

## ADDITIONS TO OROPHEA SUBGENUS SPHAEROCARPON (ANNONACEAE): REVISION AND TRANSFER OF MEZZETTIOPSIS

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### SUMMARY

The genus *Mezzettiopsis* Ridl. (Annonaceae) is revised and transferred to *Orophea* Blume subgenus *Sphaerocarpon* Keßler. Phylogenetic analysis of subgenus *Sphaerocarpon* and *Mezzettiopsis* places *Mezzettiopsis* within the subgenus. Furthermore, the prevalence of common or overlapping character states and the paucity of unique character states necessitate the transfer. Two species were transferred from *Mezzettiopsis*. Of these, one species of *Orophea* is reinstated and one new combination is made. Three species are described as new. In total, nine species are fully described. *Sphaerocarpon* is a subgenus of small, tropical, lowland trees distributed from Sulawesi westwards to South India. It is characterised by having sepals and outer petals that are sessile or nearly sessile and more or less ovate, with outer petals that are twice the size of the sepals, inner petals that are clawed, roughly diamond-shaped and connivent during development at the edges of the lamina, by miliusoid stamens, by stipitate, globose to oblongate carpodia, and by glabrous to pubescent leaves. A key to the flowering material is presented.

**Key words:** Annonaceae, *Mezzettiopsis*, *Orophea*, *Sphaerocarpon*, phylogeny.

### INTRODUCTION

The Annonaceae represent about 130 genera and 2300 species of pantropical, lowland, rarely montane, shrubs, trees or climbers. Keßler (1988) places the genus *Mezzettiopsis* Ridl. in the tribe Miliuseae Hook. f. & Thomson (as Saccopetaleae) together with the genera *Alphonsea*, *Miliusa*, *Orophea*, *Phoencanthus*, and *Platymitra*. In this tribe, only *Miliusa* now remains to be revised.

The generic delimitation between *Mezzettiopsis* Ridl. and *Orophea* Blume has always been difficult. *Mezzettiopsis* was established in 1912 by Ridley with the publication of the type species, *M. creaghii*, described from a specimen collected in Tinkayo, Sabah and named in honour of Governor Creagh. Confusion first arose when in 1913 the same species was described and published as *Orophea palawanensis* by Elmer. In a treatment of the Annonaceae of Peninsular Malaysia, Sinclair (1955) informally pronounced *M. creaghii* an *Orophea*, indicating its close affinity with *O. palawanensis*. With his revision of *Orophea* in 1988, Keßler reaffirmed the generic status of *Mezzettiopsis*, citing inner petal-, stamen-, carpel-, ovule-, and seed integument characters to distinguish *Mezzettiopsis* from *Sphaerocarpon*, his new subgenus of *Orophea*. Keßler's

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revision resulted in the synonymy of *O. palawanensis* and *M. creaghii* and the suggested transfer to *Mezzettiopsis* of five species of *Orophea*, namely: *O. hastata*, *O. monosperma*, *O. salacifolia*, *O. siamensis*, and *O. torulosa*. In 1990, Goel transferred *O. torulosa* to *Mezzettiopsis* in an article of the recent rediscovery and recollection of this species in the Andaman Islands.

This present revision of *Mezzettiopsis* transfers the genus to *Orophea* subgenus *Sphaerocarpon* resulting in a new species combination, the description of three new species, and the reinstatement of *O. torulosa*. Phylogenetic analysis corroborates the transfer. This revision is made as a contribution to the Flora Malesiana treatment of the Annonaceae.

#### VEGETATIVE MORPHOLOGY

*Orophea* subgenus *Sphaerocarpon* consists of shrubs to small trees. The leaves are subchartaceous to subcoriaceous. The leaf tips are often folded to one side at or near their bases. Hairs, if present, are simple, usually 1 mm or shorter but in *O. hirsuta* and *O. malayana* they may reach 2 mm in length. The indument is usually sparsely to densely pubescent on leaves and young twigs, often glabrescent, but in *O. hirsuta* it is hirsute and persistent on even old twigs. The lower surface of the leaves of *O. creaghii* and *O. malayana* characteristically dry dark reddish brown. Leaf venation is eucamptodromous: “with a single primary vein, the secondary veins curved upward and gradually diminishing distally within the margin and interconnected by a series of cross-veins without forming conspicuous marginal loops” following the system of Hickey (1973) and Radford et al. (1974). Klucking (1986) notes two leaf venation types pertinent to the subgenus: ‘Early Phase’ venation dominant with small amounts of ‘Middle Phase’ and occasional ‘Late Phase’ venation, and ‘Middle Phase’ dominant with small amounts of ‘Early Phase’ venation in the base of the leaf and sometimes ‘Late Phase’ venation at the upper third of the leaf. Klucking’s findings may prove to be inaccurate because of the questionable identities of some of the specimens he studied.

#### INFLORESCENCES AND FLOWERS

The flowers are arranged in 1–3-, 1–6-, or more than 6-flowered, densely bracteate, cymose, axillary inflorescences. Supra-axillary inflorescences are sometimes found in *O. hastata*, while ramiflorous inflorescences are unique to *O. monosperma*. The pedicels are articulated at the base. The bracts are usually cymbiform but in *O. malayana* triangular. Triangular bracteoles are found at the middle of the pedicels. The flower buds are always ovoid but may be surmounted by the overgrown tips of the inner petals. The sepals are valvate, sessile, connate at the base, deltoid-ovate. The outer petals are likewise valvate, sessile or nearly so, free, ovate to slightly obcordate. The inner petals are valvate, clawed, connivent before anthesis at the lateral and terminal borders of the lamina, forming a roof over the androecium and gynoecium. The lamina are roughly diamond-shaped with the borders clearly marked by an inverted V-shaped ridge covered by hairs. The inner petal tips may be shortly to largely protracted, straight to strongly recurved, smooth to very warty. The margins of the tips may also be incurved. In species with greatly protracted inner petal tips, the connivent condition of the inner petals may not be very apparent so that the inner petals may

mistakenly appear free. The inner petal tips are often keeled on their inner surface, thus making them triquetrous; however, the degree to which this feature is manifest varies. Nectaries are found at the lamina of the inner petals and range from paired simple to hooked holes, to single and variously shaped (see Keßler, 1988 for illustrations). Paired, hooked nectaries and single more or less triangular nectaries may prove to be variants of one another as the hooks need only merging together to form the latter. This condition has in fact been observed in some of the specimens studied. Single H-shaped and hippocrepiform nectaries also seem to be related: hippocrepiform nectaries with paired lateral gouges at their curved end have been observed and seem to be intermediary between hippocrepiform and H-shaped nectaries. The rounded torus is densely hairy between the inner petals and the stamens. The always miliusoid stamens are sessile or nearly so and number 6 in a single whorl, or 9 in two whorls (6+3), or 12 in two whorls (6+6). Whether or not the stamens are disposed in series seems to be partly dependent on the number of carpels of the flower. Staminodes which are commonly found in *Orophea* subgenus *Orophea* are always absent in subgenus *Sphaerocarpon*. Stamen connective prolongations never conceal the theca. They are acute, sometimes retuse, erect or recurved. These states vary within the same species, often within the same flower and are seemingly dependent on the proximity of the stamen to the gynoecium. Carpel number varies from 3 to 18 in multiples of 3 and may be sparsely hairy to completely glabrous. The stigma is sessile, globose to oblongate, and hairy, sometimes appearing like a pom-pom. An extra-gynoecial com-pitum (Endress, 1982) appearing like a jelly-like mass above the stigmas is often found. Ovules are almost always 2, but among the species with broad, incurved, strongly recurved, inner petal tips, a tendency to having more than 2 ovules (up to 6 in *O. laui*) is observed.

#### CARPIDIA

The fruits of *Orophea* subgenus *Sphaerocarpon* are all globose to shortly oblongate, and stipitate monocarps which vary in the lengths of the stipe and fruiting stalks, the diameter of the torus, the size of the monocarps, and number of monocarps that reach maturity. The fruiting stalks tend to be longer and thicker than the flowering stalks. The sepals are persistent in fruit, not caducous as reported by Van Setten & Koek-Noorman (1992) but remain attached even after the monocarps have fallen off. The monocarps are all smooth but are often found shrivelled and thus slightly rugose, a probable artefact of the drying process. *Orophea hirsuta* is unique in the subgenus in having hirsute monocarps, a curious condition considering that the carpels are completely glabrous. The remainder of the subgenus has glabrous monocarps. The fruits of *O. glabra* and *O. rubra* seem to be peculiar to these two species. At maturity, they are paired, relatively large monocarps (up to 3 cm diam.) with proportionately long stipes on a small torus.

The seeds are globose, half-globose to thick-discoid, filling the monocarps. Van Setten & Koek-Noorman (1992) reported the following additional fruit and seed features: fruit wall crustaceous, c. 0.5 mm thick, seeds with a raphe that is flat or shallowly grooved, hilum circular, ruminations spiniform to flattened pegs towards the raphe, endosperm very hard, glass-like or stony. Christmann (1986, 1987) observed a rare middle (third) integument in *O. creaghii* (sub *Mezzettiopsis creaghii*) to be absent

in the species of *Orophea* he studied, a finding that influenced Keßler to re-affirm the identity of *Mezzettiopsis* as a genus. However, Christmann included only one species of *Orophea* subgenus *Sphaerocarpon* in his studies and the middle integument may well be found in other species of the subgenus.

#### PHYLOGENY

A cladistic analysis was performed to elucidate the phylogenetic relationship between *Mezzettiopsis* and *Orophea* subgenus *Sphaerocarpon*. *Alphonsea ventricosa* and *Platymitra macrocarpa*, both species within the same tribe Miliuseae, were used as out-groups. Three species of *Orophea* subgenus *Orophea* (*O. hexandra*, *O. merrillii*, and *O. enneandra*) were also included in the analysis. Three species of subgenus *Sphaerocarpon*, namely, *O. multiflora*, *O. hainanensis*, and *O. thorelii*, were not seen and character states for these were scored from literature (Keßler, 1988) or were left ambiguous. The analysis was executed with the following characters and states (for data matrix, see Table 1):

1. Mature twigs: 0 = hairy; 1 = glabrous.
2. Petiole cross section: 0 = terete; 1 = grooved.
3. Leaf base: 0 = rounded; 1 = cordate; 2 = cuneate.
4. Leaf tip length: 0 = < 10 mm; 1 = ≥ 10 mm.
5. Leaf midrib upper surface: 0 = grooved; 1 = raised.
6. Flowers per inflorescence: 0 = ≤ 3; 1 = 4–6; 2 = > 6.
7. Outer petal vs. inner petal shape: 0 = identical; 1 = different.
8. Total length of inner petal / claw length: 0 = 0; 1 = < 0.4; 2 = ≥ 0.4.
9. Length of inner petal tip / lamina length: 0 = < 0.25; 1 = ≥ 0.25.
10. Inner petal tip: 0 = short; 1 = protracted.
11. Inner petal tip surface: 0 = smooth; 1 = warty.
12. Margins of inner petal tip: 0 = flat; 1 = incurved.
13. Inner petal tip recurvation: 0 = absent; 1 = present in bud or at anthesis;  
2 = always present.
14. Nectaries: 0 = absent; 1 = W-shaped; 2 = paired, horizontal holes; 3 = single, triangular or paired, hooked; 4 = single, undulating margin; 5 = H-shaped to hippo-crepiform; 6 = paired slits or puncture holes.
15. Stamen number: 0 = > 20; 1 = 6; 2 = 9; 3 = 12.
16. Carpel number: 0 = 2 or 8; 1 = 3; 2 = 6; 3 = 9; 4 = 12; 5 = 15; 6 = 18.
17. Carpel indument: 0 = very hairy; 1 = sparsely hairy; 2 = completely glabrous.
18. Stigma shape: 0 = globose to ellipsoid; 1 = oblongate.
19. Ovule number: 0 = > 2; 1 = 2.
20. Monocarp shape: 0 = cylindrical; 1 = spherical to oblongate.

The cladistic analysis was performed with PAUP version 3.1.1 (Swofford, 1993). All characters were treated as unordered and equally weighted. Multiple states were interpreted as polymorphic. A heuristic search was performed (MULPARS option in effect, addition sequence random). Decay indices were also determined.

Forty-two most parsimonious cladograms were found by the analysis. The cladograms are 72 steps long with polymorphic characters accounting for 14 steps (CI = 0.632, RI = 0.851). The strict consensus of the most parsimonious cladograms is

Table 1. Data matrix used for cladistic analysis.

characters species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
<i>A. ventricosa</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>P. macrocarpa</i>	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>O. hexandra</i>	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	1	0	0	0	0
<i>O. merrillii</i>	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0
<i>O. enneandra</i>	0	0	0	0	0	0	1	1	0	1	0	0	0	2	2	1	0	1	1	0
<i>O. hirsuta</i>	0	1	1	1	0	0	1	1	0	0	0	0	0	3	1	1	2	1	1	1
<i>O. multiflora</i>	1	1	0	?	0	1	1	1	0	0	0	?	0	3	2	1	?	1	1	1
<i>O. salacifolia</i>	1	1	0	0	1	0	1	1	0	0	0	0	0	3	2	5	2	0	1	1
<i>O. zeylanica</i>	1	1	0	0	0	0	1	1	0	0	0	0	0	3	1	2,3	2	1	1	1
<i>O. thorelii</i>	1	1	2	?	0	0	1	1	0	0	0	?	0	4	1	2	?	1	1	1
<i>O. hainanensis</i>	1	1	2	?	0	0	1	1	0	0	0	?	0	3	1	2	?	1	1	1
<i>O. polycarpa</i>	1	1	0,2	0	0	0	1	1	0	0	0	0	0	3	1	4	1	0,1	1	1
<i>O. uniflora</i>	1	1	0,2	0	0	0	1	1	0	0	0	0	0	3	3	2	1	1	1	1
<i>O. malayana</i>	1	1	0	1	0	0	1	2	0	0	0	0	0	3	3	1,2	1	1	1	1
<i>O. thomsonii</i>	1	1	2	1	0	0	1	2	0	0	0	0	0	2	3	2	2	1	1	1
<i>O. rubra</i>	1	1	2	1	0	1	1	1	0	0	0	0	0	3	3	2	1	0	1	1
<i>O. glabra</i>	1	1	2	1	0	1	1	1	0	0	0	0	0	3	3	2	1	0	1	1
<i>O. dodecandra</i>	1	1	2	1	0	0	1	1	0	0	0	0	0	3	3	4,6	1	0	1	1
<i>O. kerrii</i>	1	1	2	1	0	0	1	1	0	1	0	0	1	5	3	4	1	0	1	1
<i>O. siamensis</i>	1	1	2	1	0	0	1	1	0	1	0	0	1	5	1,3	4	1	0	1	1
<i>O. hastata</i>	1	1	2	1	0	0	1	1	1	1	1	0	1	6	2,3	4	1	0	1	1
<i>O. kingiana</i>	1	1	0,2	1	0	1	1	2	1	1	1	0	1	6	3	6	1	0	1	1
<i>O. creaghii</i>	1	1	0,2	1	0	2	1	2	1	1	1	1	2	6	3	6	1	0	0	1
<i>O. laui</i>	1	1	2	1	0	2	1	2	1	1	1	1	2	6	2,3	3,4,5,6	1	0	0	1
<i>O. laotica</i>	1	1	2	1	1	2	1	2	1	1	1	1	2	6	2	5	1	0	0	1
<i>O. monosperma</i>	1	1	0,2	1	1	0	1	1,2	1	1	1	1	2	6	2	5	2	0	0	1
<i>O. torulosa</i>	1	1	0	1	1	0	1	2	1	1	1	1	2	6	2	5	2	0	0	1

shown in Figure 1. The character transformation series and the decay indices are also presented.

The analysis shows that *Orophea* subgenus *Sphaerocarpon* is a monophyletic group. *Orophea hirsuta*, which shares several character states with *Orophea* subgenus *Orophea*, is shown to be the sister species of the rest of subgenus *Sphaerocarpon*. A polytomy is found where the rest of subgenus *Sphaerocarpon* splits off from a common ancestor with *O. zeylanica*. The uncertain relationship of the groups in this clade, namely, *O. thorelii*, *O. hainanensis*, *O. polycarpa*, and the sister group formed by the remaining species of subgenus *Sphaerocarpon* further along the tree, exists because several character states were left ambiguous for *O. thorelii* and *O. hainanensis*. These species could not be examined and were only scored from Keßler's (1988) description. *Orophea malayana* and *O. thomsonii* form sister species and are vegetatively very similar, both having oblong leaves with long-acuminate leaf tips. Moreover, these two species have relatively short inner petal claws and share the same number of stamens and carpels. *Orophea rubra* and *O. glabra* also form sister species and are nearly indistinguishable from each other in both vegetative and reproductive characters. *Orophea siamensis* and *O. kerrii* are also shown to be closely related. These two species seem to differ only in the kind of nectaries that they possess and in the prevalent sizes of their leaves, both characters which tend to overlap. All but one (*O. salacifolia*) of the species that Keßler recommended be transferred to *Mezzettiopsis*, together with

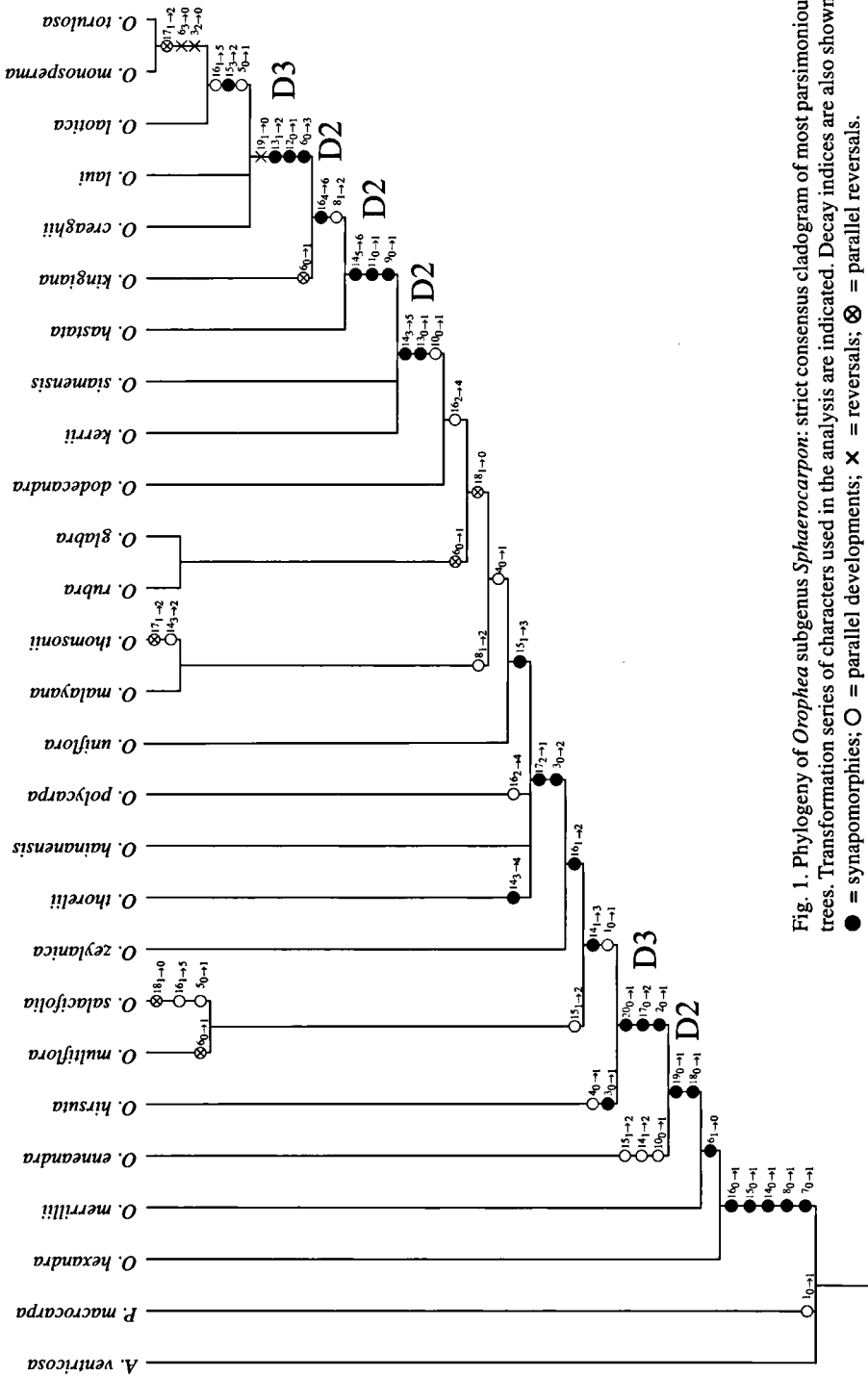


Fig. 1. Phylogeny of *Orophea* subgenus *Sphaerocarpon*: strict consensus cladogram of most parsimonious trees. Transformation series of characters used in the analysis are indicated. Decay indices are also shown. ● = synapomorphies; ○ = parallel developments; ⊗ = reversals; ⊗ = parallel reversals.

*O. kerrii*, form a sister group to the rest of subgenus *Sphaerocarpon*. This group is supported by inner petal character states such as protracted and recurved tips. Further down the clade more inner petal characters become informative: a reduction in lamina size, wartiness of the tips, and the appearance of small, slit-like nectaries are found in the clade of *O. hastata* and its sister group. Shortening of the claw, and even greater compaction of the lamina are found in the sister group of *O. hastata*. Broad, incurved, strongly recurved inner petal tips as well as a tendency to having more than 2 ovules per carpel, a novelty in the subgenus and an apparent reversal (a character state also found in *Orophea* subgenus *Orophea*), supports the sister group of *O. kingiana*. *Orophea laui* is polymorphic in stamen and carpel numbers, hence the unresolved relationship of the groups of its clade. The last three species share similar stamen and carpel numbers and all have leaves with midribs raised on the upper surface. *Orophea torulosa* and *O. monosperma* are supported as sister species by their having rounded leaf bases and completely glabrous carpels.

The strict consensus cladogram exhibits a great degree of homoplasy: eleven parallel developments, three reversals and three parallel reversals are found. Despite this, the cladogram shows the relationship between *Mezzettiopsis* and subgenus *Sphaerocarpon* and how the previous and previously purported members of *Mezzettiopsis* completely fall within subgenus *Sphaerocarpon*.

#### KEY AND DESCRIPTIONS

##### **OROPHEA subgenus SPHAEROCARPON**

*Orophea* Blume subgenus *Sphaerocarpon* Keßler, *Blumea* 33 (1988) 62; 34 (1990) 505. — Type species: *Orophea polycarpa* A.DC.

Trees or shrubs. *Leaves* sparsely pubescent to glabrous on lower surface, glabrous on upper surface (lower surface densely pubescent, upper surface sparsely pubescent in *O. hirsuta*). *Inflorescences* axillary, rarely supra-axillary or ramiflorous. *Sepals* connate at their bases, ovate to slightly obcordate, concave. *Outer petals* free, ovate to slightly obcordate, twice as large as the sepals, concave and erect in bud, flattening and spreading at maturity. *Inner petals* divisible into claw, lamina, and tip; inner petal lamina roughly diamond-shaped, connivent during development; inner petals long-clawed with laterally expanded and flattened lamina and short tips to short-clawed with small and thickened lamina and protracted, flat to incurved, straight to recurved, tips. *Nectaries* present. *Stamens* all equal in size, nearly sessile, 6 in a single whorl, 9 in two whorls (6+3), or 12 in two whorls (6+6). *Staminodes* always absent. *Carpels* 3–18 in multiples of 3, sparsely hairy to completely glabrous, roughly banana-shaped, angular in cross section. *Ovules* almost always 2 (rarely up to 3–6 in species with inner petal tips that are recurved from bud to anthesis). *Carpidia* globose to shortly oblongate, stipitate, up to 3 cm diam., glabrous (except *O. hirsuta*). *Seeds* 1–3, globose to hemispherical.

Distribution — 22 species. S India, Andaman Islands, Thailand, Laos, Cambodia, Vietnam, S China, Hainan; *Malesia*: Peninsular Malaysia, Borneo, Philippines, Sulawesi.

Notes — A chromosome count of *Orophea* spec. and *O. creaghii* (sub *Mezzettiopsis creaghii*, material not seen) by Okada (1993) found  $2n = 18$ . Christmann (1986) observed a rare middle integument in seeds of *O. creaghii* (sub *Mezzettiopsis creaghii*) that was absent in the only other species of subgenus *Sphaerocarpon* he studied (*O. polycarpa*). According to Walker (1971) the pollen grains of *Orophea* are solitary, medium-sized, globose, apolar, radiosymmetric, inaperturate (no species of subgenus *Sphaerocarpon* were studied).

#### KEY TO THE SPECIES OF OROPHEA SUBGENUS SPHAEROCARPON

(The species described here are printed in bold roman type)

- 1a. Mature twigs, densely hirsute or velvety, leaf base cordate, mature monocarps hirsute. — Indochina, Hainan, Peninsular Malaysia . . . . . ***O. hirsuta***
- b. Mature twigs generally glabrous, leaf base cuneate to rounded, never cordate, mature monocarps glabrous . . . . . 2
- 2a. Indument on bracts and bracteoles straw yellow to whitish, 1–2 mm long, flowering peduncles 10 mm long, flowering pedicels 20 mm long. — Peninsular Thailand, Peninsular Malaysia . . . . . ***O. malayana***
- b. Indument on bracts and bracteoles reddish- to golden brown, up to 1 mm long, flowering peduncles up to 8 mm long, flowering pedicels up to 12 mm long . . . . . 3
- 3a. Tips of inner petals, incurved, recurved from bud to anthesis, at anthesis double-bent, lamina relatively small (less than 25% of entire petal), laterally compressed . . . . . 4
- b. Tips of inner petals flat, erect at bud or at anthesis, if recurved at anthesis, lamina relatively large (more than 25% of entire petal), flattened, laterally expanded . . . . . 8
- 4a. Midrib on upper leaf surface flat or grooved near base of leaf . . . . . 5
- b. Midrib on upper leaf surface raised near base of leaf . . . . . 6
- 5a. Leaf tips short-caudate, drying dark reddish brown. — Peninsular Malaysia, Borneo, Palawan, Luzon, Sulawesi . . . . . **1. *O. creaghii***
- b. Leaf tips acute to short- to long-acuminate, drying yellowish- to greenish brown. — Hainan . . . . . **5. *O. laui***
- 6a. Leaves more than 3.5 times as long as wide, sometimes falcate, leaf tips not folded, inflorescences 6- to more-flowered, carpels sparsely hairy. — Laos . . . . . **4. *O. laotica***
- b. Leaves less than 3.5 times as long as wide, never falcate, leaf tips folded, inflorescences 1–3-flowered, carpels completely glabrous. — Andaman Islands . . . . . 7
- 7a. Treelets deciduous, leaves 6–10 by 3–4 cm, inflorescences ramiflorous . . . . . **6. *O. monosperma***
- b. Treelets not deciduous, leaves 9–16 by 4–7 cm, inflorescences on leafy twigs, axillary . . . . . **9. *O. torulosa***
- 8a. Stamens 9 . . . . . 9
- b. Stamens 6 or 12 . . . . . 11
- 9a. Lamina of inner petals small, compact, less than 25% of total length, inner petal tips protracted . . . . . **2. *O. hastata***
- b. Lamina of inner petals large, laterally expanded, more than 30% of total length, inner petal tips short . . . . . 10



- 10a. Leaves 5–8 by 2–3.5 cm, carpels 3. — SW China, Vietnam . . . *O. multiflora*  
 b. Leaves 7–11 by 4–5.5 cm, carpels 15. — Andaman Islands . . . **7. *O. salacifolia***
- 11a. Carpels 6 or 9 . . . . . 12  
 b. Carpels 12 or 18 . . . . . 18
- 12a. Stamens 6 . . . . . 13  
 b. Stamens 12 . . . . . 15
- 13a. Nectary single with undulating margins. — Vietnam . . . . . *O. thorelii*  
 b. Nectaries paired, hooked . . . . . 14
- 14a. Inflorescences 1-flowered, flower stalk 1.5 cm long, carpels 6. — Hainan . . . . .  
 . . . . . *O. hainanensis*  
 b. Inflorescences 2- or 3-flowered, flower stalk 3 cm long, carpels 9 (rarely 6). —  
 S India . . . . . *O. zeylanica*
- 15a. Leaves narrowly ovate, nectaries paired, horizontal slits, carpels completely gla-  
 brous. — SW India . . . . . *O. thomsonii*  
 b. Leaves lanceolate to elliptic, nectary single, horizontally broadly triangular or  
 paired, hooked, carpels sparsely hairy . . . . . 16
- 16a. Leaves 3–6 by 1.5–2.5 cm, inflorescences 1–3-flowered, stigmas long oblongate.  
 — SW India . . . . . *O. uniflora*  
 b. Leaves 4–11 by 2.5–4 cm, inflorescences 4–6-flowered, stigmas globose to  
 ellipsoid . . . . . 17
- 17a. Nectary single, horizontally broadly triangular. — Borneo . . . . . *O. rubra*  
 b. Nectaries paired hooks. — Philippines . . . . . *O. glabra*
- 18a. Inner petal lamina small, laterally compressed, less than 25% of total length .  
 . . . . . **3. *O. kingiana***  
 b. Inner petal lamina large, laterally expanded, greater than 30% of total length  
 . . . . . 19
- 19a. Nectaries paired hooks or single and horizontally broadly triangular . . . . . 20  
 b. Nectary single, hippocrepiform or H-shaped . . . . . 21
- 20a. Leaf tips acute to acutely acuminate. — Sri Lanka, Andaman Islands, Indo-  
 china, Hainan, Peninsular Malaysia, Lesser Sunda Islands (Flores, Sumba) . .  
 . . . . . *O. polycarpa*  
 b. Leaf tips caudate, falcate or folded to appear falcate. — Borneo . . . . .  
 . . . . . *O. dodecandra*
- 21a. Leaves 8.5–16.5 by 3.5–6.75 cm, nectary H-shaped. — Thailand . . . . .  
 . . . . . **8. *O. siamensis***  
 b. Leaves 7–11.5 by 3–4.5 cm, nectary hippocrepiform. — Peninsular Thailand  
 . . . . . *O. kerrii*

**1. *Orophea creaghii* (Ridl.) Leonardía & Keßler, *comb. nov.* — Fig. 2, Map 1**

*Mezzettiopsis creaghii* Ridl., Kew Bull. (1912) 389; Sarawak Mus. J. 1 (1913) 97; Keßler, Blumea 33 (1988) 62. — Type: *Creagh s.n.* (holo K; iso BM, barcode 000547317), British North Borneo, Tinkayo, April 1895, fl.

*Orophea palawanensis* Elmer, Leafl. Philipp. Bot. 5 (1913) 1721; Sinclair, Gard. Bull. Straits Settlement. 14 (1955) 398. — Type: *Elmer 12858* (hololecto NY, barcode 0026165, designated here; isolecto BM, BO, G, GH, K, L, P, U, US), Palawan, Puerto Princesa, densely forested slopes along the Balsahan River, 3-1911, fl.

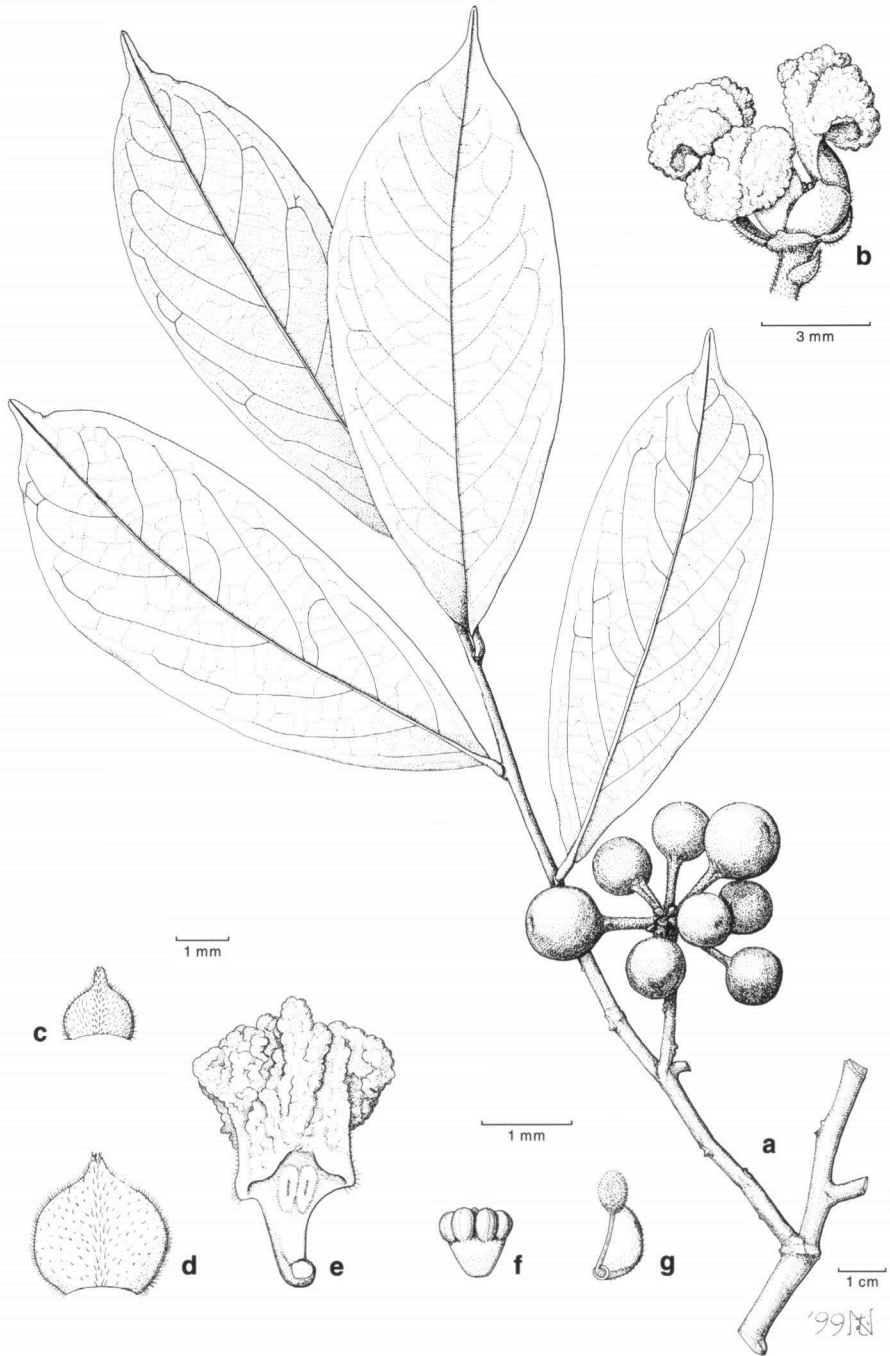
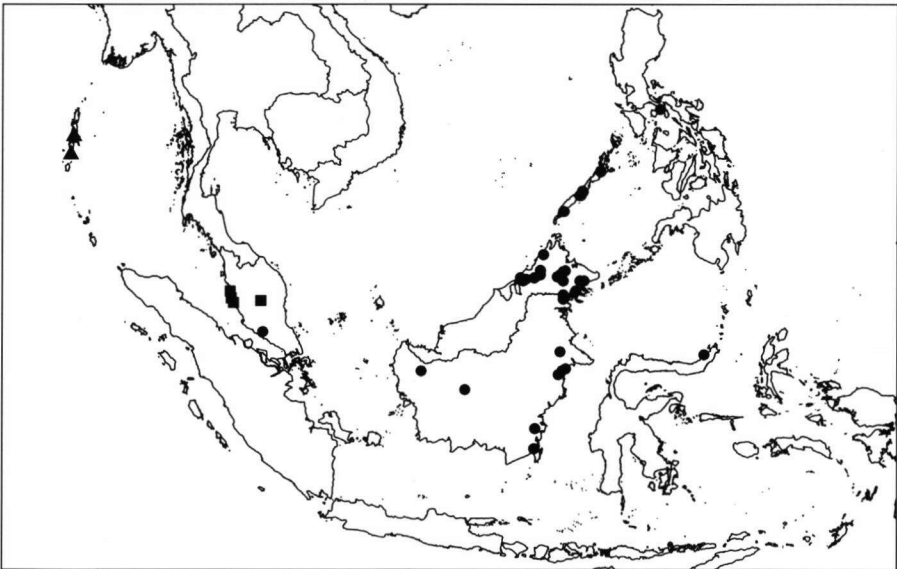


Fig. 2. *Orophea creaghii* (Ridl.) Leonardía & Keßler. a. Habit; b. flower; c. sepal; d. outer petal; e. inner petal showing nectaries; f. stamen; g. carpel [a: SAN 76985 (G. Shea; Aban), L; b–g: Bogor hort. bot. XX-D-124 collected by Keßler].

Shrubs to trees 3–25 m tall, 6–35 cm diam. *Young twigs* 1–3 mm diam., sparsely to densely pubescent. *Petioles* 3–11 mm long, 1.5–3 mm diam., sparsely pubescent. *Leaves* chartaceous to sub-coriaceous, oblong to oblong-narrowly obovate, very rarely lanceolate or inequilateral, 8–24 by 5–9 cm, base cuneate to broadly cuneate, tip folded, short-caudate up to 17 mm long, upper surface dull, dark brown, lower surface reddish brown, sparsely to densely pubescent to glabrous, secondary veins 6–10 pairs, 10–50 mm apart, at an angle of c. 50° to the midrib, inter-arching 8–14 mm from the margin, midrib grooved on upper leaf surface, sparsely pubescent to almost glabrous on lower side. *Inflorescences* axillary in many-flowered (rarely less than 6), densely pubescent cymes, peduncle 1–8 mm long; bracts cymbiform c. 4 mm long. *Pedicels* 3–12 mm long. *Sepals* deltoid-ovate to broadly ovate to orbicular, 1–2.5 by 1–2.5 mm, outer surface densely pubescent. *Outer petals* obcordate to broadly ovate to reniform, 2.5–3 by 2.5–5 mm, outer surface smooth to slightly warty, densely to sparsely pubescent. *Inner petals* shortly clawed, claw 2–3 mm long, lamina small, laterally compressed, tips protracted, broad, incurved, strongly recurved, from bud stage to anthesis, appearing like a ram's horn, very warty, sparsely to densely pubescent, c. 12 by 2–5 mm. *Nectaries* paired puncture holes or short slits. *Stamens* 12 in two whorls (6+6), 0.75–1 by 0.5–1 mm. *Carpels* 18, seemingly in three whorls (6+6+6), sparsely hairy, 0.6–0.8 mm long, 0.5 mm diam.; stigma globose to ellipsoidal, c. 0.2 mm diam. *Ovules* 2, rarely 3. *Monocarps* up to 18, globose to shortly oblongate, 11–17 mm diam.; fruiting peduncle 6–23 mm long, 1.5–3 mm diam.; fruiting pedicel 8–18 mm long, 1.5–3 mm diam.; fruiting torus 4–11 mm diam.; stipes 8.5–17 mm long, 1–2.5 mm diam. *Seed(s)* 1–3.

Distribution — *Malesia*: Peninsular Malaysia, Borneo; Philippines: Palawan and Luzon; Sulawesi: Manado.



Map 1. Distribution of *Orophea creaghii* Leonardia & Keßler (●), *O. hastata* King (■) and *O. torulosa* Hutch. (▲).

**Habitat & Ecology** — Understorey tree in non-seasonal to somewhat seasonal, primary, secondary or logged over, lowland rain forests; on hills, ridges, or flatland; on loamy, sandy, rocky, limestone, sandstone, or granitic soils. Altitude 16–1000 m. Flowering and fruiting throughout the year.

**Field notes** — Leaves dark green above, paler underneath, one note mentions that the leaves are aromatic when crushed, new flush of leaves red to purplish red. Outer bark greyish, blackish, brownish to whitish, generally smooth, inner bark yellow, sapwood white to yellow to orange. Inflorescence greenish to dull brown. Flowers fragrant, inner petals yellow to yellow green (malachite green). Fruits green when young, turning red and finally turning black. Fruiting stalks found red while fruits are still green.

**Notes** — This species is easily recognised by its leaves which tend to be oblong-narrowly obovate and dry dark reddish brown, rarely olivaceous. The nectaries are very difficult to see when the petals are dry but are quite distinct in fresh and spirit material. The stamens are consistently 12 in two whorls of 6, not twenty as first described by Ridley, nor 15–30 as mentioned in Keßler's revision of *Orophea*. The carpels are also consistently 18, not 6 to many as originally described.

## 2. *Orophea hastata* King — Map 1

*Orophea hastata* King, J. As. Soc. Beng. 61 (1892) 83; Sinclair, Gard. Bull. Sing. 14 (1955) 397.

— Type: King's coll. 7323 (hololecto K, designated here; isolecto BM, G, L), Perak, dense jungle, rocky locale, 3-1895, fl.

Treelets to trees 6–13 m tall. *Young twigs* 1.5–2 mm diam., sparsely to densely pubescent. *Petioles* 3.5–5 mm long, 2–2.5 mm diam., sparsely pubescent. *Leaves* chartaceous to sub-coriaceous, elliptic to oblong, 8.5–22 by 3–9.5 cm, base cuneate to rounded, tip folded, short-caudate up to 18 mm long, upper surface dull greyish brown, lower surface greenish brown, sparsely pubescent to almost glabrous, secondary veins 6–9 pairs, 10–36 mm apart, at an angle of 40–60° to the midrib, inter-arching 4–8 mm from the margin, midrib grooved on upper leaf surface, almost glabrous on lower side. *Inflorescences* axillary to supra-axillary, in 1–3-flowered, densely pubescent cymes; peduncles c. 3.5 mm long, sparsely to densely pubescent; bracts cymbiform, up to 4 mm long. *Pedicels* c. 2 mm long. *Sepals* deltoid-ovate, 1.5–2 by c. 1.5 mm, outer surface densely pubescent. *Outer petals* ovate to orbicular, c. 3 by c. 3 mm; outer surface slightly warty, densely pubescent. *Inner petals* long-clawed, claw c. 4 mm long; lamina slightly expanded laterally; tips protracted, slightly recurved, erect in bud, slightly warty, almost glabrous, c. 5 by c. 2.5 mm. *Nectaries* paired slits. *Stamens* 9 in two whorls (6+3), 0.6–1 by 0.6–1 mm. *Carpels* 12, sparsely hairy, 0.75–0.8 mm long, 0.3–0.5 mm diam.; stigma ellipsoidal, c. 0.2 mm long axis. *Ovules* 2. *Monocarps* 5 or 6, globose, 11–15 mm diam.; fruiting peduncle 5–8 mm long, 1.5–2 mm diam.; fruiting pedicel 4–6 mm long, 1.5–2 mm diam.; fruiting torus 3–5 mm diam.; stipes 1–3 mm long, 1–2 mm diam. *Seed* 1.

**Distribution** — *Malesia*: Peninsular Malaysia.

**Habitat & Ecology** — Dense jungle on rocky locale to beside rocky streams. Altitude 160–330 m. Flowering: March, June.

**Field notes** — Leaves dark green. Inner petals dark red with dark yellow points.

Notes — Both flowering and fruiting syntypes were available for the revision; unfortunately, there was none that was both flowering and fruiting at the same time. However, since the fruiting specimens were vegetatively very similar to the flowering specimens, both having large, shortly-oblong leaves that dry light brown, a feature that hitherto is found only in this species, and since the fruits were found to be supra-axillary, consistent with the descriptions of King and Sinclair and a character state that is unique to this species, it was decided to place both fruiting and flowering specimens together in *O. hastata*. Nevertheless there remains the possibility that the fruiting specimens are in fact another species: perhaps a yet undescribed species or possibly *O. kerrii* or *O. siamensis*, both of which occur in adjacent Peninsular Thailand. Although these two species tend to have smaller and more lanceolate leaves, gradations to larger, more oblong leaves would make them vegetatively very similar to *O. hastata*.

### 3. *Orophea kingiana* Leonardia & Keßler, *spec. nov.* — Fig. 3, Map 2

Arbor 5–16 m alta. Folia oblonga, chartacea, 8.5–18 cm longa, 3.5–8 cm lata, subglabra, apice breviter caudata, basi late cuneata usque rotundata, costa supra canaliculata, nervis lateralis 6–8-paribus, omnibus curvato-ascendentibus 5–14 mm ante marginem conjunctis; petioli 3–4 mm longi, 1–2 mm crassi. Inflorescentiae axillares, 1–6-floribus. Sepala deltoidea ad late ovata, ca. 2 mm longa, ca. 2 mm lata. Petala exteriora sepalis similia, 3–5 mm longa, 2–4 mm lata, glabra, interiora lamina parva, ungue ca. 1–1.5 mm longa, apice reflexa, verrucosa, nectariis duobus pellucidis. Stamina 12 (6+6), staminodia desunt. Carpella 18, sparse hirsuta; ovula 2. Carpodia matura desunt. Typus: *King's coll.* 7386 (holo L; iso K), Perak, near Gunung Bubu, dense jungle, 3-1885, fl.

*Orophea dodecandra* auct. non Miq.: King, J. As. Soc. Beng. 11 (1892) 83; Sinclair, Gard. Bull. Sing. 14 (1955) 397.

Treelets 5–16 m tall, 1.8–2.4 m diam. *Young twigs* 1–2 mm diam., sparsely pubescent to almost glabrous. *Petioles* 3–4 mm long, 1–2 mm diam., sparsely pubescent to glabrous. *Leaves* chartaceous, oblong, 8.5–18 by 3.5–8 cm, base broadly cuneate to rounded, tip folded, sometimes falcate, short-caudate up to 14 mm long, upper surface dull brown, lower surface dull reddish- or yellowish brown, almost glabrous, secondary veins 6–8 pairs 16–35 mm apart, at an angle of 30–55° with the midrib, inter-arching 5–14 mm from the margin, midrib grooved on upper leaf surface, almost glabrous to glabrous on lower side. *Inflorescences* axillary in 1–6-flowered, densely pubescent cymes; peduncles 1–3 mm long; bracts cymbiform, 2–4 mm long. Pedicels 7–10 mm long. *Sepals* deltoid-ovate to broad ovate, c. 2 by c. 2 mm, outer surface glabrous to almost glabrous. *Outer petals* narrowly ovate to ovate, 3–5 by 2–4 mm; outer surface slightly warty, densely to sparsely pubescent. *Inner petals* shortly clawed, claw 1–1.5 mm long; lamina laterally compressed; tips protracted, linear, divergent or weakly recurved, erect in bud, slightly warty, almost glabrous, 7–12 by 1.5–2 mm. *Nectaries* paired slits or swollen pellucid hollows. *Stamens* 12 in two whorls (6+6), c. 0.6 by c. 0.6 mm. *Carpels* 18, sparsely hairy, 0.8–1 mm long, 0.5 mm diam.; stigma ellipsoidal, c. 0.25 mm long. *Ovules* 2. *Fruits* immature.

Distribution — *Malesia*: Peninsular Malaysia.

Habitat & Ecology — In dense bamboo forests. Altitude 100–170 m. Flowering: March, April.

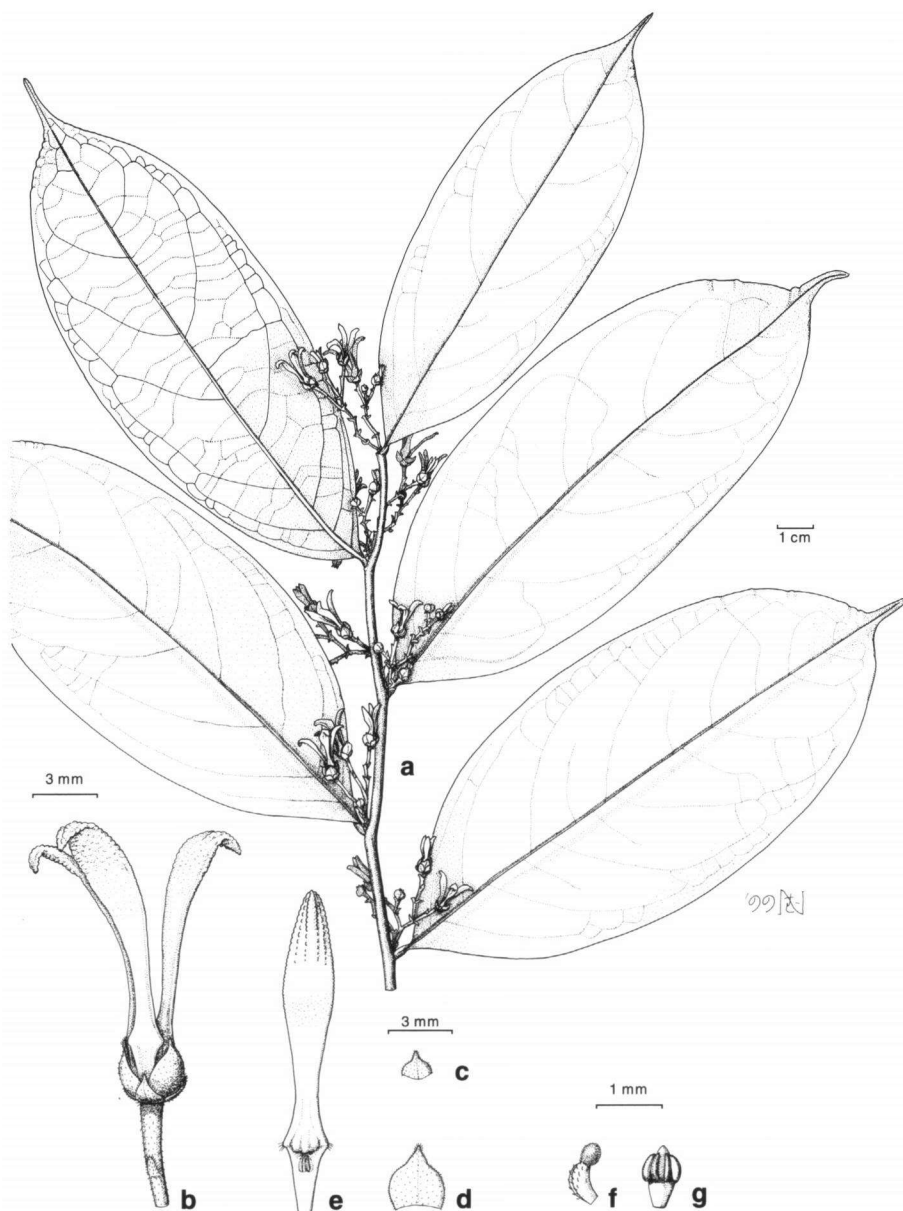
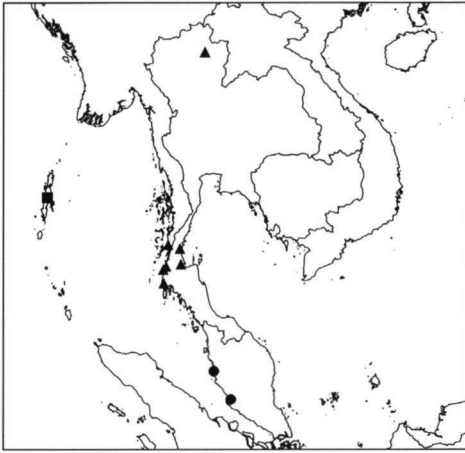


Fig. 3. *Orophea kingiana* Leonardía & Keßler. a. Habit; b. flower; c. sepal; d. outer petal; e. inner petal showing nectaries; f. stamen; g. carpel (King's collector 7386, K isotype).

Field notes — Leaves deep green, young leaves light green. Flowers dark red with green calyx. Fruits green when young.

Notes — This new species was misidentified by both King and Sinclair as Miquel's *O. dodecandra*. It is distinct in having different inner petals: the lamina are compact and the tips are protracted and almost linear. On the other hand, the inner petals of



Map 2. Distribution of *Orophea kingiana* Leonardía & Keßler (●), *O. monosperma* Craib (■) and *O. siamensis* Craib (▲).

*O. dodecandra* have laterally expanded lamina and shortened tips. The specific epithet was written down by Tien Ban on one of the sheets examined but was apparently never published.

#### 4. *Orophea laotica* Leonardía & Keßler, *spec. nov.* — Fig. 4, Map 3

Arbor ca. 8 m alta. Folia oblonga vel falcata, 13–17 cm longa, 3–5 cm lata, chartacea vel subcoriacea, subglabra, apice acuminata, basi late cuneata, costa supra prominentia, nervis lateralis ca. 8-paribus, omnibus curvato-ascendentibus 3–4 mm ante marginem conjunctis; petioli 4–5 mm longi, ca. 2 mm crassi. Inflorescentiae axillares, multiflorae. Sepala anguste ovata ad ovata. Petala exteriora anguste ovata, ca. 5 mm longa, ca. 3.5 mm lata, pubescentia, interiora lamina parva, ungue ca. 2.5 mm longa, apice reflexa, verrucosissima, nectariis duobus rimae similis. Stamina 9 (6+3), staminodia desunt. Carpella 15, ovula 2 vel 3. Carpodia desunt. — Typus: *Kerr 20825* (holo K; iso BM, L), Laos, Tha Tom, in evergreen bamboo forest, 1-4-1932, fl.

Treelet 8 m tall. *Young twigs* c. 2 mm diam., sparsely pubescent to almost glabrous. *Petioles* 4–5 mm long, c. 2 mm diam. *Leaves* thick chartaceous to subcoriaceous, narrowly oblong to slightly falcate, 13–17 by 3–5 cm, base broadly cuneate, tip unfolded, long-acuminate up to 15 mm long, upper surface dull, reddish brown, lower surface smooth, reddish brown, sparsely pubescent to almost glabrous, secondary veins c. 8 pairs, 18–26 mm apart, at an angle of c. 45° to the midrib, inter-arching 3–4 mm from the margin, midrib raised on upper leaf surface, especially towards the base. *Inflorescences* axillary in many-flowered (greater than 6) densely pubescent cymes; peduncle c. 1 mm; bracts cymbiform c. 3 mm long. Pedicels c. 8 mm long. *Sepals* narrowly ovate to ovate, c. 3 by c. 2 mm, densely pubescent. *Outer petals* narrowly ovate, c. 5 by c. 3.5 mm; outer surface slightly warty, densely to sparsely pubescent, margins ciliate. *Inner petals* shortly clawed, claw c. 2.5 mm long; lamina small; tips protracted, broad, incurved, strongly recurved, from bud to anthesis, very warty, sparsely pubescent, 15–18 by c. 4 mm. *Nectaries* paired slits. *Stamens* 9 in two whorls (6+3), 1 by 1 mm. *Carpels* 15, sparsely hairy, c. 1 mm long, c. 0.5 mm diam.; stigma globose to ellipsoidal, c. 0.25 mm diam. *Ovules* 2 or 3. *Fruits* not seen.

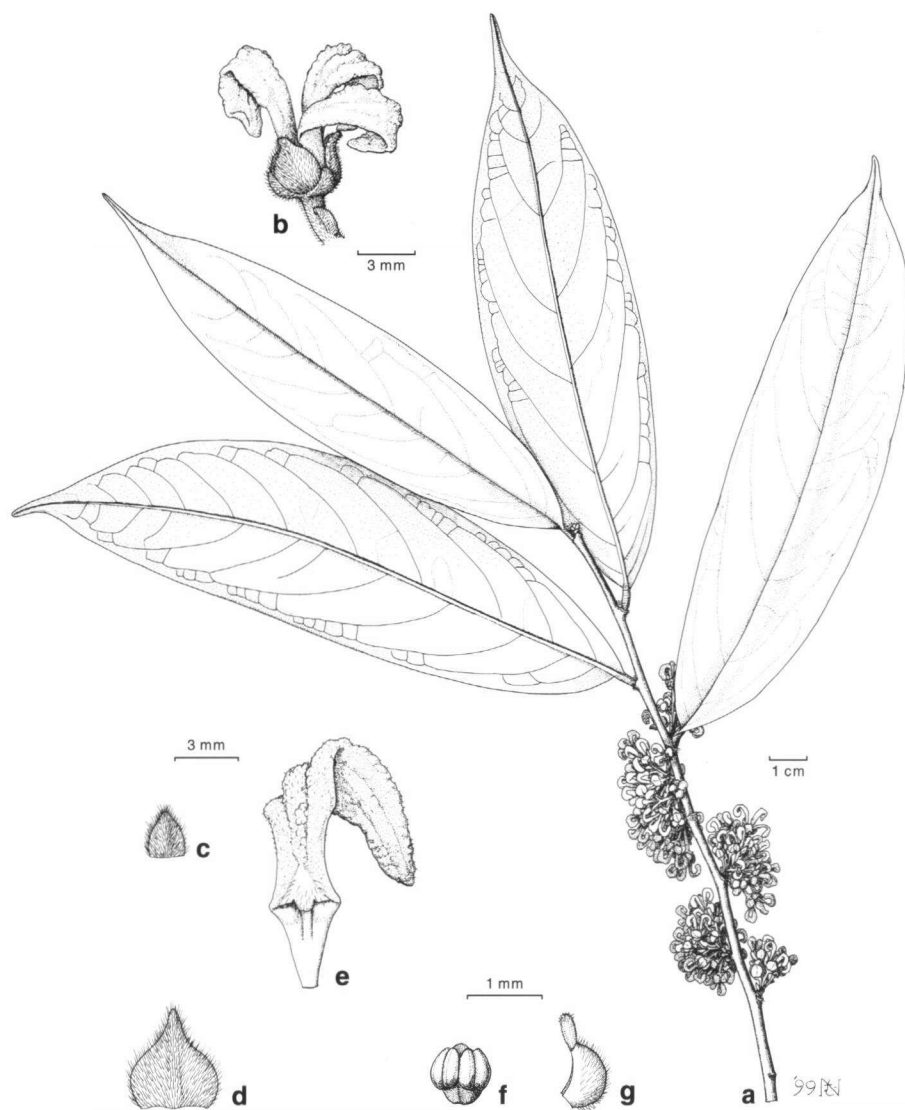


Fig. 4. *Orophea laotica* Leonardia & Keßler. a. Habit; b. flower; c. sepal; d. outer petal; e. inner petal showing nectaries; f. stamen; g. carpel (Kerr 20825, K holotype).

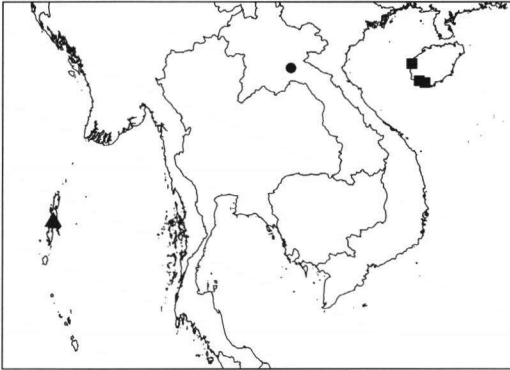
Distribution — Laos.

Habitat & Ecology — Evergreen bamboo forest. Altitude c. 200 m. Flowering: April.

Field note — Flowers green.

Notes — This species is closely related to *O. creaghii* and shares many of its character states. It is distinguished by having narrowly oblong to slightly falcate leaves and a distinctly raised midrib on the upper leaf surface. Moreover, the flowers of this





Map 3. Distribution of *Orophea laotica* Leonardía & Keßler (●), *O. laui* Leonardía & Keßler (■) and *O. salacifolia* Hutch. (▲).

species are narrower and less rotund, the sepals, notably, are narrowly ovate and longer than the sepals of *O. creaghii*. The nectaries are more easily seen and appear as longer slits than the puncture-hole nectaries of *O. creaghii*. Stamen and carpel numbers, both of which have shown to be reliable and informative characters, are also different for these two species. Lastly, carpels with three ovules are common in the flowers of the one specimen of this species, a relatively rare find in *O. creaghii*.

### 5. *Orophea laui* Leonardía & Keßler, *spec. nov.* — Fig. 5, Map 3

Frutex vel arbor 2.5–15 m alta. Folia oblonga vel anguste oblonge-obovata ad lanceolata, 5.5–19 cm longa, 2.25–7.5 cm lata, chartacea, apice acuta vel acuminata, basi cuneata, costa supra applanata vel plus minusve canaliculata, nervis lateralibus 7–11-paribus, omnibus curvato-ascendentibus 2–4(6.5–10) mm ante marginem conjunctis; petioli 3–7 mm longi, 1.5–3 mm crassi. Inflorescentiae axillares, multiflorae. Sepala deltoidea, ovata ad late ovata. Petala exteriora anguste ad late ovata, 3–4 mm longa, 3–4 mm lata, plus minusve verrucosa, interiora lamina parva, ungue 2–4 mm longa, apice reflexa, verrucosa, nectariis non observatis. Stamina 9 vel 12 (6+6), staminodia desunt. Carpella 9, 12, 15 vel 18, ovula 2–6. Carpodia ca. 10. — Typus: *Lau 337* (holo P; iso A, BM, G, K, NY, US), Hainan, Ngai District, rare, dry, gentle slope, sandy soil, woody thicket, 30-7-1932, fl.

*Mezzettiopsis creaghii* auct. non Ridl.: Merr., Lingnan Sci. J. 14 (1935) 5.

Shrubs to treelets 2.5–15 m tall, 10–30(–50) cm diam. *Young twigs* 1–2 mm diam., sparsely pubescent to glabrous. *Petiols* 3–7 mm long, 1.5–3 mm diam. *Leaves* chartaceous to thick chartaceous, oblong to narrowly oblong-obovate or lanceolate, 5.5–19 by 2.25–7.5 cm, base cuneate, tip folded, acute to short acuminate, c. 10 mm long, upper surface dull, dark brown to greyish green, lower surface light reddish- to greenish- to yellowish-brown, sparsely pubescent to glabrous, secondary veins 7–11 pairs, 6–25 mm apart, at an angle of 35–60° to the midrib, inter-arching 2–4(6.5–10) mm from the margin, midrib flat to slightly grooved on upper leaf surface, sparsely pubescent on lower side. *Inflorescences* axillary in many-flowered (greater than 6), densely pubescent cymes; peduncles 4–15 mm long; bracts cymbiform 2–3 mm long; pedicels 9–12 mm long. *Sepals* deltoid to ovate to broadly ovate, 2–2.5 by c. 2 mm, outer surface densely pubescent. *Outer petals* narrowly to broadly ovate, 3–4 by 3–4 mm; outer surface slightly warty, densely to sparsely pubescent. *Inner petals* shortly clawed,

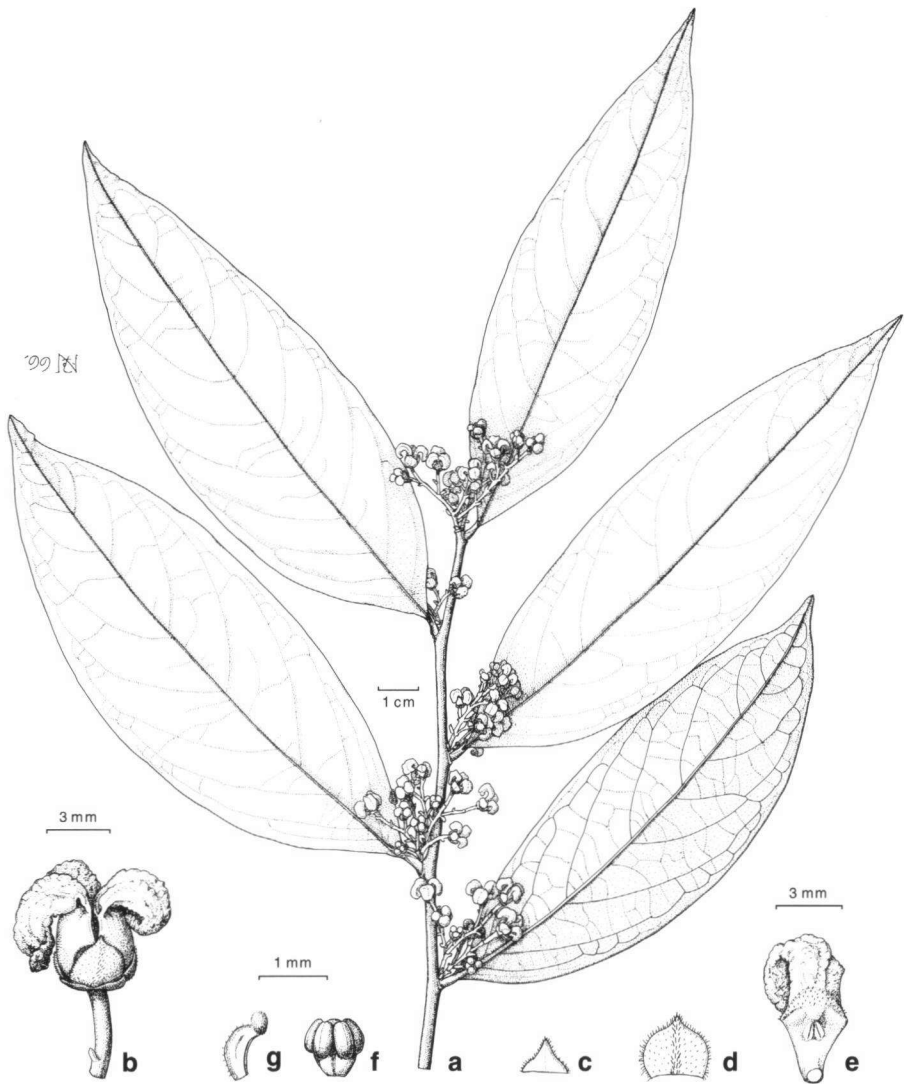


Fig. 5. *Orophea laui* Leonardía & Kessler. a. Habit; b. flower; c. sepal; d. outer petal; e. inner petal showing nectaries; f. stamen; g. carpel (*Lau 337*, NY isotype).

claw 2–4 mm long; lamina small; tips protracted, broad, incurved, strongly recurved, from bud to anthesis, slightly warty, sparsely hairy, 9–12 by 2–4 mm. *Nectaries* not observed (absent?). *Stamens* 9 in a single whorl or 12 in two whorls (6+6), sometimes 14 (7+7), c. 1 by c. 1 mm. *Carpels* 9, 11, 12, 15, or 18, sometimes laterally compressed, sparsely hairy, c. 1 by c. 0.5 mm diam.; stigma globose to ellipsoid, c. 0.2 mm diam. *Ovules* 2–6. *Monocarps* c. 10, globose, 10–13 mm diam.; fruiting peduncle c. 2–12 mm long, 1.5–2 mm diam.; fruiting pedicel 4–9 mm long, 1.5–2 mm diam.; fruiting torus c. 5 mm diam.; stipes 6–10 mm long, c. 1 mm diam. *Seed(s)* 1 or 2.

Distribution — Hainan.

Habitat & Ecology — In thickets or forests; on mountain tops, dry cliffs, dry or moist gentle slopes or stream sides; sandy, clayey or loamy soil. Altitude up to 630 m. Flowering: January, March to July; fruiting: April to July.

Field note — Flowers white or yellow to green.

Note — This species is certainly closely related to *O. creaghii*, a fact that Merrill observed when he did not distinguish the two species in his 1935 publication cited above. The following table lists their differences:

	<i>Orophea creaghii</i>	<i>Orophea laui</i>
Leaf tips	short-caudate	acute to acuminate
Inner petal wartiness	very warty	warty
Stamen number	consistently 12 (6+6)	polymorphic (9, 6+6, 7+7)
Carpel shape	more or less terete	sometimes laterally compressed
Carpel number	consistently 18	polymorphic (9, 11, 12, 15, 18)
Ovule number	2, very rarely 3	regularly 2–6

## 6. *Orophea monosperma* Craib — Map 2

*Orophea monosperma* Craib, Kew Bull (1915) 433.

*Orophea polycarpa* auct. non A.DC.: Kurz, Rep. Veg. Andaman Isl. (1870) App. A ('B') 1 (incl. *Melodorum monospermum* Kurz, nom.); Hook.f. & Thomson, Fl. Brit. Ind. 1 (1872) 91; Kurz, J. As. Soc. Beng. 43 (1874) 57; King, J. As. Soc. Beng. 61 (1892) 85. — Type: Kurz s.n. (hololecto K ('Rec'd, 23/9/67')), fr.

Treelets? *Young twigs* 1–2 mm diam., sparsely pubescent to almost glabrous. *Petioles* 1–3 mm long, 1–1.5 mm diam. *Leaves* chartaceous to subcoriaceous, broadly oblong, sometimes inequilateral, 6–10.5 by 3–4 cm, base cuneate to rounded, tip folded, short-to long-caudate to acuminate up to 12.5 mm long, upper surface dull, dark brown to reddish brown, lower surface reddish brown, almost glabrous, secondary veins 7–9 pairs, 10–16 mm apart, at an angle of 40–50° to the midrib, inter-arching 2–4 mm from the margin, midrib raised on upper leaf surface, sparsely pubescent to almost glabrous on lower side. *Inflorescences* ramiflorous on old leaf axils in lax, 1–3-flowered, densely pubescent cymes; peduncle 1–2 mm long; bracts cymbiform c. 2 mm long; pedicels 5–6 mm long. *Sepals* deltoid-ovate, c. 2 by c. 2 mm, outer surface densely pubescent. *Outer petals* ovate to orbicular, 5–6 by 3.5–4 mm; outer surface slightly warty, sparsely to densely pubescent. *Inner petals* shortly clawed, claw 2–4 mm long; lamina small; tips protracted, broad, incurved, strongly recurved, from bud to anthesis, warty, sparsely to densely pubescent, 6–8 by 3–5 mm. *Nectaries* not observed. *Stamens* 9, c. 1 by 0.5–0.8 mm. *Carpels* 15, glabrous, 0.8–1 by 0.3–0.5 mm; stigma ellipsoidal, 0.2–0.25 mm long. *Ovules* 2 or 3. *Monocarps* 3 or 4, globose, c. 10 mm diam.; fruiting peduncle c. 12 mm long, 0.5–1.5 mm diam., fruiting pedicel c. 10 mm long, 0.5–1.5 mm diam., fruiting torus c. 2 mm diam.; stipes 2–3 mm long, c. 1 mm diam. *Seed(s)* 1 or 2.

Distribution — Andaman Islands.

Habitat & Ecology — Flowering: April; fruiting: August.

Note — This species seems to be a deciduous plant with a seasonal growth-habit. The twigs are many-branched with young growth. Additionally, the flowers are borne ramiflorous on old shoots. The fruiting stalks, both peduncle and pedicel, are distinctively curved, not straight.

### 7. *Orophea salacifolia* Hutch. — Map 3

*Orophea salacifolia* Hutch., Kew Bull. (1923) 371. — Type: *Parkinson 1156* (holo K; iso CAL), Andaman Islands, Betapuo valley, fl.

Treelet. *Young twigs* 1.5–2 mm diam., almost glabrous to glabrous. *Petioles* 2–4 mm long, 1.5–2 mm diam. *Leaves* chartaceous, oblong 7–11 by 4–5.5 cm, base rounded, tip folded, short-caudate up to 7 mm long, upper surface dull, dark brown, lower surface olivaceous-brown, almost glabrous, secondary veins 6 or 7 pairs, 15–20 mm apart, at an angle of 65–70° to the midrib, inter-arching 7–11 mm from the margin, midrib raised on upper leaf surface, sparsely pubescent to almost glabrous on lower side. *Inflorescences* axillary in 1–3-flowered, densely pubescent cymes; peduncle < 1 mm long; bracts cymbiform c. 3.5 mm long; pedicels c. 4 mm long. *Sepals* deltoid-ovate, c. 2 by c. 2 mm, densely pubescent on outer surface. *Outer petals* ovate, c. 5 by c. 5 mm; outer surface smooth, densely pubescent. *Inner petals* long-clawed, claw 4 mm long; lamina laterally expanded, more or less deltoid, c. 4 by c. 3.5 mm; tip short, smooth, glabrous. *Nectaries* paired, hooked. *Stamens* 9 in two whorls (6+3), c. 1 by c. 1 mm. *Carpels* 15, glabrous, c. 1 by c. 0.3 mm; stigma globose. *Ovules* 2. *Fruits* not seen.

Distribution — Andaman Islands.

Habitat & Ecology — Flowering: April.

Note — This species is known only from type.

### 8. *Orophea siamensis* Craib — Map 4

*Orophea siamensis* Craib, Kew Bull. (1922) 228. — Type: *Kerr 5069* (hololecto AB; isolecto BM, K, P), Thailand, Hue Wao, in evergreen forest, fl., fr.

Shrubs to treelets 1.5–8 m tall, 3–4 cm diam. *Young twigs* 1–2 mm diam., sparsely to densely pubescent. *Petioles* 3–7 mm long, 1–2.5 mm diam., sparsely pubescent to almost glabrous. *Leaves* sub-chartaceous to sub-coriaceous, oblong, rarely narrowly ovate, 8.5–16.5 by 3.5–6.75 cm, base cuneate to broadly cuneate, sometimes appearing attenuate, tip not folded, acuminate up to 20 mm long, upper surface dull greyish brown, lower surface light- or reddish brown to greenish grey, almost glabrous to glabrous; secondary veins 5–7 pairs, 15–33 mm apart, at an angle of 25–60° to the midrib, inter-arching 5–8 mm from the margin; midrib shallowly grooved to almost flat on upper leaf surface, sparsely pubescent to glabrous on lower side. *Inflorescences* axillary in 1–3-flowered, sparsely to densely pubescent cymes; peduncles 1–4 mm long; bracts cymbiform, c. 3 mm long; pedicels 3–5 mm long. *Sepals* ovate to deltoid, 1.5–2 by c. 1.5 mm, outer surface densely pubescent. *Outer petals* obcordate to ovate to orbicular, 3–5 by 3–4.5 mm; outer surface smooth, densely to sparsely pubescent. *Inner petals* shortly clawed, claw 1–2.5 mm long; lamina laterally expanded; tips protracted, weakly recurved at anthesis, erect in bud, slightly warty, sparsely pubescent

to glabrous, 7–11 by 3–3.5 mm. *Nectary* H-shaped. *Stamens* 12 in two whorls (6+6) or 6 in a single whorl, 1–1.25 by 0.75–1.25 mm. *Carpels* 12 or 13, sparsely hairy, c. 1 by 0.5–0.6 mm; stigma ellipsoidal, 0.2–0.3 mm along the long axis. *Ovules* 2. *Mono-carps* c. 10, globose, c. 10 mm diam.; fruiting peduncle c. 5 mm long, c. 1.5 mm diam., fruiting pedicel c. 5 mm long, c. 1.5 mm diam.; fruiting torus c. 2 mm diam.; stipes c. 2.5 mm long, c. 1 mm diam. *Seeds* 1 or 2.

Distribution — Thailand.

Habitat & Ecology — In primary or secondary forests; in shade, along trails; on granitic bedrock. Altitude 0–700 m. Flowering: December to April; fruiting: April.

Field note — Leaves dark green above, light green underneath; pedicels, sepals and outer petals maroonish, inner petals pinkish maroonish, tips of inner petals cream, ripe carpels mottled green and maroonish.

Note — This species is very similar to *O. kerrii* differing only in having slightly larger leaves and H-shaped nectaries. More material is needed to show whether these two species are different enough to keep them separate.

### 9. *Orophea torulosa* Hutch. — Map 4

*Orophea torulosa* Hutch., Kew Bull. (1923) 115. — *Mezzettiopsis torulosa* (Hutch.) Goel, J. Econ.

Tax. Bot. 14 (1990) 143. — Type: *Parkinson 10* (hololecto K, excluding the fruits), Middle Andaman Islands, 15-3-1913, fl.

Treelets 7–8 m tall. *Young twigs* 1–2 mm diam., almost glabrous. *Petioles* 3–6 mm long, 1.5–2 mm diam., sparsely pubescent to almost glabrous. *Leaves* chartaceous, oblong to narrowly-obovate, sometimes slightly inequilateral, 9–15.5 by 4–6.5 cm, base rounded, tip folded, short-caudate, up to c. 13 mm long, upper surface dull, dark brown, lower surface yellowish-, reddish- or greenish brown, sparsely pubescent to glabrous, secondary veins 8–12 pairs, 10–23 mm apart, at an angle of 45–50° with the midrib, inter-arching 3–5 mm from margin; midrib raised on upper leaf surface, almost glabrous to glabrous. *Inflorescences* axillary in 1–3-flowered, sparsely to densely pubescent cymes; peduncles 2–5 mm long; bracts cymbiform, 2 mm long; pedicels c. 5 mm long. *Sepals* deltoid-ovate, c. 2 by c. 2 mm, outer surface densely pubescent. *Outer petals* ovate to broadly ovate, 4–5 by 3–3.5 mm, outer surface slightly warty, densely pubescent. *Inner petals* shortly clawed, claw 2–3 mm long; lamina small; tips protracted, broad, incurved, strongly recurved, from bud to anthesis, slightly warty, sparsely pubescent, 10–12 by 2–3 mm. *Nectaries* not observed. *Stamens* 9 in two whorls (6+3), 1 by 0.75–1 mm. *Carpels* 15, glabrous, 0.75–1 mm long, c. 0.5 mm diam., stigma ellipsoidal, c. 0.25 mm long axis. *Ovules* 2 or 3. *Fruits* not seen.

Distribution — Andaman Islands.

Habitat & Ecology — Inland forests. Altitude c. 25 m. Flowering: March to May.

Field note — Flowers greenish cream.

Note — The fruit mounted alongside the flowering branch on the holotype sheet does not belong to the flowering branch but is probably a fruit of *O. katschallica* Kurz. It is unfortunate that the specific epithet is descriptive of the fruit; however, choosing the flowering branch as the lectotype better conserves general use of the name.

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## IDENTIFICATION LIST

The number after the colon refers to the species as listed in the key and in the list below. Institute collections are presented together and their collectors are mentioned in brackets. Where collection numbers are not available, the collection dates are written between brackets.

- |                        |                                      |
|------------------------|--------------------------------------|
| 1 = <i>O. creaghii</i> | 6 = <i>O. monosperma</i>             |
| 2 = <i>O. hastata</i>  | 7 = <i>O. salacifolia</i>            |
| 3 = <i>O. kingiana</i> | 8 = <i>O. siamensis</i>              |
| 4 = <i>O. laotica</i>  | 9 = <i>O. torulosa</i>               |
| 5 = <i>O. laui</i>     | 10 = <i>O. (Sphaerocarpon) spec.</i> |

- Alvins 1176: 10; 1271: 1 — Arifin, Insyah & Keßler AA1137: 1.  
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 Collins 2459: 10.  
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 5142: 1.  
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 1 — Poilane 17495: 10.  
 Rahmat si Boeca 7172: 10; 10287: 2; 10289: 2.  
 S 45258 (Dyg. Awa & Paie): 1; 45696 (Dyg. Awa & Paie): 1 — SAN A2949 (Wood): 1; A4413  
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Accepted names are in roman type. Synonyms are printed in *italics*. New names are in **bold** type.

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