------------------------------------
G_celebica 28                           ----------------------------------------------------------------------------------------------------
G_costata BL03                          CAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCAGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_cymosa 037                            AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_cymosa 042                            AAAAGAGAATTTT-GTTGACTCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTTGTGGAAATATAAAGGGACTTTCC--------------------
G_diospyrifolia var. minor BB06         ----------------------------------------------------------------------------------------------------
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G_diospyrifolia var. diospyrifolia 078   ----------------------------------------------------------------------------------------------------
G_discoidea SL01                         ----------------------------------------------------------------------------------------------------
G_dulcis 050                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_forbesii 024                           AAAAGAGAATTTT-GTTGACCCCAATCGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTCGGGCGAAAATAGAAAGGGAC
G_lateriflora 040                        AAAAGAGAATTTT-GTTGACCCCAATTGGGTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_magostana LAO                          ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB08       ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB09       ----------------------------------------------------------------------------------------------------
G_malaccensis var. pseudomangostana SP01 ----------------------------------------------------------------------------------------------------
G_mangostana 096                         ----------------------------------------------------------------------------------------------------
G_megaphylla 041                         AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_nitida 119                             ----------------------------------------------------------------------------------------------------
G_penangiana 006                         ----------------------------------------------------------------------------------------------------
G_picrorhiza 039                         AAAAAAGAA------TTGACCCCAATTGGTTGGAACAAAAAAGGTATCGGTGGGTTCTTGGAAATAGAAAGGGACTTTTC--------------------
G_rigida 029                             AAAAAAAAATTTTGGTTAACCCCCATTGGTTGGAAA-CCAAAGGTTTTGGGGGGTTTCTTGAAATAGAAAGGGACTTTTC--------------------
G_rigida 045                             ------------------------------------------------------------------------GAC--TTC--------------------
G_rigida 049                             AAAAGAGAATTTT-GTTGACCCCAATTGG-TGG-ACCAAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_rigida 057                             AAAAGAGAATTTT-GTTGACCCCAATTGG-TGG-ACCAAAAAGGTATCGGTGGGTTCGTGGAAATAAAAAGGGACTTTTC--------------------
G_rostrata 007                           AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGCGGGTTCGTGGAAATAGAGAGGGACTTTTC--------------------
G_rostrata 09091                         AAAAGAGAATTTT-GTTGACCCCAATTGGTTAGAAC-AAAAAGGTATCGGCGGGTTCGTGGAAATAGAGAGGGACTTTTCG-------------------
G_scortechinii 089                       AAAAGAGAATTTT-GTTGACCCCAATGGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_sp. B1 011                             AAAAGAGAATTTT-GTTGACCCCAATCGGTTGGAAC-AAAAAGGTATCGGCGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_sp. D1 064                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGCGGGTTCGTGGAAATAGAGAGGGACTTTTC--------------------
G_sp. D1 07071                           AAAAGAGAATTAT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGCGGGTTCGT-GAAATAGAGAGGGACTTTTC--------------------
G_sp. D3 P02                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGCGGGTTCGTGGAAATAGAGAGGGACTTTTCGGACGAAATTAGA-------
G_sp. M4 022                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_sp. M5 069                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_sp. M6 093                             AAAGAGAATTTTG-TTGAACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTC-TGGAAATAGAAAGGGACTTTTC--------------------
G_sp. M6 094                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_sp. X1 052                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_sp. X2 080                             AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_trianii K02                            AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAATTGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_urophylla 001                          AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------
G_urophylla 081                          ????????????????????????????????????????????????????????????????????????????????????????????????????
G_xanthochymuscf 032                     AAAAGAGAATTTT-GTTGACCCCAATTGGTTGGAAC-AAAAAGGTATCGGTGGGTTCGTGGAAATAGAAAGGGACTTTTC--------------------


                                                 410       420       430       440       450       460       470       480       490       500
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        ----------------------------------------------------------------------------------------------------
G_balica 021                             -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_cataractalis 077                       ----------------------------------------------------------------------------------------------------
G_celebica 002                           ----------------------------------------------------------------------------------------------------
G_celebica 003                           ----------------------------------------------------------------------------------------------------
G_celebica 009                           ----------------------------------------------------------------------------------------------------
G_celebica 023                           ----------------------------------------------------------------------------------------------------
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G_celebica 027                                   ----------------------------------------------------------------------------------------------------
G_celebica 033                                   ----------------------------------------------------------------------------------------------------
G_celebica 059                                   ----------------------------------------------------------------------------------------------------
G_celebica 28                                    ----------------------------------------------------------------------------------------------------
G_costata BL03                                   -----GGGCGAAATTAAAAAGGAAAAGGTCTGTACTTTTCTATTTTCATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_cymosa 037                                     -----GGGCGAAATTAAAAA------GGTCTGTACTTTTCTATTTTTATTTTTCTAAGTCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTCTAAA
G_cymosa 042                                     ------GGCGAAATTAAAAA------GGTCTGTACTACTCTATTTTTATTTTTCTAAGTCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_diospyrifolia var. minor BB06                  ----------------------------------------------------------------------------------------------------
G_diospyrifolia var. diospyrifolia 078           ----------------------------------------------------------------------------------------------------
G_discoidea SL01                                 ----------------------------------------------------------------------------------------------------
G_dulcis 050                                     -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_forbesii 024                                   TTTTCGGGCGAAATTAAAAAGGAAAAGGTCTGTACTTTTCTATTTTCATTTTTCTAAATCGAATTTTTCAATTCGAAATTT--CGAATTGATTGTATAAA
G_lateriflora 040                                -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_magostana LAO                                  ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB08              ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB09              ----------------------------------------------------------------------------------------------------
G_malaccensis var. pseudomangostana SP01         ----------------------------------------------------------------------------------------------------
G_mangostana 096                                 ----------------------------------------------------------------------------------------------------
G_megaphylla 041                                 -----GGGCGAAATTAAAAA------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTG------
G_nitida 119                                     ----------------------------------------------------------------------------------------------------
G_penangiana 006                                 ----------------------------------------------------------------------------------------------------
G_picrorhiza 039                                 -----GGGCGAAATTAAAAA------GGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTATTCAATTCGAAATTT--CGAATTGATTGTATAAA
G_rigida 029                                     -----GGGCGGAATTAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTTAATCGAATTTTTCAATTAGAAATTT--CGATTTGATTGTATAAA
G_rigida 045                                     ------GGCG-AATTAAAA-GGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGATTTGATTGTATAAA
G_rigida 049                                     -----GGGCGAAATTAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGATTTGATTGTATAAA
G_rigida 057                                     -----GGGCGAAATTAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGATTTGATTGTATAAA
G_rostrata 007                                   -----GGGCGAAATTAAAAG------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTCGAAATTT--CGAATTGATTGTATAAA
G_rostrata 09091                                 -----GGGCGAAATAAAAAG------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTCGAAATTT--CGAATTGATTGTATAAA
G_scortechinii 089                               -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_sp. B1 011                                     -----GGGCGAAATTAAAAAGGAAAAGTACAGACCTTTTCCTTTTTAATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTAATTGTATAAA
G_sp. D1 064                                     -----GGGCGAAATTAAAAG------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTCGAAATTT--CCAATTGATTGTATAAA
G_sp. D1 07071                                   -----GGGCGAAATTAAAAG------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTCGAAATTT--CGAATTGATTGTATAAA
G_sp. D3 P02                                     --------CGAAATTAAAAG------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTCGAAATTT--CGAATTGATTGTATAAA
G_sp. M4 022                                     -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_sp. M5 069                                     -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_sp. M6 093                                     -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_sp. M6 094                                     -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_sp. X1 052                                     -----GGGCGAAATTAAAAA------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTG------
G_sp. X2 080                                     -----GGGCGAAATTAAAAA------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTG------
G_trianii K02                                    -----GGGCGAAATTAAAAAGAAAAAGGTCTGTACTTTTCTATTTTCATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_urophylla 001                                  -----GGGCGAAATGAAAAAGGAAAAGGTCTGTACTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTGTATAAA
G_urophylla 081                                  ???????????????????????????????????????????????????????????????????????????AAATTT--CGAATTGATTGTATAAA
G_xanthochymuscf 032                             -----GGGCGAAATTAAAAA------GGTCTGTGCTTTTCTATTTTTATTTTTCTAAATCGAATTTTTCAATTAGAAATTT--CGAATTGATTG------
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                                            510       520       530       540       550       560       570       580       590       600
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        ----------------------------------------------------------------------------------------------------
G_balica 021                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_cataractalis 077                       ----------------------------------------------------------------------------------------------------
G_celebica 002                           ----------------------------------------------------------------------------------------------------
G_celebica 003                           ----------------------------------------------------------------------------------------------------
G_celebica 009                           ----------------------------------------------------------------------------------------------------
G_celebica 023                           ----------------------------------------------------------------------------------------------------
G_celebica 027                           ----------------------------------------------------------------------------------------------------
G_celebica 033                           ----------------------------------------------------------------------------------------------------
G_celebica 059                           ----------------------------------------------------------------------------------------------------
G_celebica 28                            ----------------------------------------------------------------------------------------------------
G_costata BL03                           TCAAATCGACGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_cymosa 037                             TCAAATCGAAGAAGTTTTCGTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_cymosa 042                             TCAAATCGAAGAAGTTTTCGTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_diospyrifolia var. minor BB06          ----------------------------------------------------------------------------------------------------
G_diospyrifolia var. diospyrifolia 078   ----------------------------------------------------------------------------------------------------
G_discoidea SL01                         ----------------------------------------------------------------------------------------------------
G_dulcis 050                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_forbesii 024                           TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATAAAAAATCA------------------
G_lateriflora 040                        TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_magostana LAO                          ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB08      ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB09      ----------------------------------------------------------------------------------------------------
G_malaccensis var. pseudomangostana SP01 ----------------------------------------------------------------------------------------------------
G_mangostana 096                         ----------------------------------------------------------------------------------------------------
G_megaphylla 041                         ----------------------------------------------------------------------------------------------------
G_nitida 119                             ----------------------------------------------------------------------------------------------------
G_penangiana 006                         ----------------------------------------------------------------------------------------------------
G_picrorhiza 039                         TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_rigida 029                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_rigida 045                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_rigida 049                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_rigida 057                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATC-ATATAAAATCA------------------
G_rostrata 007                           TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCAAATATTGATTGCTAATTG
G_rostrata 09091                         TCAAATCTAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCAAATATTGA-------TTG
G_scortechinii 089                       TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_sp. B1 011                               TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA-----------------
-

G_sp. D1 064                               TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCAAATATTGA-------
TTG
G_sp. D1 07071                           TCAAATCGAAGAAGTTTTCTTAT-----------------------------------------------------------------------------
G_sp. D3 P02                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCAAATATTGA-------TTG
G_sp. M4 022                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_sp. M5 069                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_sp. M6 093                             TCAAATCAAAGAAGTTTTCTTATTTTTTATATCTTATAGCAATCAATATAAAATATATCTTATAGCAATC-ATAT-AAATCA------------------
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G_sp. M6 094                              TCAAATCGAAGAAGTTTTCTTATTTTTTATATCTTATAGCAATCAATATAAAATATATCTTATAGCAATCAATATAAAATCA------------------
G_sp. X1 052                              ----------------------------------------------------------------------------------------------------
G_sp. X2 080                              ----------------------------------------------------------------------------------------------------
G_trianii K02                             TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_urophylla 001                           TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_urophylla 081                           TCAAATCGAAGAAGTTTTCTTATTTTTTA--------------------------TATCTTATAGCAATCAATATAAAATCA------------------
G_xanthochymus cf. 032                    ----------------------------------------------------------------------------------------------------


                                             610       620       630       640       650       660       670       680       690       700
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                         ----------------------------------------------------------------------------------------------------
G_balica 021                              -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_cataractalis 077                        ----------------------------------------------------------------------------------------------------
G_celebica 002                            ----------------------------------------------------------------------------------------------------
G_celebica 003                            ----------------------------------------------------------------------------------------------------
G_celebica 009                            ----------------------------------------------------------------------------------------------------
G_celebica 023                            ----------------------------------------------------------------------------------------------------
G_celebica 027                            ----------------------------------------------------------------------------------------------------
G_celebica 033                            ----------------------------------------------------------------------------------------------------
G_celebica 059                            ----------------------------------------------------------------------------------------------------
G_celebica 28                             ----------------------------------------------------------------------------------------------------
G_costata BL03                            -----------------------------------AATATTGAGTTAGAGATATCTTTTT-AACCCCTAACTTTACTTTTA-------------------
G_cymosa 037                              -----------------------------------AATATTCAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTTACTTTATTTAT----------
G_cymosa 042                              -----------------------------------AATATTCAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTTATTTAT---------------
G_diospyrifolia var. minor BB06           ----------------------------------------------------------------------------------------------------
G_diospyrifolia var. diospyrifolia 078    ----------------------------------------------------------------------------------------------------
G_discoidea SL01                          ----------------------------------------------------------------------------------------------------
G_dulcis 050                              -----------------------------------AATATTGAGTAGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_forbesii 024                            -----------------------------------AATATTGAGTTAGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_lateriflora 040                         -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_magostana LAO                           ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB08       ----------------------------------------------------------------------------------------------------
G_malaccensis var. malaccensis BB09       ----------------------------------------------------------------------------------------------------
G_malaccensis var. pseudomangostana SP01  ----------------------------------------------------------------------------------------------------
G_mangostana 096                          ----------------------------------------------------------------------------------------------------
G_megaphylla 041                          ----AAGATATAAAAAATATTGATTAGTTGATTGGAATATTGAGTCGGAGATGTCTTTTTAAACCCCTAACTTTACTTT---------------------
G_nitida 119                              ----------------------------------------------------------------------------------------------------
G_penangiana 006                          ----------------------------------------------------------------------------------------------------
G_picrorhiza 039                          -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_rigida 029                              -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_rigida 045                              -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_rigida 049                              -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_rigida 057                              -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
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G_rostrata 007                          CTATAAGATATAAAAAATATTGATTAGTTGATTTGAATATTGAGTTGGAAATATCTTTTT-AATCCCTAACTTGACTTT---------------------
G_rostrata 09091                        CTATAAGATATAAAAAATATTGATTAGTTGATTTGAATATTGAGTTGGAAATATCTTTTT-AATCCCTAACTTGACTTT---------------------
G_scortechinii 089                      -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_sp. B1 011                            -----------------------------------AATATTGAGTTAGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_sp. D1 064                            CTATAAGATATAAAAAATATTGATTAGTTGATTTGAATATTGAGTTGGAAATATCTTTTT-AATCCCTAACTTGACTTT---------------------
G_sp. D1 07071                          ----------------------------------------------------------------------------------------------------
G_sp. D3 P02                            CTATAAGATATAAAAAATATTGATTAGTGGATTTGAATATTGAGTGGGAAATATCTTTTT-AATCCCTAACTGGACTTT---------------------
G_sp. M4 022                            -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_sp. M5 069                            -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_sp. M6 093                            -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_sp. M6 094                            -----------------------------------AATATTGAGTTGGAGATATCTTTTA-ACCCCCTAACTTTACTTT---------------------
G_sp. X1 052                            ----AAGATATAAAAAATATTGATTAGTTGATTGGAATATTGAGTCGGAGATATCTTTTTAAACCCCTAACTTTACTTT---------------------
G_sp. X2 080                            ----AAGATATAAAAAATATTGATTAGTTGATTGGAATATTGAGTCGGAGATATCTTTTTAAACCCCTAACTTTACTTT---------------------
G_trianii K02                           -----------------------------------AATATTGAGTTAGAGATATCTTTTT-AACCCCTAACTTTACTTTAATTTATCTAATTTATTTAAA
G_urophylla 001                         -----------------------------------AATATTGAGTTGGAGATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_urophylla 081                         -----------------------------------AATATTGAGTGGAGAATATCTTTTT-AACCCCTAACTTTACTTT---------------------
G_xanthochymus cf. 032                  ----AAGATATAAAAAATATTGATTAGTTGATTGGAATATTGAGTCGGAGATATCTTTTTAAACCCCTAACTTTACTTT---------------------


                                                710       720       730       740       750       760       770       780       790       800
                                        ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                       -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_balica 021                            -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_cataractalis 077                      -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_celebica 002                          -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_celebica 003                          -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_celebica 009                          -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_celebica 023                          -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_celebica 027                          -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TGGAGGGATACAT
G_celebica 033                          -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_celebica 059                          -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_celebica 28                           -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_costata BL03                          --TTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_cymosa 037                            -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGAATTAATTTA------TTTAGGGATTCAT
G_cymosa 042                            -ATTTATCTAATTTATTTAAATGGTATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------T------------
G_diospyrifolia var. minor BB06         -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_diospyrifolia var. diospyrifolia 078  -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_discoidea SL01                        -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_dulcis 050                            -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_forbesii 024                          -ATTTATCTAATTTATTTAAAGGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTCATTTA------TTTAGGGATTCAT
G_lateriflora 040                       -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATCTTGATTTTTTTAGGGATTCA-TTTTTTTAGGGATTCATTTT------TTTAGGGATTCAT
G_magostana LAO                         -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_malaccensis var. malaccensis BB08     -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_malaccensis var. malaccensis BB09     -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
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G_malaccensis var. pseudomangostana SP01 -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_mangostana 096                         -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_megaphylla 041                         -ATTTATCTAATTTATTTTAATGATATTTTTTAGTAGATC----------------TGGATTTTTTTTAGGGATTTATTTATTTTTATTTAGGGATTCAT
G_nitida 119                             -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_penangiana 006                         -----------TTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATACAT
G_picrorhiza 039                         -ATTTATCTAATTTATTTTTATAATGTTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTCATCTA------TTTAGGGATTCAT
G_rigida 029                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_rigida 045                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_rigida 049                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_rigida 057                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_rostrata 007                           -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTCATTTA------TTTAGGAATTCAT
G_rostrata 09091                         -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTCATTTA------TTTAGGAATTCAT
G_scortechinii 089                       -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTGAGGGATTCAT
G_sp. B1 011                             AATTTATCTAATTTATTTAAAGGATATTTTTTAGTAGATC----------------TTGATTTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_sp. D1 064                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTCATTTA------TTTAGGGATTCAT
G_sp. D1 07071                           ----------------------------------------------------------------------------------------------------
G_sp. D3 P02                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTCATTTA------TTTAGGAATTCAT
G_sp. M4 022                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_sp. M5 069                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_sp. M6 093                             -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_sp. M6 094                             -ATTTATCTAATTAATTTAAATGATATTTTTTAGTACATC----------------TTGA--TTTTTTAGGGATTAATTTA------TTTAGGGATCCAT
G_sp. X1 052                             -ATTTATCTAATTTATTTTAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTTATTTATTTTTATTTAGGGATTCAT
G_sp. X2 080                             -ATTTATCTAATTTATTTTAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTTATTTATTTTTATTTAGGGATTCAT
G_trianii K02                            AATTTATCTAATTTATTAAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_urophylla 001                          -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTAATTTA------TTTAGGGATTCAT
G_urophylla 081                          -ATTTATCTAATTTATTTAAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTCATTTA------TTTAGGGATTCAT
G_xanthochymus cf. 032                   -ATTTATCTAATTTATTTTAATGATATTTTTTAGTAGATC----------------TTGA-TTTTTTTAGGGATTTATTTATTTTTATTTAGGGATTCAT


                                            810       820       830       840       850       860       870       880       890       900
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_balica 021                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_cataractalis 077                       TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_celebica 002                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTTATTTC--------------ATCTAGAAA
G_celebica 003                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTTATTTC--------------ATCTAGAAA
G_celebica 009                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_celebica 023                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_celebica 027                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTATATGAACTTAGCTAATTTC--------------ATCTAGAAA
G_celebica 033                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_celebica 059                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_celebica 28                            TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_costata BL03                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTC--------------ATCTAGAAA
G_cymosa 037                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCATATTTC--------------ATCTAGAAA
G_cymosa 042                             ----ATCTAAAT-GAATATTATTTA-GGTATG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCATATTTC--------------ATTTAGAAA
G_diospyrifolia var. minor BB06          TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
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G_diospyrifolia var. diospyrifolia 078   TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_discoidea SL01                         TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_dulcis 050                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_forbesii 024                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCATATTTC--------------ATCTAGAAA
G_lateriflora 040                        TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_magostana LAO                          TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_malaccensis var. malaccensis BB08      TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_malaccensis var. malaccensis BB09      TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_malaccensis var. pseudomangostana SP01 TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_mangostana 096                         TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_megaphylla 041                         TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCATATTTC--------------ATCTAGAAA
G_nitida 119                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_penangiana 006                         TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCTAATTTC--------------ATCTAGAAA
G_picrorhiza 039                         TTAGATCTAAAT-GAAT----------------------------CCCTAAA----TAGATGAAATATGCTAATTTC--------------ATCTAGAAA
G_rigida 029                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTCATCTAGAAAGTATAATCTAGAAA
G_rigida 045                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTCATCTAGAAAGTATAATCTAGAAA
G_rigida 049                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTCATCTAGAAAGTATAATCTAGAAA
G_rigida 057                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTCATCTAGAAAGTATAATCTAGAAA
G_rostrata 007                           TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTC--------------ATCTAGAAA
G_rostrata 09091                         TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTC--------------ATCTAGAAA
G_scortechinii 089                       TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_sp. B1 011                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTATAACTTTCTAGATGAAATTAGCATATTTC--------------ATCTAGAAA
G_sp. D1 064                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAAGATGCTTATTTC--------------ATCTAGAAA
G_sp. D1 07071                           ----------------------------------------------------------------------------------------------------
G_sp. D3 P02                             TAAAATTTAAAAGGAAAATTATTTAGGGTAAGGTTTTAAGGAATTTTAAAATTTTTAGGGGAAAATGGGCAAATTTT--------------ATTTTGAAA
G_sp. M4 022                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_sp. M5 069                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_sp. M6 093                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATTAAATATGCATATTTC--------------ATCTAGAAA
G_sp. M6 094                             TAAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATCC-AT-TCTTTCTAGATGAAAATTGCATATTTC--------------ATCTAGA--
G_sp. X1 052                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTC--------------ATCTAGAAA
G_sp. X2 080                             TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATTAGCATATTTC--------------ATCTAGAAA
G_trianii K02                            TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTC--------------ATCTAGAAA
G_urophylla 001                          TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_urophylla 081                          TTAGATCTACAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCATATTTC--------------ATCTAGAAA
G_xanthochymus cf. 032                   TTAGATCTAAAT-GAATATTATTTA-GGTACG--TTTAAAGAATTCTAT-ACTTTCTAGATGAAATATGCTAATTTC--------------ATCTAGAAA


                                            910       920       930       940       950       960       970       980       990      1000
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_balica 021                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTAAAATTTGA
G_cataractalis 077                       GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_celebica 002                           GTATAGA-TATAGTATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_celebica 003                           GAAATGA-TATAGTATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
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G_celebica 009                           GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_celebica 023                           GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_celebica 027                           GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATT-A-------------AAAATTAAATTTTA
G_celebica 033                           GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_celebica 059                           GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_celebica 28                            GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_costata BL03                           GTATAGA-TATATAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTAAAATTTGA
G_cymosa 037                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------GAATTTCAATTTGA
G_cymosa 042                             GTATAGA-TATAGTATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------GAATTTCAATTTTA
G_diospyrifolia var. minor BB06          GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_diospyrifolia var. diospyrifolia 078   GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_discoidea SL01                         GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_dulcis 050                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC-------------------------------------------------
G_forbesii 024                           GTATAGA-TATAGAATAACTAGAAAATCTTTGTCTTTTCTATTTTC-------------TATATCTATATTTC-------------AAATTTAAATTTGA
G_lateriflora 040                        GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTTAAATTTGA
G_magostana LAO                          GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTCAATTTTA
G_malaccensis var. malaccensis BB08      GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_malaccensis var. malaccensis BB09      GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_malaccensis var. pseudomangostana SP01 GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_mangostana 096                         GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTCAATTTTA
G_megaphylla 041                         GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTATATTTTCATTTC--------GATATCTATATTTC-------------AAATTTAAATTGAA
G_nitida 119                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTAAAATTTTA
G_penangiana 006                         GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTCTACATTTCTATATCTATATTTA-------------AAATTTAAATTTTA
G_picrorhiza 039                         GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_rigida 029                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTT-------------AAATTTAAATTTTA
G_rigida 045                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTT-------------AAATTTAAATTTTA
G_rigida 049                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTT-------------AAATTTAAATTTTA
G_rigida 057                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTT-------------AAATTTAAATTTTA
G_rostrata 007                           GTATAGA-TATAGAATAACTAGAAAATTT---------------------------------------------------------------------AA
G_rostrata 09091                         GTATAGA-TATAGAATAACTAGAAAATTTTTGTTTTTTCTATTTTCATTTT---AAATATAGATATAGATTTAAATATAGATATAGAAATGAAAATAGAA
G_scortechinii 089                       GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTTAAATTTGT
G_sp. B1 011                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTC-------------TATATCTATATTTC-------------AAATTTAAATTTGA
G_sp. D1 064                             GTATAGA-TATAGAATAACTAGAAAATTT----------------------------------------------------------------------A
G_sp. D1 07071                           ----------------------------------------------------------------------------------------------------
G_sp. D3 P02                             GGGAAAAAAAAAGGAAAAAAAAAAAATTTTTTTTTTTTTTTTTTTCATTT---------------------TAAATATAGATATAGAAATGAAAATTTAA
G_sp. M4 022                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTAAAATTTGA
G_sp. M5 069                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTTAAATTTGA
G_sp. M6 093                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTTAAATTTGA
G_sp. M6 094                             ----------------------------------------------------------------------------------------------------
G_sp. X1 052                             GTATAGA-TATATAATAACTAGAAAATTTTTGTCTTTTATATTTTCATTTC--------GATATCTATATTTC-------------AAATTTAAATTGAA
G_sp. X2 080                             GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTATATTTTCATTTC--------GATATCTATATTTC-------------AAATTTAAATTGAA
G_trianii K02                            GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTA-------------AAATTTAAATTTTA
G_urophylla 001                          GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTTAAATTTGA
G_urophylla 081                          GTATAGA-TATAGAATAACTAGAAAATTTTTGTCTTTTCTATTTTCATTTC--------TATATCTATATTTC-------------AAATTTTAATTTGA
G_xanthochymus cf. 032                   GTATAGA-TATATAATAACTAGAAAATTTTTGTCTTTTATATTTTCATTTC--------GATATCTATATTTC-------------AAATTTAAATTGAA
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                                            1010      1020      1030      1040      1050      1060      1070      1080      1090      1100
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_balica 021                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATATGTCATATATTATGTCATATATTAAATT--
G_cataractalis 077                       AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_celebica 002                           AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_celebica 003                           AA-TATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_celebica 009                           AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_celebica 023                           AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_celebica 027                           AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTATATT--
G_celebica 033                           AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_celebica 059                           AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_celebica 28                            AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_costata BL03                           AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_cymosa 037                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAGTT--
G_cymosa 042                             AA-CATTTAATCTGTTA-------TATTTTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAGTT--
G_diospyrifolia var. minor BB06          AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_diospyrifolia var. diospyrifolia 078   AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_discoidea SL01                         AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_dulcis 050                             ----------------------------------------------------------------------------------------------------
G_forbesii 024                           AA-CATTTAATCTGTTA-------TATTCTATATAATATGTTATATATTAATAATTAATATA--TTT-TA---------TTTTGTCATAGATTAAATT--
G_lateriflora 040                        AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_magostana LAO                          AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_malaccensis var. malaccensis BB08       AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_malaccensis var. malaccensis BB09       AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_malaccensis var. pseudomangostana SP01 AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_mangostana 096                         AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_megaphylla 041                         AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_nitida 119                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_penangiana 006                         AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_picrorhiza 039                         AA-CATTTAATCTGTTA-------TATTATATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATATT
G_rigida 029                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_rigida 045                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_rigida 049                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_rigida 057                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_rostrata 007                           AA-CATTTAGTCTGTTA-------TATTCTATACAATATGTTATATATTAATATATAATATA--TTTATA------------TGTCATATATTAAATT--
G_rostrata 09091                         AA-CATTTAGTCTGTTA-------TATTCTATACAATATGTTATATATTAATATATAATATA--TTTATA------------TGTCATATATTAAATT--
G_scortechinii 089                       AA-CATTTAATCTGTTA-------TATTCTATACTATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_sp. B1 011                             AA-CATTTAATCTGTTATATTCTATATTCTATATAATATGTTATATATTAATAATTAATATA--TTT---------------TGTCATAGATTAAATT--
G_sp. D1 064                             AA-CATTTAGTCTGTTA-------TATTCTATACAATATGTTATATATTAATATATAATATA--TTTATA------------TGTCATATATTAAATT--
G_sp. D1 07071                           ----------------------------------------------------------------------------------------------------
G_sp. D3 P02                             AA-CATTTAGTCTGTTA-------TATTCTATACAATATGTTATATATTAATATATAATATA--TTTATA------------TGTCATATATTAAATT--
G_sp. M4 022                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATATGTCATATATTATGACATATATTAAATT--
G_sp. M5 069                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_sp. M6 093                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAATATTA
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G_sp. M6 094                             ----------------------------------------------------------------------------------------------------
G_sp. X1 052                             AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_sp. X2 080                             AACCATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAAGTAATAATTTAATATA------------TGTCATATATTAAATT--
G_trianii K02                            AA-CATTTTATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--
G_urophylla 001                          AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGCCATATATTAAATT--
G_urophylla 081                          AA-CATTTAATCTGTTA-------TATTCTATACCATA-GTTATATATTAATAATTAATATA--TTTATA------------TGCCATATATTAAATT--
G_xanthochymus cf. 032                   AA-CATTTAATCTGTTA-------TATTCTATACAATATGTTATATATTAATAATTAATATA--TTTATA------------TGTCATATATTAAATT--


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                                            1110      1120      1130      1140      1150      1160      1170      1180      1190      1200
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G_acuticosta BB01                        ------ATGTACATTAACCATATA-CATATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_balica 021                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAAGAAATAAATAAAGGAATTTCAA
G_cataractalis 077                       ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_celebica 002                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTT--
G_celebica 003                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_celebica 009                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_celebica 023                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_celebica 027                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAA----------------------------------------
G_celebica 033                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_celebica 059                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_celebica 28                            ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_costata BL03                           ------ATGTACATTAACCATATA-CATATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT----------------------AAATAAAGTAATTTCAA
G_cymosa 037                             ------ATGTAAATTAACCA-------TATAAAAGAAA------TAGAATTTCCTAAAAATAAAT-------AAAAAATAAATAAATAAAGGAATTTCAA
G_cymosa 042                             ------ATGTAAATTAACCA-------TATAAAAGAAA------TAGAATTTCCTAAAAATAAAT-------AAAAAATAAATAAATAAAGGAATTTCAA
G_diospyrifolia var. minor BB06          ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_diospyrifolia var. diospyrifolia 078   ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_discoidea SL01                         ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_dulcis 050                             ----------------------------------------------------------------------------------------------------
G_forbesii 024                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTCCCTAAAAAT------------------AAATAAATAAAGGAATTTCAA
G_lateriflora 040                        ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAATAAATAAATAAAGGAATTTCAA
G_magostana LAO                          ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_malaccensis var. malaccensis BB08      ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_malaccensis var. malaccensis BB09      ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_malaccensis var. pseudomangostana SP01 ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_mangostana 096                         ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_megaphylla 041                         ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAGTAGAATTTCCTAAAAAT-----------AAAAAATAAATAAATAAAGGAATTTCAA
G_nitida 119                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA-AAAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_penangiana 006                         ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATA--AAATAAAAAAGAAATAAATAAAGGAATTTCAA
G_picrorhiza 039                         AATTTAATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------------AAAATAAATAAAGGAATTTCAA
G_rigida 029                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAAGAAATAAATAAAGGAATTTCAA
G_rigida 045                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAAGAAATAAATAAAGGAATTTCAA
G_rigida 049                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAAGAAATAAATAAAGGAATTTCAA
G_rigida 057                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAAGAAATAAATAAAGGAATTTCAA
G_rostrata 007                           ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT------------AAATAAATATAAATAAAGGAATTTCAA
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G_rostrata 09091                         ------ATGTACATTAACCATAT--AATATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAATATAAAAATAAATAAATATAAATAAAGGAATTTAAA
G_scortechinii 089                       ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAATAAATAAATAAAGGAATTTCAA
G_sp. B1 011                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTCCCTAAAAAT-----------------GAAAAAAATAAAGGAATTTCCA
G_sp. D1 064                             ------ATGTACATTAACCA-------TATAATAGAAAAAGGAATAGAATTTCCTAAAAAT------------AAATAAATATAAATAAAGGAATTTCTA
G_sp. D1 07071                           ----------------------------------------------------------------------------------------------------
G_sp. D3 P02                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATAAAT----------------ATAAATAAAGGAATTTCAA
G_sp. M4 022                             ------ATGTACATTAACCATATAAAAGATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAATAAATAAATAAAGGAATTTCAA
G_sp. M5 069                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAATT-----------AAAAATAAATAAATAAAGGAATTTCAA
G_sp. M6 093                             AATT--ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTTAAAA--------ATAAAAAAAAAAAATAAATAAAGGAATTTCAA
G_sp. M6 094                             ----------------------------------------------------------------------------------------------------
G_sp. X1 052                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAGTAGAATTTCCTAAAAAT-----------AAAAAATAAATAAATAAAGGAATTTCAA
G_sp. X2 080                             ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAGTAGAATTTCCTAAAACT------------AAAAACTAACTAACAAAGGAACTTTAA
G_trianii K02                            ------ATGTACATTAACCA-------TAGAAAAGAAAAAGGAATAGAATTTACTAAAAAT-----------AAAAAAGAAATAAATAAAGGAATTTCAA
G_urophylla 001                          ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAATAGAATTTCCTAAAAAT-----------AAAAAATAAATAAATAAAGGAATTTCAA
G_urophylla 081                          ------ATGTACATTAACCA-------TATAAAAGAAAAAGGTATAGAATTTCCTAAAA------------TAAAAAATAAATAAATAAAGGCATTTCAA
G_xanthochymus cf. 032                   ------ATGTACATTAACCA-------TATAAAAGAAAAAGGAGTAGAATTTCCTAAAAAT-----------AAAAAATAAATAAATAAAGGAATTTCAA


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                                                 1210      1220      1230      1240      1250      1260      1270      1280
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....
G_acuticosta BB01                        AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_balica 021                             AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAA---
G_cataractalis 077                       AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_celebica 002                           -----------------------------------------------------------------------------------------
G_celebica 003                           AATAATGAAGAGAGATA-------AAAAAAAGAGAAAAGGAATTTTCCTGTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_celebica 009                           AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_celebica 023                           AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTAAAGTTTTCCTTTTTCTGA---AATAGTGGATAAAAA
G_celebica 027                           -----------------------------------------------------------------------------------------
G_celebica 033                           AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATTA-AA
G_celebica 059                           AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCGAA--ACATGGTAAAATAAAT
G_celebica 28                            AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGT--TTATAAGTGATAAAAA
G_costata BL03                           AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTTTGA---AATAGTGGATAAAAA
G_cymosa 037                             AATAATGAAGAGAGA-A--------AAAAAAGAGAAAAGGAATTTTCCTTTTTAAGTCTTCCTTCTTCTGA---AATAGTGGATAATAA
G_cymosa 042                             AATAATGAAGAGAGAAA--------AAAAAAGAGAAAAGGAATTTTCCTTTTTAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_diospyrifolia var. minor BB06          AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_diospyrifolia var. diospyrifolia 078   AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---ATGTGATAAAATAGT
G_discoidea SL01                         AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCC-TTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_dulcis 050                             -----------------------------------------------------------------------------------------
G_forbesii 024                           AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTTCTTTTCAAGTCTTCCTTCGTTCGAGGTGATAGTGGAGTGGAA
G_lateriflora 040                        AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_magostana LAO                          AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTTTTCCTTTTTCTGA---AATAGTGGATAAAAA
G_malaccensis var. malaccensis BB08      AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTTCTYCCCTCCTNCTG-AAATAGTKGGATAAAA
G_malaccensis var. malaccensis BB09      AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_malaccensis var. pseudomangostana SP01 AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTYTYCTGA---AATAGTGGATAAAAA
G_mangostana 096                         AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
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G_megaphylla 041                          AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTTTTCTGA---AATAGAGGAATA---
G_nitida 119                              AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_penangiana 006                          AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCT-CCTTCTTCTGA---AATAGTGGATAAAAA
G_picrorhiza 039                          AATACTGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGCCTTCCTTCTTCTGA---AATAGTGGATAAACA
G_rigida 029                              AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCTTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGAT-----
G_rigida 045                              AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCTTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_rigida 049                              AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCTTTTTCAAGTCTTCCTTCTTCGAA---AATAGTGGATT----
G_rigida 057                              AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCTTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_rostrata 007                            AATAATGAAGAGAGAT-------------------------------------------------------------------------
G_rostrata 09091                          AATAATGAAGAGAGAT---------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA--AAGTAGTGGAAAAAAT
G_scortechinii 089                        AATAATGAAGAGAGA--------------------------------------------------------------------------
G_sp. B1 011                              AATAATGAAGAGAGA--------------------------------------------------------------------------
G_sp. D1 064                              AATTATGAAGAGAGATA----------AAAAGAGAAAAGGAATTTTCCTTTTACAGTCATCCCTGTTCTAGAATAGGGATGCAAGAAGG
G_sp. D1 07071                            -----------------------------------------------------------------------------------------
G_sp. D3 P02                              AATAATGAAGAGAGATAAAAAAGATAAAAAAGAGGAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_sp. M4 022                              AATAATGAAGAGAGAA---------AAAAAAGAGAAAAGGACTTTTCCTTTTCAAGTCTTCCTTCTTCTGA--AAATAGGGC-------
G_sp. M5 069                              AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_sp. M6 093                              AATAATGAAGAGAGAAA------------------------------------------------------------------------
G_sp. M6 094                              -----------------------------------------------------------------------------------------
G_sp. X1 052                              AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTTTTCTGA---AATAGTGGATAAAAA
G_sp. X2 080                              AACAACGAAGAGAGACA--------AAAAAAGAGAAAAGGAATTTTCCTTTT-AAGTCTTCCTTTTTGTAACA----------------
G_trianii K02                             AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCTTCTGA---AATAGTGGATAAAAA
G_urophylla 001                           AATAATGAAGAGAGATA-------AAAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTCTTCCTTCGTGTGA--GA-TAGGGATA-AACT
G_urophylla 081                           AATAATGAAGAGAGATT--------AAAAAAGAGAAAAGGAATTTTCCTTTTCATA---------------------------------
G_xanthochymus cf. 032                    AATAATGAAGAGAGATA--------AAAAAAGAGAAAAGGAATTTTCCTTTTCAAGTATTCATTAGTCGAG-ATGATAGTGCATAAGCC

                                          Gap coded
                                          ***       ***  *                      *    ******  ** **   **         **  * * *** *        *     *
                                                  10        20        30        40        50        60        70        80        90       100
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                        001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1---1-----
G. balica 021                             ?11110011111110001-1--011-00100000100100010-0000-1--1-11----11-1-1-11-1-11----1--111-1----1-1-----1-
G. cataractalis 077                       001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. celebica 002                           0011100111111100110-1---------------------------------------1101010110101100001-011101001-1-1--00000
G. celebica 003                           ????????1110110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. celebica 009                           001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. celebica 023                           001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. celebica 027                           ?011100111111100010-1---------------------------------------1101010110101100001-111101001-1-1--0????
G. celebica 033                           001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. celebica 059                           ?01110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. celebica 28                            001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. costata BL03                           000010011011100001-1--011-00100000100100010-0000-1--1-1--1--11-1-1-11-1-11----1--111-1--1-1---1-----
G. cymosa 037                             001111011111110001-1--011-00100100100100010-0001-1--1-1----111-1-1-11-1-11----1--111-1--1-1-1--1----
G. cymosa 042                             001110111111110001-1--011-001000001001000-1-0001-1--1-1---1-11-111-11-1-11----1--111-1--1-1-1--1----
G. diospyrifolia var minor BB06           101110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. diospyrifolia var diospyrifolia 078    011110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
```

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G. discoidea SL01                        001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. dulcis 050                            ?01110011111110001010-011-00100000100100010-000001001-11-0--11010101101011??????????????????????????
G. forbesii 024                          001110011111110001-0-0011-0000010010010000000000-1--1-11----11-1-1-11-1-11--1----111-1-1-11-1-------
G. lateriflora 040                       001110001111110001-1--010101100000100100010-0000-1--1-11-----1-1-1-11-1-11----1--111-1--1-1-1-----1-
G. magostana LAO3                        001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. malaccensis var malaccensis BB08      001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. malaccensis var malaccensis BB09      001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. malaccensis var pseudomangostana P01  001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. mangostana 096                        001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. megaphylla 041                        001110011111110000-1--011-00100000100100010-00011------1----1----1-11-1-11----1--111-1--1-1-1-----1-
G. nitida 119                            001110011111110001--1---------------------------------------11-1-1-11-1-11----1--111-1--1-1-1-------
G. penangiana 006                        001110011111110001--1---------------------------------------11-1-1-11-1-11-------111-1--1-1-1-------
G. picrorhiza 039                        001110011111010001-1--010101100001-00000010-0001-1--1-11----11-1-11----111----1--111-1--1---1-------
G. rigida 029                            ??1110011111110001-1--000000000000000100010-0000-1--1-11----11-1-1-11-1--1----1--111-1--1-1-1-----1-
G. rigida 045                            001110011111110001-1--001-00-1----------1-1-0110-1--1-11----11-1-1-11-1--1----1--111-1--1-1-1-----1-
G. rigida 049                            ??1110011111110001-1--001-00000000111000010-0000-1--1-11----11-1-1-11-1--1----1--111-1--1-1-1-----1-
G. rigida 057                            001110011111110001-1--010000000000111000010-0000-11-1-11----11-1-1-11-1--1----1--111-1--1-1-1-----1-
G. rostrata 007                          ??????????011100110001011-00101000100100010-000101000011-0--1101010110101110------1101001-1-1--000-1
G. rostrata 09091                        001110010111110011-1--011-0010100010010000010001-1---111----11-1-1-11-1-11-----1--11-1--1-1--1------
G. scortechinii 089                      ???????????1110001010-011-00100000100100010-000001001-11-0--1101010110101100001-011101001-1-1--00010
G. spB1 011                              ?????????111110001010-011-00100010100100010-000001001-101000100101011000110010--0110011---1-1--000--
G. spD1 064                              001110011111110011-1--01--10101000100100010-0001-1---111----11-1-1-11-1-11-1------11-1--1-1-1------1
G. spD1 07071                            ???110000011110001-1--011-00101000100101010-0001????????????????????????????????????????????????????
G. spD3 P02                              001110011111110011-1--011-0010100010010000001001-1---111----11-1--------1----1----11-1--1-1-1-------
G. spM4 022                              001110011111110001-1--011-00100000100100010-0000-1--1-11----11-1-1-11-1-11----1--111-1----1-------1-
G. spM5 069                              001110011111110001-1--011-00100000100100010-0000-1--1-11----11-1-1-11-1-11----1--111-1--1-1-1-------
G. spM6 093                              001110010111111101010-010100100000100110010-000000111-11-0--1101010110101100001-011101001-011--00100
G. spM6 094                              ????10011111110001010-011-00100000100100010-000000001-11-0--1-11010111101???????????????????????????
G. spX1 052                              001110001111110000-1--011-00100000100100010-00011------1----11---1-11-1-11----1--111-1--1-1-1-----1-
G. spX2 080                              001110001111110000-1--011-00100000100100010-00011------1----11---1-11-1-11----1--1-1----1-1-1------1
G. trianii K02                           001110011111110001-0-0111-00100000100100010-0000-1--1-1-----11-1-1-11-1-11----1--111-1--1-1-1-----1-
G. urophylla 001                         001110011111110001-1--011-00100000100100010-0000-1--1-11----11-1-1-11-1-11----1--111-1--1-1-1-----1-
G. urophylla 081                         ????????????????????????????????????????????????01001-11-0--1101010110101100001-011111001-1-1--01-00
G. xanthochymus cf. 032                  ?01110011111110000-1--011-00100000100100010-00011------1----11---1-11-1-11----1--111-1--1-1-1-----1-


                                           *       *    *****
                                                  110
                                          ....|....|....|....
G. acuticosta BB01                        -------1-----1?????
G. balica 021                             -------------1?????
G. cataractalis 077                       -------1-----1?????
G. celebica 002                           0000000100?????????
G. celebica 003                           -------1----1??????
G. celebica 009                           -------1-----1?????
G. celebica 023                           -------1-----1?????
G. celebica 027                           ???????????????????
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G. celebica 033	-------1-----1?????
G. celebica 059	-------1-----1?????
G. celebica 28	-------1-----1?????
G. costata BL03	--1----------1?????
G. cymosa 037	----1-----1--1?????
G. cymosa 042	----1--------1?????
G. diospyrifolia var minor BB06	-------1-----1?????
G. diospyrifolia var diospyrifo	-------1-----1?????
G. discoidea SL01	-------1-----1-1???
G. dulcis 050	???????????????????
G. forbesii 024	-1-----------1?????
G. lateriflora 040	-------------1?????
G. magostana LAO3	-------1-----1?????
G. malaccensis var malaccensis BB08	-------1-----1?????
G. malaccensis var malaccensis BB09	-------1-----1?????
G. malaccensis var pseudomangostana SP01	-------1-----1?????
G. mangostana 096	-------1-----1?????
G. megaphylla 041	-------------1?????
G. nitida 119	-------1-----1?????
G. penangiana 006	--------1----1----1
G. picrorhiza 039	1------------1?????
G. rigida 029	-------------1?????
G. rigida 045	-------------1?????
G. rigida 049	-------------1?????
G. rigida 057	-------------1?????
G. rostrata 007	000---0--00????????
G. rostrata 09091	-----------1???????
G. scortechinii 089	0000--0--0?????????
G. sp.B1 011	100---0--0?????????
G. sp.D1 064	--------------1????
G. sp.D1 07071	???????????????????
G. sp.D3 P02	------1????????????
G. sp.M4 022	-----------1???????
G. sp.M5 069	---1---------1?????
G. sp.M6 093	00000-0--00????????
G. sp.M6 094	???????????????????
G. sp.X1 052	-------------1?????
G. sp.X2 080	-------------1--1??
G. trianii K02	-------------1?????
G. urophylla 001	------------1??????
G. urophylla 081	00000-0--000-1000??
G. xanthochymuscf 032	-------------1?????

APPENDIX VII

Matrix of *trn*D-*trn*T sequences and binary gap coded characters. Asterices indicate excluded characters in the analysis.

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                                         *************************************************
                                                   10        20        30        40        50        60        70        80        90
100
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                       ????????????????????????????????????????ACATAGAC-GA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCC-TATTTAACTT-AG
G. cataractalis 077                      ?????????????????????????????????????CCACG-TAGACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. celebica 002                          ????????????????????????????????????????????????????????????????????????????????????????????????????
G. celebica 023                          ?????????GGGGGCTTAGGGAATTCCTTGGATTATGGCACCTAGANCAGAGTCCTATTCCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. celebica 033                          ?????????????????????????????????????AGCC-CTAAAC-GA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. cymosa 037                            ??????????????????TATGGATTCCTGAAATAGCCACTGACGGACAGA-T-CT-CATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. diospyrifolia var dumosa 078          ???????????????????????????????????????CC-CTAGACAGA-T-CTATATCTGTC-TGGCAATGGAAATAAATTCCATATTTAACTT-AA
G. diospyrifolia var minor BB06          ?????????????????????????????????AATAGCCA-CTAGACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. discoidea_SL01                        ?????????????????????????????????TGATAGCCACTAAACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. malaccensis var. malaccensis BB08     ?????CCTAGTTAAGGGGCTTAGGGATTCCTGAATTAGCCAACTAGACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. malaccensis var. pseudomangostana SP01ATTTCCGGTTCTGTGCCTTAATGGGAAAAATAAGAAATAGCACTAGAC-GA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. malaccenssis BB09                     ????????????????????????????????????????????GAACTGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. mangostana LAO                        ???????????????????????GGAATTCCGAAATAGGCCACTAGACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. megaphylla 041                        ????????????????????????????????AGATGAATCCCGAAATAGC-CACTAGACATGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. penangiana 006                        ????????????????????????????TCCTGAATAGCCA-CTAGACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. rigida 029                            ?????????????????????????TGTTCCTGAATAGCCA-CTAGACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AT
G. rigida 045                            ????????GGTTAATGGGCTTAGGGATTTCCTGAAATAGCC-CTAGAC-GA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AT
G. rigida 049                            ????????????????????????????????????????????????????????????????????????????????????????????????????
G. rigida 057                            ?????????????????????????????????????????????AACAGA-T-CT-TATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AT
G. rostrata 007                          ??????????????????????????????????????GCCAATAAACAGA-T-CT-TATCTGTT-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. spD2 P02                              ???????????????????????????????????AAATAGCCAAAGACGA-T-CTTATTCTGTC-TGGCTATGGAAATAGATTCC-TATTTAACTT-AG
G. spM4 022                              ????????????????????????????????AAATAGACCACTAGACAGA-T-CT-TATCTGTTTGGACTATGGAAATAGATTCCATATTTAACTT-AG
G. spX2 080                              ????????????????????????????????AANGATTGCCGAAATTAGC-CACTAGACATGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG
G. trianii K02                           ???????????????????????????????????GAAAGCCCTAGACAGA-T-AA-GATCTGTC-TGGCTATGGAAATAGATTCCATATTTAACTT-AG


                                                 110       120       130       140       150       160       170       180       190       200
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                        ATAT-TATATATCTTATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. cataractalis 077                       ATAT-TATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. celebica 002                           ???????????????????????????????????????TGATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. celebica 023                           ATAT-TATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. celebica 033                           ATAT-TATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. cymosa 037                             ATAT-TATATATCTGATCTATAT-ATCTATATATAATAAATATATATATA-AGATATGTGCTATAGGATATGTAGTATAAAAGGAAA-TAGTATAAAAAT
G. diospyrifolia var dumosa 078           ATATTAATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGAATATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. diospyrifolia var minor BB06           ATAT-TATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. discoidea_SL01                         ATAT-TATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
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G. malaccensis var. malaccensis BB08       ATAT-TATATATCTGATATATCTGAT--------ATATCTGATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. malaccensis var. pseudomangostana SP01  ATAT-TATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. malaccenssis BB09                       ATAT-TATATATCTGATATATCTGAT--------ATATCTGATCTATATATAGTAAATATAAATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. mangostana LAO                          ATAT-TATATATCTGATATATCTGAT--------ATATCTGATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. megaphylla 041                          ATAT-TATATATCTAATTTAGATATTAT------ATATCTAATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. penangiana 006                          ATATGTATATATCTGATATATCT-----------------GATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. rigida 029                              ATAT-TATATATCTGAT--------------------------CTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. rigida 045                              ATAT-TATATATCTGAT--------------------------CTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. rigida 049                              ????????????????????????????????????????????????????????????????????????????????????????????????????
G. rigida 057                              ATAT-TATATATCTGAT--------------------------CTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. rostrata 007                            ATAT-TATATATCTAATCTATATATAGTAA----ATATCTAATCTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. spD2 P02                                ATAT-TATATATCTAAT--------------------------CTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAAAATAGTATAAAAAT
G. spM4 022                                ATAT-TATATATCTGAT--------------------------CTATATATAGTAAATATATAT-----ATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. spX2 080                                ATAT-TATATATCTAAT--------------------------CTATATATAGTAAATATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT
G. trianii K02                             ATAT-TGTATATCTGAT--------------------------CTATATATATTTACTATATATAGA-TATGTAGTATAAAAAAAA--TAGTATAAAAAT


                                                  210       220       230       240       250       260       270       280       290       300
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                       ATAAC--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. cataractalis 077                      ATA-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. celebica 002                          ATC-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. celebica 023                          ATC-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. celebica 033                          ATC-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. cymosa 037                            ATTC---------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. diospyrifolia var dumosa 078          ATA-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. diospyrifolia var minor BB06          ATT-C--------TTCTTAAAATTTTTTATTTTTTATTCTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. discoidea_SL01                        ATT-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. malaccensis var. malaccensis BB08     ATT-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. malaccensis var. pseudomangostana SP01ATT-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. malaccenssis BB09                     ATT-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. mangostana LAO                        ATC-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. megaphylla 041                        ATTCCATTGTTGATTCTTAACATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. penangiana 006                        ATTAC--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. rigida 029                            ATT-C--------TTCTTAAAATTTTTTATT-------CTTAGATGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. rigida 045                            ATT-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. rigida 049                            ????????????????????????????????????????????????????????????????????????????????????????????????????
G. rigida 057                            ATT-C--------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. rostrata 007                          ATTCCATTATTGATTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. spD2 P02                              ATTCCATTGTTGATTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. spM4 022                              ATTC---------TTCTTAAAATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
G. spX2 080                              ATTCCATTGTTGATTCTTAACATTTTTTATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGAATTCATAGTAGCTCATTCATAAACGAAAA
G. trianii K02                           ATT-C--------TTCTTAAAATTTTTGATT-------CTTAGAAGTGTATAAGTGTACAAACAAACTAGA-TTCATAGTAGCTCATTCATAAACGAAAA
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                                                 310       320       330       340       350       360       370       380       390       400
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                        ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAAAAAAAAA-------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. cataractalis 077                       ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAAAAAAAAA-------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. celebica 002                           ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. celebica 023                           ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAAAAAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. celebica 033                           ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. cymosa 037                             ACTGGGTTTACCTAATCTAAAACTAGTGAATATAAGAAAAAAAAAAAA-----TGA-TAAAT-CTGGAAATCTGAGAAGATGGATAAACTTAAATAAGTT
G. diospyrifolia var dumosa 078           ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. diospyrifolia var minor BB06           ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. discoidea_SL01                         ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAAAAAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. malaccensis var. malaccensis BB08      ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAA-------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. malaccensis var. pseudomangostana SP01 ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAA-------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. malaccenssis BB09                      ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAA-------TGGATAACTTATTTT----ATGTTTATCCATCTTCT-CAAATTTCCA
G. mangostana LAO                         ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAA-------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. megaphylla 041                         ACTGGGTTTACCTAATCTAAAACTAGTGAATATAAGAAAAAAAA--------ATGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAGATTTCCG
G. penangiana 006                         ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAAA-----TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. rigida 029                             ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAAAAA---TGGATAACTTATTT-----AAGTTTATCCATTTTTT-CAGATTTCCA
G. rigida 045                             ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAAAA----TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. rigida 049                             ?????????????????????????????????????????????????????????????????TT-----AAGTTTATCCATTTTTT-CAGATTTCCA
G. rigida 057                             ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAA-AAAAAAAAAA---TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. rostrata 007                           ACTGGGTTTACCTAAT-----ACTAGTGAATATAAGAAAAAAAAAAAAA----TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAAATTTCCA
G. spD2 P02                               ACTGGGTTTACCTAAT-----ACTAGTGAATATAAGAAA-AAAAAAAA-----TGGATAACTTATTTATTTTATGTTTATCCATCTTCT-CAAATTTCCA
G. spM4 022                               ACTGGGTTTACCTAATCTAAGACTAGTGAATATAAGAAAAAAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAGATTTCCA
G. spX2 080                               ACTGGGTTTACCTAATCTAAAACTAGTGAATATAAGAAAAAAAAAAA------TGGATAACTTATTT-----ATGTTTATCCATCTTCT-CAGATTTCCG
G. trianii K02                            ACTGGGTTTACCTAATCTAAGACTAGTAAATATAAGAAAAAAAAAAAAAAAAATGGATAAATTCTGAAAAAAATGGATTAAAAATAAAT------AAGTT


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                                                 410       420       430       440       450       460       470       480       490
500
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                        GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. cataractalis 077                       GA-TTTATCATTTTTTTT----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. celebica 002                           GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. celebica 023                           GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. celebica 033                           GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. cymosa 037                             ACCCATTTTTTTTTTTTTTTTT-CATTTCCTGGTTAA--GTCTGAGATAT------------------------------------AAGTATGAGATAGA
G. diospyrifolia var dumosa 078           GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. diospyrifolia var minor BB06           GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. discoidea_SL01                         GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. malaccensis var. malaccensis BB08      GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. malaccensis var. pseudomangostana SP01 GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. malaccenssis BB09                      GA-TTTATCATTTTTTTT----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
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G. mangostana LAO                          GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. megaphylla 041                          GA-TTTATCATTTTTTTTTTTG-AATTTCCTGGTT---------------------------------------------------AAGTCTGAGATAGA
G. penangiana 006                          GA-TTTATGATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. rigida 029                              GA-TTTATCATTTTTTTTTTTT------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. rigida 045                              GA-TTTATCATTTTTTT-----------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. rigida 049                              GA-TTTATCATTTTTTTTTTTT------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. rigida 057                              GA-TTTATCATTTTTTTTTTTT------CCTGGTTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. rostrata 007                            GATTTTCTCATTTTTTTT--TTTCATTTCCTGGTT---------------------------------------------------AAGTCTGAGATAGA
G. spD2 P02                                AA-TTTCTCATTTTTTTTTTTTTTTTTCCCGGGTTAAAGGTTTCAGATTTCCAGATTTCTCATTTTTTTTTTTTCATTTCCTGGTTAAGTCTGAGATAGA
G. spM4 022                                GA-TTTATCAATTTTTTTTTTT---TTTCCTGGGTAA--GTCTGAGATAT------------------------------------AAGTCTGAGATAGA
G. spX2 080                                GA-TTTATCATTTTTTTTTTTG-AATTTCCTGGTT---------------------------------------------------AAGTCTGAGATAGA
G. trianii K02                             ATCCATTTTTTTTTTTTTTT----ATTTCCTGGTTAA--GTTTGAGATAT------------------------------------AAGTTTGAGATAGA


                                                510       520       530       540       550       560       570       580       590       600
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                       TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. cataractalis 077                      TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. celebica 002                          TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. celebica 023                          TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. celebica 033                          TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAA-GTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. cymosa 037                            TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAA--GTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. diospyrifolia var dumosa 078          TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT--------------------AAAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. diospyrifolia var minor BB06          TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. discoidea_SL01                        TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. malaccensis var. malaccensis BB08     TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. malaccensis var. pseudomangostana SP01TATATGCCTATTTCTCTTAACAATGGGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. malaccenssis BB09                     TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. mangostana LAO                        TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. megaphylla 041                        TATATGCCTTTTTCTCTTAACAATGAATTAATCAAT---------------------AAAAAAA--GTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. penangiana 006                        TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. rigida 029                            TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAA-GTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. rigida 045                            TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAAAGTGAGCACAATCCCGGTTCGCCCGCTTTTCTGAC
G. rigida 049                            TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAA-GTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. rigida 057                            TATATGCCTATTTCTCTTAACAATGAGTTAATCAAT---------------------AAAAAAAA-GTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. rostrata 007                          TATATGTCTATTTCTATTAACAATGAGTTAATCAAT---------------------AAAAAAA--GTGAGCGCAATCCCGTTTCGCGCGCTTTTCTGAC
G. spD2 P02                              TATATGTCTATTTCTATTAACAATGAGTTAATCAAT---------------------AAAAAAA--GTGAGCGCAATCCCGTTTCGCGCGCTTTTCTGAC
G. spM4 022                              TATATGCCTATTTCTCTTAACAATGAGTTAATCAATCTTAACAATGAGTTAATGAATAAAAAAAAAGTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. spX2 080                              TATATGCCTTTTTCTCTTAACAATGAATTAATCAAT---------------------AAAAAAA--GTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC
G. trianii K02                           TATATGCCTATTTCT---------GAGTTAATCAAT---------------------AAAAAAAAAGTGAGCGCAATCCCGTTTCGCCCGCTTTTCTGAC


                                                610       620       630       640       650       660       670       680       690       700
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                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                        TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. cataractalis 077                       TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. celebica 002                           TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. celebica 023                           TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. celebica 033                           TTTCAGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. cymosa 037                             TTTCCGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCCAAAAACTATTTATACTA
G. diospyrifolia var dumosa 078           TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. diospyrifolia var minor BB06           TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. discoidea_SL01                         TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. malaccensis var. malaccensis BB08      TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. malaccensis var. pseudomangostana SP01 TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. malaccenssis BB09                      TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. mangostana LAO                         TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. megaphylla 041                         TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTAGTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. penangiana 006                         TTTCTGACAGA-CCAATCATTCCATGAAAAGTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTAT-GACAATTTCAAAAAACTATT-ATACTA
G. rigida 029                             TTTCAGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. rigida 045                             TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. rigida 049                             TTTCAGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. rigida 057                             TTTCAGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. rostrata 007                           TTTCTGGCAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTAGTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. spD2 P02                               TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTAGTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. spM4 022                               TTTCTGACAGA-CCAACCATTCCAT-------GAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. spX2 080                               TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTAGTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA
G. trianii K02                            TTTCTGACAGA-CCAATCATTCCATGAAA-GTGAAAGTATATTTCGAATTTATTCATACAATTTCGTTCTATTGACAATTTCAAAAAACTATTTATACTA


                                                 710       720       730       740       750       760       770       780       790       800
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                        TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. cataractalis 077                       TGAAAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. celebica 002                           TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. celebica 023                           TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. celebica 033                           TGAGAATAGTATGCTGACACTCCGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. cymosa 037                             TGAGAATAGTATGCTGACACTCCGGCAAATAGGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. diospyrifolia var dumosa 078           TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGAACATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. diospyrifolia var minor BB06           TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. discoidea_SL01                         TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. malaccensis var. malaccensis BB08      TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. malaccensis var. pseudomangostana SP01 TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. malaccenssis BB09                      TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. mangostana LAO                         TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. megaphylla 041                         TGAGAATAGTATGCTGACACTCCGGCAAATAGGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. penangiana 006                         TGAGAATAGTATGCTGACA--CCGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. rigida 029                             TGAGAATAGTATGCTGACACTCCGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
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G. rigida 045                             TGAGAATAGTATGCTGACACTCTGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. rigida 049                             TGAGAATAGTATGCTGACACTCCGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. rigida 057                             TGAGAATAGTATGCTGACACTCCGGCAAATACGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. rostrata 007                           TGAGAATAGTATGCTGACACTCCGGCAAAAAGGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. spD2 P02                               TGAGAATAGTATGCTGACACTCCGGCAAATAGGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTGTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. spM4 022                               TGAGAATAGTATGCTGACACTCCGGCAAATAGGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. spX2 080                               TGAGAATAGTATGCTGACACTCCGGCAAATAGGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG
G. trianii K02                            TGAGAATAGTATGCTGACACTCCGGCAAATAGGCCCCCATCGTCTAGTGGTTCAGGA-CATCTCTCTTTCAAGGAGGCAGCGGGGATTCGACTTCCCCTG


                                                810       820       830       840       850       860       870       880       890       900
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                       GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. cataractalis 077                      GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. celebica 002                          GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGGGAC
G. celebica 023                          GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. celebica 033                          GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. cymosa 037                            GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATCAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGAAGTGGTTAATGGGGACGG-AC
G. diospyrifolia var dumosa 078          GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. diospyrifolia var minor BB06          GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. discoidea_SL01                        GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. malaccensis var. malaccensis BB08     GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. malaccensis var. pseudomangostana SP01GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. malaccenssis BB09                     GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. mangostana LAO                        GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. megaphylla 041                        GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTTTTAATCAATCTGGGATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. penangiana 006                        GGGGTAGGGTATTACGAAAGGAAGTTGATGATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. rigida 029                            GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. rigida 045                            GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AT
G. rigida 049                            GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. rigida 057                            GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. rostrata 007                          GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATCAATCCGGAATTGATTCTTCCTGGGTCGATGCCCGAAGTGGTTAATGGGGACGG-AT
G. spD2 P02                              GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATCAATCCGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC
G. spM4 022                              GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGGACT
G. spX2 080                              GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTTTGAATCAATCTGGGATTGATTCTTCCTGGGTCGATGCCCGAAGTGGTTAATGGGGACGG-AC
G. trianii K02                           GGGGTAGGGTATTACGAAAGGAAGTTGATCATGAATTATTAATAAATCTGGAATTGATTCTTCCTGGGTCGATGCCCGA-GTGGTTAATGGGGACGG-AC


                                                910       920       930       940       950       960       970       980       990      1000
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                       -TGTAAATTCG-TTGGCAATATGTTTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. cataractalis 077                      -TGTAAATTCG-T-GGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. celebica 002                          -TGTAAATTCG-TTGGCAATATGTTTACGCTGGTTCAAATCCAGCTCGGCCCAATTATTCACTGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
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G. celebica 023                          -TGTAAATTCG-TTGGCAATATGTTTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACTGATCCGCCATGAAATGATATAACCCCTTTTTTTCTCT
G. celebica 033                          -TGTAA-TTCG-T-GGCAATATGTTTACGCTGGTTCAAATCCAGCTCGGCCCAATTATTCACTGATCCGCCATGAAATGATATAACCCC-TTTTTTCTCT
G. cymosa 037                            -TGTA???????????????????????????????????????????????????????????????????????????????????????????????
G. diospyrifolia var dumosa 078          TTGTAAATTCG-T-GGCGATAAC?????????????????????????????????????????????????????????????????????????????
G. diospyrifolia var minor BB06          -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. discoidea_SL01                        -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. malaccensis var. malaccensis BB08     -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. malaccensis var. pseudomangostana SP01-TGTAA-TTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. malaccenssis BB09                     -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. mangostana LAO                        -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. megaphylla 041                        -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCG-TTTCTTCTCT
G. penangiana 006                        -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. rigida 029                            -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. rigida 045                            CTGTAA-TT???????????????????????????????????????????????????????????????????????????????????????????
G. rigida 049                            -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. rigida 057                            -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. rostrata 007                          ????????????????????????????????????????????????????????????????????????????????????????????????????
G. spD2 P02                              -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCC-TTTCTTCTCT
G. spM4 022                              GTATTCGTTGGCGCATC???????????????????????????????????????????????????????????????????????????????????
G. spX2 080                              -TGTAATT????????????????????????????????????????????????????????????????????????????????????????????
G. trianii K02                           -TGTAAATTCG-TTGGCAATATGTCTACGCTGGTTCAAATCCAGCTCGGCCCAATAATTCACCGATCCGCCATGAAATGATATAACCCG-TTTCTTCTCT


                                              1010      1020      1030      1040      1050      1060      1070      1080      1090      1100
                                          ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                        T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. cataractalis 077                       T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. celebica 002                           T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. celebica 023                           T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTTTGTTTTACTTCTTATTTATTTATTT----GAT-------TTGCTTTATTTTTTCCCA
G. celebica 033                           T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTTTGTTTTACTTCTTATTTATTTATTT----GAT-------TTGCTTTATTTTTTCCCA
G. cymosa 037                             ????????????????????????????????????????????????????????????????????????????????????????????????????
G. diospyrifolia var dumosa 078           ????????????????????????????????????????????????????????????????????????????????????????????????????
G. diospyrifolia var minor BB06           TCTTCTCTTGAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. discoidea_SL01                         T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTTTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. malaccensis var. malaccensis BB08      T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. malaccensis var. pseudomangostana SP01 T--------GAAATGTCCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. malaccenssis BB09                      T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. mangostana LAO                         T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. megaphylla 041                         T--------GAAATG-CCTGATAGAGAAAAAAGTCCAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. penangiana 006                         T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. rigida 029                             T--------GAAATG-CCTGATAGAGAAAAAAATCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. rigida 045                             ????????????????????????????????????????????????????????????????????????????????????????????????????
G. rigida 049                             T--------GAAATG-CCTGATAGAGAAAAAAATCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. rigida 057                             T--------GAAATG-CCTGATAGAGAAAAAAATCAAAATTTCTGTTCTACTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. rostrata 007                           ????????????????????????????????????????????????????????????????????????????????????????????????????
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G. spD2 P02                             T--------GAAATG-CCTGATAGAGAAAAAAGTCCAAATTTCTGTTCTATTTCTTATTTATTTATTT----GAT-------TTGCTCTATTTTTTCCCA
G. spM4 022                             ????????????????????????????????????????????????????????????????????????????????????????????????????
G. spX2 080                             ????????????????????????????????????????????????????????????????????????????????????????????????????
G. trianii K02                          T--------GAAATG-CCTGATAGAGAAAAAAGTCAAAATTTCTGTTCTACTTCTTATTTATTTATTTATTTGATATTTGATTTGCTCTATTTTTTCCCA


                                              1110      1120      1130      1140      1150      1160      1170      1180      1190
1200
                                        ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
 G. acuticosta BB01                     CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAA--GATAACTAGTAATCTGTTAATCTG
 G. cataractalis 077                    CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAAAAGATAACTAGTAATCTGTTAATCTG
 G. celebica 002                        CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAAA-GATAACTAGTAATCTGTTAATCTG
 G. celebica 023                        CAAATTATGATCGATCACGATTTGTATAAAGATTTATTATCAATTCGATTTGGATTTGAAATAACCAAAAAAAAA-GATAACTAGTAATCTGTTAATCTG
 G. celebica 033                        CAAATTATGATCGATCACGATTTGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAAA-GATAACTAGTAATCTGTTAATCTG
 G. cymosa 037                          ????????????????????????????????????????????????????????????????????????????????????????????????????
 G. diospyrifolia var dumosa 078        ????????????????????????????????????????????????????????????????????????????????????????????????????
 G. diospyrifolia var minor BB06        CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAAA-GATAACTAGTAATCTGTTAATCTG
 G. discoidea_SL01                      CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAA--GATAACTAGTAATCTGTTAATCTG
 G. malaccensis var. malaccensis BB08   CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAA--GATAACTAGTAATCTGTTAATCTG
 G. malaccensis var. pseudomangostana SP01CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAA--GATAACTAGTAATCTGTTAATCTG
 G. malaccenssis BB09                   CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAA--GATAACTAGTAATCTGTTAATCTG
 G. mangostana LAO                      CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAA--GATAACTAGTAATCTGTTAATCTG
 G. megaphylla 041                      CAAATTATGATCGATCACGATTCATATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAA---GATAACTAGTAATCTGTTAATCTG
 G. penangiana 006                      CAAATTATGATCGATCACGATTCGTATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAAA--GATAACTAGTAATCTGTTAATCTG
 G. rigida 029                          CAAATTATGATCGATCACGATTCATATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAA---GATAACTAGTAATCTGTTAATCTG
 G. rigida 045                          ????????????????????????????????????????????????????????????????????????????????????????????????????
 G. rigida 049                          CAAATTATGATCGATCACGATTCATATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAA---GATAACTAGTAATCTGTTAATCTG
 G. rigida 057                          CAAATTATGATCGATCACGATTCATATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAA---GATAACTAGTAATCTGTTAATCTG
 G. rostrata 007                        ????????????????????????????????????????????????????????????????????????????????????????????????????
 G. spD2 P02                            CAAATTATGATCGATCACGATTCATATAAAGATTTTTTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAA---GATAACTAGTAATCTGTTAATCTG
 G. spM4 022                            ????????????????????????????????????????????????????????????????????????????????????????????????????
 G. spX2 080                            ????????????????????????????????????????????????????????????????????????????????????????????????????
 G. trianii K02                         CAAATTATGATCGATCACGATTCATATAAAGATTTATTATCAAT-CGATTTGGATTTGAAATAACAAAAAAAA---GATAACTAGTAATCTGTAAATCTG


                                              1210      1220      1230      1240      1250      1260      1270      1280      1290
1300
                                        ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
 G. acuticosta BB01                     TGCCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
 G. cataractalis 077                    TGCCCTTATTACTTTACTCTAAAACTTTAAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTGTCGCACAACGCAGCGCGAA------
 G. celebica 002                        TGCCCTTATTACTTTACTAT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
 G. celebica 023                        TGCCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
 G. celebica 033                        TGCCCTTATTACTTTACTTTT------TAAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
 G. cymosa 037                          ????????????????????????????????????????????????????????????????????????????????????????????????????
 G. diospyrifolia var dumosa 078        ????????????????????????????????????????????????????????????????????????????????????????????????????
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G. diospyrifolia var minor BB06          TGCCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. discoidea_SL01                        TGCCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. malaccensis var. malaccensis BB08     TACCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. malaccensis var. pseudomangostana SP01TGCCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. malaccenssis BB09                     TACCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. mangostana LAO                        TACCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. megaphylla 041                        TGTCCTTATTACTTT------------------GTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCGGCGCGAATGGAAA
G. penangiana 006                        TGCCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. rigida 029                            TGCCCTTATTACTTTACTCT--------ACAGCGTATATCTACGGAACTAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. rigida 045                            ????????????????????????????????????????????????????????????????????????????????????????????????????
G. rigida 049                            TGCCCTTATTACTTTACTCT--------ACAGCGTATATCTACGGAACTAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCAGCGCGAA------
G. rigida 057                            TGCCCTTATTACTTTACTCT--------ACAGTGTATATCTACGGAACTAGCAATACAATATAGCACCCGCYTTCTCGCACAACGCAGCGCGAA------
G. rostrata 007                          ????????????????????????????????????????????????????????????????????????????????????????????????????
G. spD2 P02                              TGCACTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTCGCACAACGCGGCGCGAA------
G. spM4 022                              ????????????????????????????????????????????????????????????????????????????????????????????????????
G. spX2 080                              ????????????????????????????????????????????????????????????????????????????????????????????????????
G. trianii K02                           TGCCCTTATTACTTTACTCT--------AAAGTGTATATCTACGGAAATAGCAATACAATATAGCACCCGCCTTCTTGCACAACGCAGCGCGAA------

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                                                 1310      1320      1330      1340      1350      1360      1370      1380      1390
1400
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|
G. acuticosta BB01                       ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTT????????????0001
G. cataractalis 077                      ---------TGGAAATCGAAAGAATGGAAATAGAAAGAAAGGGTTTGAA???????????????????????????????????????????????0100
G. celebica 002                          ---------GGGAA-TCAAAAGGAAGG?????????????????????????????????????????????????????????????????????????
G. celebica 023                          ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTTT???????????0000
G. celebica 033                          ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATG?????????????????????????????????????????????1001
G. cymosa 037                            ????????????????????????????????????????????????????????????????????????????????????????????????0000
G. diospyrifolia var dumosa 078          ????????????????????????????????????????????????????????????????????????????????????????????????1000
G. diospyrifolia var minor BB06          ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTTATATA???????1000
G. discoidea_SL01                        ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACT????????????????0000
G. malaccensis var. malaccensis BB08     ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTT????????????0000
G. malaccensis var. pseudomangostana SP01---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTT????????????0001
G. malaccenssis BB09                     ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTTATATTTAA???????0
G. mangostana LAO                        ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTT????????????0000
G. megaphylla 041                        TAGAAAGAATGGAAATAGAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACA??????????????????0000
G. penangiana 006                        ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTTTTCATTAATTTG1000
G. rigida 029                            ---------CGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTTTTC?????????1000
G. rigida 045                            ????????????????????????????????????????????????????????????????????????????????????????????????1001
G. rigida 049                            ---------CGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTTTCATATTA????????
G. rigida 057                            ---------CGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTTT??????????????0
G. rostrata 007                          ????????????????????????????????????????????????????????????????????????????????????????????????0000
G. spD2 P02                              ------------------------TGGAAATAGAAAGAAAGGGTTTGAATGAAATTTTAAGAATACGTATGCTGTACACTTTTT????????????0000
G. spM4 022                              ????????????????????????????????????????????????????????????????????????????????????????????????0000
G. spX2 080                              ????????????????????????????????????????????????????????????????????????????????????????????????0000
G. trianii K02                           ---------TGGAAATCAAAAGAATGGAAATAGAAAGAAAGGGTTTGAA???????????????????????????????????????????????0000
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                                         ******* **   *  * * **  * *****       ** * * *  ** *     *  *** *******  *   **********
                                                1410      1420      1430      1440      1450      1460      1470      1480
                                         ....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|....|..
G. acuticosta BB01                       111111101-----00101-0011100001----001-10011-------01101-00101000111101011111101-01-10-0
G. cataractalis 077                      111101101-----00101-1011100001----001-10010-1-----01101-00101000111101111111100000010-0
G. celebica 002                          ??????????????00101-10111010001---001-10011-------01101-00101000110101011111100101-10-1
G. celebica 023                          000101101-----00101-10111000001---001-10011-------01101-00101000111101001111000101-10-0
G. celebica 033                          111101101-----00101-10111010001---001-10011-------01101-01101000111111111111100100110-0
G. cymosa 037                            1111011001000010000101-110000001--110000000000001001101-1-1010001011???????????????????
G. diospyrifolia var dumosa 078          110101001-----00001-10111010001---001-10011-------011001001010000110011????????????????
G. diospyrifolia var minor BB06          111101101-----00101-10101010001---001-10011-------01101-00101000111101010111100101-10-0
G. discoidea_SL01                        111101101-----00101-10111000001---001-10011-------01101-00101000111101011111101-01-10-0
G. malaccensis var. malaccensis BB08     11110110001---00101-1011101001----001-10011-------01101-00101000111101011111101-01-10-0
G. malaccensis var. pseudomangostana SP01111101101-----00101-1011101001----001-10011-------01101-00101000111111011011101-01-10-0
G. malaccenssis BB09                     11110110001---00101-1011101001----000110010-1-----01101-00101000111101011111101-01-10-0
G. mangostana LAO                        11110110001---00101-1011101001----001-10011-------01101-00101000111101011111101-01-10-0
G. megaphylla 041                        1001011000001-00101-00011001000000001-1001000000101--01-1-10100011110101111111--1--0000
G. penangiana 006                        111101001-----00101-001110100001--001-10011-------01101-001001111111-1-111111-1--1-1???
G. rigida 029                            11110111------00101-10111010000001001-10010000-1--01101-0110100011110101111111--01-10-0
G. rigida 045                            11110111------00101-1011101000001-001-10011-------01101-0010100011101??????????????????
G. rigida 049                            ????????????????????????????????????1-10010000-1--01101-0110100011110101111111--01-10-0
G. rigida 057                            11110111------00101-10111010000001001-10010000-1--01101-0110100011110101111111--01-10-0
G. rostrata 007                          1111011000000100101-0001110000001-001-1000010000001--01-1-101000101????????????????????
G. spD2 P02                              11011111------001000000111100001--000010010000000000001-1-10100011110101111111--01--1??
G. spM4 022                              11100111------01-01-01-11000001---001-1001000010-00110000011-0001100000????????????????
G. spX2 080                              10010111------00101-00010000001---001-1001000000101--01-1-10100010110??????????????????
G. trianii K02                           11110111------00101-101110000000000000-100000100-001111-0010100011110101110011--01-10-0
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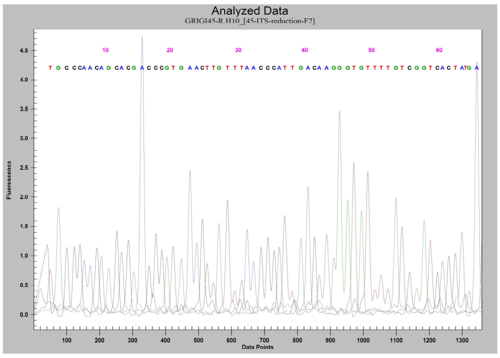
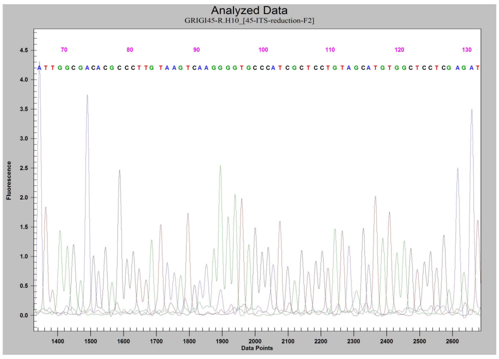
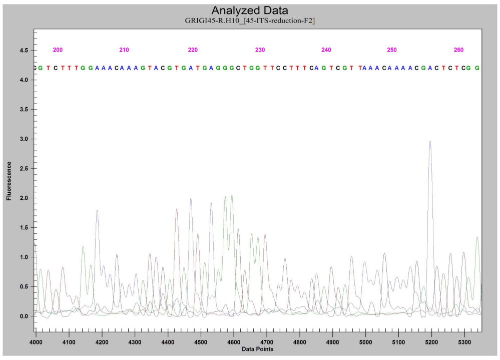
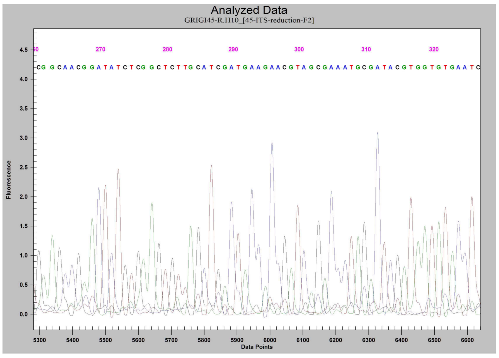
APPENDIX VIII

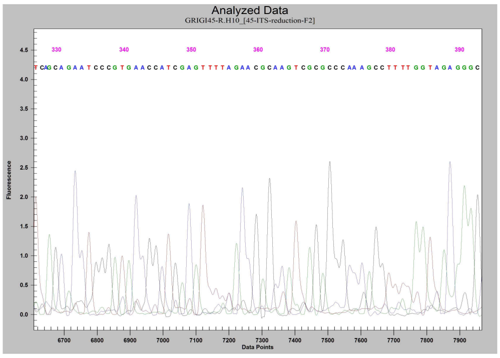
Electropherogram of *Garcinia rigida* Miq. (accession 045) upstream sequence of ITS.

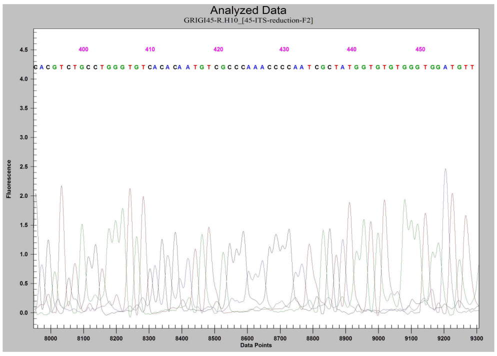


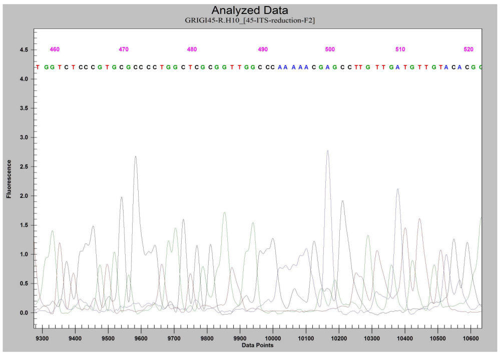


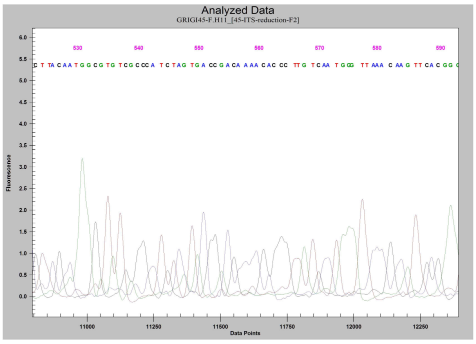












APPENDIX IX

Electropherogram of *Garcinia mangostana* L. (accession 096) upstream sequence of ITS.