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A REVISION OF THE OLD WORLD SPECIES OF *CALOPHYLLUM* (GUTTIFERAE)

P. F. STEVENS

WHEN I ARRIVED in Lae, Papua New Guinea, in May, 1970, as a junior and rather raw Forest Botanist, the question arose as to which economically important group of plants I should revise. M. J. E. Coode suggested the Guttiferae, although he later admitted that it was hardly the group to give to somebody with little taxonomic experience, or even to anyone with whom one may later wish to communicate in a civilized fashion. However, a revision of the Papuan species of *Calophyllum* L., the genus of the Guttiferae with the most species attaining loggable size, duly appeared (Stevens, 1974a), and my interest in the genus as a whole was stimulated. When I moved to the Arnold Arboretum of Harvard University, I was able to extend my studies on the genus; the resulting revision of the Old World taxa is presented here. The relatively few New World species will shortly be studied.

Calophyllum, the largest genus in the Calophylloideae, can be readily recognized by its opposite leaves with closely and regularly parallel veins that alternate with latex canals; flowers that usually appear to be hermaphroditic; ovary with a single, basal, anatropous ovule; and fruit that is drupelike. These characters, apart from the second, are derived ones (although it should be noted that fruit structure in other Calophylloideae is poorly known), and *Calophyllum* is probably strictly monophyletic—i.e., it includes only (and all) the extant derivatives of a single lineage.

Superficially, the species are all rather similar; once seen, the genus should not be subsequently misidentified. Nevertheless, there are over 200 names available for species in the Old World alone. Although the natural tendency is to work on other, more obviously tractable genera, careful study of taxa like *Calophyllum* is needed to lay the foundations for future, more specifically evolution-oriented studies that are, in turn, essential before evolution in tropical rain forests can be appreciated.

The questions that I asked myself as I extended my studies were three. Is it or is it not possible to recognize taxa throughout the range of the genus in the Old World? If it is possible, how did the taxa that I had previously recognized in Papuasias relate to these? Are there relationships between the

patterns of morphological variation in *Calophyllum* and ecological or other variables that suggest ideas relating to the evolutionary history of some of the species?

In the course of the examination of about 7000 numbers of the genus from the Old World, as well as field work in Malesia in 1975/76, the questions were resolved in somewhat unexpected ways. Species, based on discontinuities in the variation pattern of morphological characters, have been recognized throughout the range of the genus, although the taxonomy of the genus in Madagascar and Vietnam, in particular, is still poorly understood. No super-specific taxa, even informal ones, can be maintained. One hundred and seventy-nine species have been described, although some are poorly known and are merely given a number; varieties are recognized in eight species. Although in a few cases deliberately narrow or conservative species limits have been adopted, field experience, as well as the distinctness of most taxa, suggest that the number of recognized taxa is not too high. There will be reductions, but more taxa remain to be described.

Characters from all organ systems have been used in the classification, and preliminary observations made on lamina anatomy are mentioned in a number of cases. A few of the characters studied are of particular interest. It was, perhaps, to be expected that a survey of the fruits of the genus would be of considerable systematic importance (see Smith & Darwin, 1974; Stevens, 1974a), but the variation in seedlings and young plants surpassed all expectations and provided much information of systematic significance. This variation, which is greater in the young plant than in the seedling, and greater in the seedling than in the germinating plant, is as extensive as that in any comparable group of plants. Additional variation in "growth characters" occurs in the adult plant as well; this, too, is of considerable systematic importance and has rarely been reported before. An additional suite of highly important characters, totally ignored for the better part of a century, has been provided by a study of the often rather bizarre hair types. Finally, polyembryony has been discovered in a few taxa.

Most of the taxa that I had recognized in Papuasias stood up to the closer and wider examination possible in this study; no Papuan taxon has an unexpected range in West Malesia. Indeed, insofar as there is a major dividing line within *Calophyllum* in the Indo-Malesian region, it occurs between New Guinea and Borneo. The area from Sulawesi to Samoa forms one region, while that from Borneo and the Philippines to India forms another.

Little that is definite can be said with regard either to the selective value of the characters observed or to the evolutionary history of the genus or any of its species. However, I have attempted to put our knowledge of the genus into biogeographic, ecological, and evolutionary frameworks, more in the hope of stimulating further work than in an attempt to answer specific questions. It is clear that many of the taxa recognized do have particular ecological preferences and discrete geographic ranges, and the kind and amount of variation in seedling and growth characters, in particular, may relate to both the current ecology of individual species and the process of diversification within the genus. The suspicion that apomixis occurs in some taxa opens

another, possibly very important, line of inquiry. The importance of the question that is so apparent in the field—how several apparently similar species can grow in one place—is manifest to those interested in tropical ecology. The question remains unanswered, but it now can be phrased much more exactly.

The present treatment can, however, be considered only provisional, even in the context of the recognition of morphologically definable species. The genus has been woefully undercollected in the past throughout much of its range, and we still do not know the basic morphology of many taxa, much less understand their infraspecific variation or details of their distribution patterns. Study is still needed, much of it in the field, and extensions of our knowledge of several suites of characters, especially those concerning growth and anatomy, are immediate desiderata; we must find out much more about the ecology and breeding systems of the species in the genus.

Study of the other genera of the Calophylloideae is planned. With this, as well as with studies by S. W. Jones, J.-F. LeRoy, and N. K. B. Robson of other genera in the Guttiferae, variation in *Calophyllum* will be placed in a more general context, and phylogenetic analysis of this variation may become possible. In the absence of this wider context, however, phylogenetic analysis is premature.

TAXONOMIC HISTORY

Linnaeus included two species of *Calophyllum*, *C. inophyllum*¹ and *C. calaba*, in the first edition of *Species Plantarum*. The protolog of *C. calaba* contains references to three currently recognized species, but it was not until Willdenow (1811) described *C. apetalum* that the elements in *C. calaba* began to be disentangled. Confusion over the correct use of the name still persists; *C. calaba* should be typified on the element from Sri Lanka in the protolog (Stevens, 1980b).

Subsequent to those of Linnaeus, the first taxa still referable to *Calophyllum* were described by Willdenow (1811). The majority of taxa in India and Ceylon were recognized early by Wight (1839, 1840) and Thwaites (1858), while Choisy (1849, in a preprint of an article eventually appearing in 1851) described a number of taxa based on specimens from Wallich's herbarium. Choisy's work was not very satisfactory, and although Planchon and Triana (1862a) managed to disentangle the relationships between the names, specimens cited, and descriptions in Choisy's treatment, the nomenclatural consequences of Choisy's work still haunt workers on the genus. The other major early worker on *Calophyllum* was Miquel (1854, 1859, 1861), who described a number of taxa from western Malesia.

Planchon and Triana (1862a; see discussion after *Calophyllum teysmannii* for publication date of their work) first revised the genus, and despite their evident trepidation in disentangling Choisy's work and the problems caused by the poor material available to them, they more than succeeded in their

¹ Authorities for Indo-Malesian taxa are given in the species accounts.

modest aim of facilitating the task of subsequent monographers. They described nine species from the Old World as new and recognized a total of 29 species from this region, not including doubtful or incompletely known taxa. Only two of the species they recognized are not maintained as formal taxa in this revision, but almost a third of the names that they used are nomenclaturally incorrect. Unfortunately, they could not incorporate some of the taxa described by Miquel in their revision, and subsequent workers have not examined the material on which Miquel based his names; not surprisingly, Miquel's names are the earliest for three common Malesian species.

After Planchon and Triana's publication, there was little work of any note on the genus for almost thirty years. Anderson and Hooker described a number of Indian taxa (Anderson, 1874), while Pierre (1885) named and illustrated a number of taxa from mainland Southeast Asia.

Vesque (1889, 1893) was the second and last person to revise the genus; he examined the anatomy and indumentum of many species (see Vesque, 1889, for illustrations), and in his contribution to *Monographiae Phanerogamarum* (1893), he incorporated detailed descriptions of the hairs and lamina anatomy in the species descriptions. He recognized four sections—*Inophyllum* Vesque, *Microphyllum* Vesque, *Apetalum* Vesque, and *Hypodermata* Vesque—in the Old World, in part delimited on tepal ("sepal" plus "petal") number. The sections were subdivided informally on anatomical and/or morphological characters. Species from the New World were not assigned to sections. In the Old World Vesque recognized 35 species, with 17 additional species being less well known and not assigned to sections; his species limits basically followed those of Planchon and Triana. Like Clarke (1894), I do not know on what specimens Vesque (1893) based his anatomical work; it was clearly not always or not only on those specimens designated by an exclamation mark in his publication.

Subsequent to Vesque's publications, work on *Calophyllum* has been local in scope. Henderson and Wyatt-Smith's excellent study (1956) of the Malayan species is the most important in this time, although—despite the authors' unrivaled field knowledge of the genus—they were careful to point out the provisional nature of their account. They found that bark and slash characters were often helpful in recognizing a species, that the leaves, although superficially so similar, were often diagnostic of a species, and that a supraspecific classification based on tepal number was impossible to employ. They recognized 46 taxa, of which they described 20; 43 of these taxa are maintained here at some level, although often with different names. Whitmore (1973) basically followed Henderson and Wyatt-Smith's work.

There is little other recent work of note. Perrier de la Bâthie (1951) wrote an account of the Madagascan species, while Maheshwari (1960) provided a somewhat cursory treatment of those from India. Pitard (1910) and Gagnepain (1943) dealt with the genus in the Vietnam-Cambodia area; unfortunately, the new names proposed by the latter are invalid since the descriptions are in French. Recent accounts of the members of the genus in Papuasias (Stevens, 1974a) and the South Pacific region (Smith & Darwin, 1974) paid considerable attention to the structure of the fruit for the first time; in neither were

sections recognized. Stevens (*op. cit.*) also gave brief details of the lamina anatomy of the Papuasian species and described the germination and young plant of some species.

VARIATION IN THE GENUS AND ITS USE IN CLASSIFICATION

GERMINATION AND YOUNG PLANT

In the main part of this paper, accounts of germination, the seedling,² and the growth of the young plant are given for 36 species (33 primarily Malesian species, two from Sri Lanka, and one from the Mascarenes), and details of some of these stages are recorded for several others. The initial indications of the taxonomic importance of these early stages of growth, which resulted from observations on eight Papuasian species (Stevens, 1974a), are fully confirmed. Even species with the same growth patterns in their initial stages (see below) can be distinguished by the use of such additional characters as leaf shape and size and the color of the young leaves—characters that are not discussed in detail here; as a result, most species are recognizable from a very early age. The variation found has helped to clarify some taxonomic problems, for example, the limits of *Calophyllum rigidum* and *C. venulosum*, the relationships between *C. venulosum*, *C. grandiflorum*, and *C. waliense*, and between *C. teysmannii* and *C. sclerophyllum*. However, there is great need for much more comparative data that should be gathered both in the botanic garden and in the wild. Some of the characters apparent in these early stages are discussed below.

It will be realized, from reading the accounts, that for a number of species progeny of only a single tree has been observed. A further complicating factor is that in most cases the observations were made in the wild, with germination and the young plants occurring under a variety of conditions; these factors are discussed below. Despite these caveats, there seems to be little infraspecific variation in many characters of these early stages. The main exceptions are variation in the number of pairs of leaves in the seedling and in their disposition (rather less variation), as well as in the presence of scale leaves in both axillary and terminal innovations³ in the young plant. However, in *Calophyllum soulattri*, and perhaps also in *C. tetrapterum*, there is infraspecific variation both in germination and in the growth of the young plant; this situation requires more study.

Interspecific variation in germination, the seedling, and the growth of the young plant can be accommodated in fifteen classes (FIGURE 1, a–o; TABLE 1). The differences between some of the classes are clearly slight and may prove to be unimportant when more data accumulate. The seedlings all conform to the *Heliciopsis* type and subtype (de Vogel, 1980).

²The seedling is defined here as the plantlet after germination when growth in length ceases for the first time.

³An innovation is the extension growth produced between two successive periods of rest.

FIGURE 1. Germination, seedlings, and young plants. Capital letters denote germination types, lower case letters show young plant types (double letters denote older stages), the seedling types are unmarked. For further explanation, see text.

TABLE 1. Species of *Calophyllum* known to have early growth conforming to the types shown in Figure 1.

a.	<i>Calophyllum sclerophyllum</i> .
b.	<i>Calophyllum calaba</i> var. <i>bracteatum</i> , <i>C. grandiflorum</i> , <i>C. moonii</i> .
c.	<i>Calophyllum scriblitifolium</i> .
d.	<i>Calophyllum biflorum</i> , <i>C. euryphyllum</i> , <i>C. ferrugineum</i> var. <i>ferrugineum</i> and var. <i>oblongifolium</i> , <i>C. sundaicum</i> , <i>C. teysmannii</i> var. <i>teysmannii</i> and var. <i>inophylloide</i> , <i>C. tomentosum</i> , <i>C. wallichianum</i> var. <i>wallichianum</i> and var. <i>incrassatum</i> .
e.	<i>Calophyllum brassii</i> , <i>C. soulattri</i> (part), <i>C. venulosum</i> (only one seedling known).
f.	<i>Calophyllum robustum</i> , <i>C. rupicola</i> variant.
g.	<i>Calophyllum gracilipes</i> , <i>C. recurvatum</i> .
h.	<i>Calophyllum blancoi</i> (?), <i>C. obliquinervium</i> (growth slow, but habitat dry), <i>C. tetrapterum</i> var. <i>tetrapterum</i> .
i.	<i>Calophyllum rigidum</i> (seedling internode 0.5–2.7 cm. long).
j.	<i>Calophyllum alboramulum</i> (seedling internodes ca. 1 cm.), <i>C. papuanum</i> , <i>C. pauciflorum</i> , <i>C. pisiferum</i> (two or three pairs of seedling leaves), <i>C. suberosum</i> .
k.	<i>Calophyllum nodosum</i> .
l.	<i>Calophyllum pulcherrimum</i> .
m.	<i>Calophyllum inophyllum</i> , <i>C. tacamahaca</i> .
n.	<i>Calophyllum soulattri</i> (part), <i>C. streimannii</i> , <i>C. waliense</i> (seedling internode ca. 1.5 cm. long).
o.	<i>Calophyllum neo-ebudicum</i> , <i>C. peekelii</i> .

GERMINATION. Germination in *Calophyllum* is cryptocotylar: the cotyledons remain more or less enclosed in the stone, and the hypocotyl is short. This germination type is likely to be constant throughout the genus. The radicle may emerge in as few as ten days after the fruit falls to the ground in species with thin stone walls, or in as much as three months in species with thicker walls. The radicle is at, or near, the base of the fruit and may emerge during germination in one of three ways.

In the majority of species for which germination is known, the radicle breaks through the stone just to one side of the base (FIGURE 1, A). In species with thick-walled stones, such as *Calophyllum euryphyllum*, the wall adjacent to the radicle is thinner than that elsewhere (FIGURE 6, b), thus facilitating emergence of the radicle. Similar areas of thinner wall can be seen in other species with thick-walled stones (e.g., *C. goniocarpum*, *C. trachycaule*, and *C. vexans*), which presumably germinate in the same way.

A few species with moderately thick to thick stone walls have a basal plug that is pushed out by the radicle during germination (FIGURE 1, C). This plug can be seen both in a longitudinal section of the stone as oblique lines (FIGURE 6, i) and in the surface view of the cleaned stone, usually as a circular area that is lighter in color than the rest of the stone and is sharply demarcated from it. Species with basal plugs do not necessarily have thicker stone walls than those without them; thus *Calophyllum euryphyl-*

lum, which lacks a plug, has much thicker walls than the variant of *C. soulattri*, which has one.

In *Calophyllum tacamahaca* the basal plug is pushed out by the radicle, but the adjacent wall of the stone is also broken (FIGURE 1, B). This is possibly due to the fact that the radicle faces further away from the base of the fruit than is usual in the genus.

SEEDLING. The number and arrangement of the seedling's leaves are of considerable systematic importance (the seedling stages are unlettered in FIGURE 1). However, there is some intraspecific variation in the number of pairs of seedling leaves: *Calophyllum pisiferum* has two or three pairs; *C. papuanum* has two, three, or four. In some species that have two pairs, the internode between these leaves is clearly shorter than subsequently developed internodes, and the four seedling leaves may appear to be verticillate. In some other species the two pairs of leaves are separated by well-developed internodes, while yet other species may be intermediate in this character, as is possibly the case in *C. rigidum*. *Calophyllum teysmannii* nearly always has two pairs of leaves pseudoverticillately arranged, but occasional seedlings have three or more pairs separated by well-developed internodes.

The lowest pair(s) of seedling leaves may be small and soon fall off; this situation is especially common in taxa with three or more pairs. However, such small leaves cannot be confused with the scale leaves of species like *Calophyllum pulcherrimum*.

YOUNG PLANT. After a period when there is no growth, a bud on the seedling grows out and produces one or more pairs of leaves before growth stops again. There is considerable taxonomically useful interspecific variation at this stage also.

The terminal bud is usually functional. The plant is erect, and the leaves are opposite; all leaves are fully expanded, each pair being separated by well-developed internodes. The single example (*Calophyllum sclerophyllum*) in which the young plant has alternate leaves needs confirmation.

In several species the internodes of the young plants are short, often less than 1.5 cm. long; only after some time are internodes of greater length produced. The development of such short internodes is genotypically controlled in *Calophyllum soulattri* (Stevens, 1974) and probably also in *C. brassii*, *C. gracilipes*, *C. grandiflorum*, *C. recurvatum*, and *C. venulosum*; in all of these species each flush may consist of only a single pair of leaves, and the increase in height of the plant is slow. However, young plants of many species may appear to grow like this when occurring in unfavorable habitats, and the young plants of species with small fruits may initially produce rather short internodes. As a result, observation of this character is difficult.

Species with either long or short internodes may have an initially more or less plagiotropic stem. The leaves tend to be arranged in two ranks along the stem because of twisting both in the internodal regions and of the petioles. Subsequent straightening of the axis generally occurs within 15 cm. of the stem apex.

In those species in which the terminal bud does not function, growth is by the development of an axillary bud that first produces one or two pairs of scale leaves separated by short internodes, and then pairs of expanded leaves separated by longer internodes; this growth pattern is then repeated and the whole axillary shoot system is more or less plagiotropic. Although it is not clear that the axillary buds in young plants of *Calophyllum pulcherrimum* (in which the adult plant characteristically has such a growth pattern) always produce the first flush, functional terminal buds are absent in plants of slightly greater size on up to the adult. In *Mesua nagassarium* (Burman f.) Kostermans, also of the Guttiferae, the mature plant of which has a similar growth pattern to that of *C. pulcherrimum*, the terminal bud of the seedling is not functional, and growth is by development of axillary buds (pers. obs.).

ARCHITECTURE

Little is known about the developmental stages between the young plant and the flowering and fruiting adult plant, so the diversity of the genus in terms of architectural models (Hallé, Oldeman, & Tomlinson, 1978) is unclear. However, growth of all species appears to be discontinuous, and branching is rhythmic. Most species probably conform to Rauh's model, in which the trunk and branches are orthotropic and the inflorescences are axillary. Species such as *Calophyllum alboramulum* differ only in having terminal inflorescences; they conform to Scarrone's model. Those species in which the stem is initially plagiotropic appear to conform to two subtypes of Troll's model, those that have a functional terminal bud (e.g., *Calophyllum gracilipes*) and those that do not (e.g., *C. pulcherrimum*).

HABIT, TRUNK, AND BARK

There are numerous characteristics of the trunk and bark that help one to distinguish between and recognize species in the field. Henderson and Wyatt-Smith (1956) have compiled a useful table of miscellaneous field data, including these characters, for the species from Malaya and Singapore.

Species of *Calophyllum* are usually trees, often with a clean, straight bole (FIGURE 2, a, e). Species such as *C. nodosum* (FIGURE 2, c) may form shrubs, but there is considerable infraspecific variation in habit. Some species, such as *C. rufigemmatum*, habitually reach a larger size than others. Observations on the way the branches are held are few, but there is clearly interesting variation. Species such as *C. peekelii* have erect branches, twigs, and leaves, while in species such as *C. pulcherrimum* and *C. rigidum* at least the smaller branches are pendulous.

Throughout the genus, presence or absence of stilt roots, flying buttresses, or plank buttresses tends to be rather constant within a species. Knee roots, loop roots, or pneumatophores (FIGURE 2, b) are uncommon, occurring only in swamp-dwelling taxa. Although the presence of such characters is often constant in a species, pneumatophores may be found in plants of *C. soulattri* growing in swamps, but do not occur in plants growing elsewhere—a not uncommon phenomenon.

FIGURE 2. Habit, trunk, and bark. a, *Calophyllum teysmannii* var. *inophylloide*; b, *C. ardens* (note pneumatophores); c, *C. nodosum*; d, e, *C. aff. castaneum* (d, note boat-shaped fissures). (Photographs, P. S. Ashton.)

The most useful bark characters include color and texture of the outer bark, color of the inner surface of the outer and of the under bark, and color, amount, opacity, and stickiness of the latex. Plants of many species of *Calophyllum* have distinctive, diamond- to boat-shaped fissures (FIGURE 2, d), especially when young; the fissures may become deeper and confluent with age. The bark of other taxa may be smooth, smooth except for vertical lines of lenticels, or exfoliating in flakes or scales (FIGURE 2, a).

Unfortunately, many of these characters are qualitative. Trunks of *Calophyllum roseocostatum* and *C. tetrapterum* of about the same size have yellowish bark with discrete, diamond- to boat-shaped fissures, yet they are not identical; latex color confirms identification based on the subtle differences between the two. Furthermore, bark color and texture vary considerably with age in some taxa; thus the bark of *C. teysmannii*, although initially smooth, later becomes deeply furrowed, while the bark of such taxa as *C. wallichianum* var. *incrassatum* and especially *C. collinum* remains fairly smooth even in moderate-sized trees. The color of the latex in twigs and fruits often differs from that of the trunk, and this difference may be responsible for some of the infraspecific variation recorded for latex color. It is difficult to interpret other people's field notes; hence, the description of the bark and trunk characters prefacing each species should be treated with caution.

LEAF ARRANGEMENT AND SHOOT GROWTH

In the arrangement of leaves and the growth of the shoots, there are numerous taxonomically important characters, practically all of which have been overlooked in earlier studies.

The leaves are nearly always opposite and decussate, as is characteristic of most of the Guttiferae, but leaves of *Calophyllum caledonicum* may be opposite, truly whorled in threes (cf. Planchon & Triana, 1862b), alternate, or adjacent (in pairs at a node, but not opposite). All these arrangements may occur on a single shoot, although the leaves are usually wholly decussate, or rarely wholly whorled. Sporadic variants with the leaves in whorls of three also occur elsewhere: I have seen seedlings of *C. pulcherrimum* with such whorled leaves. More important variation occurs in young plants of *C. sclerophyllum*, in which the leaves are borne singly and the stem is zigzag; the adult plant has decussate leaves (see also above). This observation needs confirmation since it is uncommon for any Guttiferae outside the Kielmeyeroideae to have alternate leaves at any stage of their life history (see Engler, 1925; Willis, 1974). Exceptions occur in some West African species of *Psorospermum* Spach (Hypericoideae) such as *P. alternifolium* Hochr. (N. K. B. Robson, pers. comm.) and perhaps in seedlings of *Paramammea* Leroy (Calophylloideae; Leroy, 1977).

The internodes on each innovation are usually of similar length, and leaves at each node are fully expanded. However, there is consistent variation in internode length along each innovation and/or in the development of the leaves in some species.

In a number of species the first pair(s) of leaves of the axillary innovations

are reduced to scales and are separated from the main stem and from each other by very short internodes that are usually less than 5 mm. long; the other pairs of leaves of the innovation are fully expanded and are separated by well-developed internodes. Although scale leaves are usually supposed to be absent in the Guttiferae (see, for example, Hutchinson, 1969), they occur in a number of western Malesian species of *Calophyllum*, primarily in the *C. garcinoides*, *C. pulcherrimum*, and *C. pyriforme* groups. (The first and last of these groups have functional terminal buds; in the *C. pulcherrimum* group the terminal bud rarely functions, and growth is primarily by the development of axillary buds.) These scale leaves are caducous and are best recognized on herbarium specimens by the scars that they leave (FIGURE 7, b); in species with stout stems and infrequent branching, they are difficult to observe.

Intraspecific variation in the presence of scale leaves may occur (e.g., in *Calophyllum macrocarpum*, *C. pisiferum*, and *C. tetrapterum*). Scale leaves occur at least sometimes on axillary innovations of very young plants in several species (e.g., *C. biflorum*, *C. rigidum*, *C. novoguineense*, and *C. tomentosum*), but are lacking on adult plants of these species. They are found on terminal innovations of young plants of *C. scriblitifolium*, but whether or not they occur in mature plants is unknown; they are occasionally found on young plants of *C. recurvatum* but not in the adult plant. There are also the fairly general tendencies for the first internode of the innovation to be shorter than the others and for the first pair of leaves to fall off early. Although more observations on young plants—as well as on adult material—at a suitable stage (just after an innovation has begun to grow) are needed, the presence of scale leaves and associated short internodes is an important taxonomic character and is very useful in identifying sterile material.

The first-developed internode of axillary innovations in *Calophyllum pervillei* and *C. milvum* and its relatives (all from Madagascar), and in *Calophyllum praetermissum* (Borneo), is notably longer than the others; subsequent internodes are approximately equal in length (FIGURE 3, c). A similarly long “basal” internode occurs in *Calophyllum* sp. 61⁴ (FIGURE 3, e), but this internode is not the first produced in the innovation. In other species the last internode of an innovation may be so reduced as to be almost absent (e.g., only 1.5 mm. long); the four leaves of the terminal group then appear to be pseudovercillate (*C. verticillatum* and *C. chapelieri*, both from Madagascar). Less extreme reduction occurs in such species as *C. cuneifolium* (Sri Lanka), *C. obliquinervium* (West Malesia), and *C. ceriferum* (Vietnam). The seedling of *C. obliquinervium* does not have pseudovercillate leaves (see above), but details are unknown for the other species.

Some of the variation described above correlates with certain more dynamic aspects of shoot development that, unfortunately, are very poorly known. Although in many species of *Calophyllum* each innovation consists of several pairs of leaves (FIGURE 3, a), some species, probably including all those with

⁴Species with numbers, but no names, are not described formally; the number refers to the Species Accounts.

FIGURE 3. Shoot growth. Arrows denote start of most recent innovation. For explanation, see text.

well-marked horizontal lines at the nodes (FIGURE 7, a; see also below), usually produce only one or two (rarely more) pairs of leaves per innovation (FIGURE 3, c). Such species include *C. aureobrunnescens*, *C. calaba*, *C. euryphyllum*, *C. leleanii*, *C. moonii* (young plant also), *C. papuanum*,⁵ *C. pauciflorum*,

⁵Observations on these species kindly confirmed by K. Damas and E. E. Henty (pers. comm.).

C. persimile (young plant also), *C. rufigemmatum*, *C. soulattri* (young plant also),⁵ *C. suberosum*, *C. teysmannii* var. *teysmannii* and var. *bursiculum*, and *C. vexans*. It is interesting to note that although adult plants of *C. teysmannii* var. *inophylloide* produce many leaves each flush, this is not so in the young plant; plants of *C. wallichianum* var. *incrassatum* apparently show similar variation. The taxa that produce few leaves each flush seem to do so largely independent of the vigor of the plant.

Hallé *et al.* (1978) distinguish two types of branch development, prolepsis and syllepsis, that are often correlated with the morphology of the shoot. Both types occur in *Calophyllum*, although there is no easily observable morphological correlation. At least sometimes in *C. inophyllum* and *C. brasiliense* Camb., axillary shoots are sylleptic, developing without an obvious pause and also contemporaneously with the axis from which they arise; however, the first internode of such shoots is not notably elongated as seems to be common in sylleptic shoots. *Calophyllum depressinervosum*, *C. nodosum* (FIGURE 3, b), and *C. pulcherrimum* all have proleptic shoots; the shoots develop from buds that have undergone a period of rest, and there are basal scales. All taxa that are recorded as having such basal scales probably show this type of growth pattern (see also FIGURE 3, e). In all taxa that produce a single pair of leaves per innovation (and in many that produce several pairs), the buds are proleptic in the timing of their development, but there are no basal scales; the first internode of the axillary innovation may be slightly shorter than the first internode produced by the terminal bud (FIGURE 3, a, c). Finally, in *C. praetermissum* and *C. milvum* (in the latter only probably), the first internode produced by the proleptic axillary bud is notably longer than those subsequently produced (FIGURE 3, d).

INDUMENTUM AND HAIR TYPE

With the possible exception of the poorly known *Calophyllum* sp. 73, the buds of which consist of imbricate scales (see below), all species have some indumentum, at least on their buds. In some species that have scale leaves at the bases of the innovations, the terminal buds tend to be glabrous, or to have hairs only at the edges of the bud scales. In these species, there can be great variation in the development of the indumentum on the terminal bud either on different specimens (*C. garcinioides*) or on a single specimen (*C. nodosum*). In specimens of *C. depressinervosum* from Borneo, the lateral buds also tend to be glabrous. Generally speaking, the more coriaceous and less leaflike outer pair of bud scales have obvious indumentum.

A number of species characteristically have indumentum that is either very well (e.g., *Calophyllum molle*) or very poorly developed (e.g., *C. inophyllum*), or distributed distinctively on the plant (e.g., *C. insularum*). However, many species (e.g., *C. collinum*, *C. rubiginosum*, *C. soulattri*, and *C. teysmannii*) display considerable infraspecific variation in the development and distribution of indumentum. In *C. euryphyllum* and *C. robustum* the indumentum of young plants observed is less well developed than that of adults, although a single individual has not been followed throughout its life.

Of much greater taxonomic importance is hair structure. Vesque (1893)

described in detail the hairs of 31 of the 35 species that he treated; he had illustrated hairs of 27 species in his earlier (1889) work. Hair structure has otherwise been almost completely ignored, although, as will become apparent below, it shows a great deal of taxonomically important variation.

A microscope is needed to observe hair structure, since in many species the hairs are only about 40 μm . long. Hairs can be scraped from the terminal bud and mounted in water. Since they are brittle, they often break; thus Vesque did not describe the interesting basal portion of the hairs of *Calophyllum soulattri* (his *C. spectabile*) or *C. pentapetalum* (his *C. amplexicaule*, *C. buxifolium*, and *C. pseudotacamahaca*). In the present study hairs were examined by means of both ordinary and polarized light; the specimens examined covered both the morphological variation and the geographic distribution of the species.

Describing the hairs is difficult because their shape is basically irregular. Terms currently used for different hair types (Payne, 1978) offer little help, yet there is no point in coining new terms. In all species the hairs are basically uniseriate, and in many they are more or less adaxially curved. Even in species with long, apparently straight hairs, the cell arrangement at the very base may give an indication of this adaxial curvature (e.g., *Calophyllum cucullatum*, FIGURE 22, a, b). Some cells near the base are usually papillate; the papillae of individual cells project and are often restricted to, or better developed on, the abaxial surface. Rather short (less than 300 μm .), adaxially curved hairs with basal papillae (FIGURE 9) are the most common type in the genus. In a few species with small hairs, the papillae cover the hair and make the cell arrangement beneath invisible (*C. subsessile*, FIGURE 29, n). Even in some species with long hairs, all the cells may be papillate, although there is often infraspecific variation in the development of these papillae (*C. venulosum*, FIGURE 29, o-q, s-u).

Some species (e.g., *Calophyllum bracteatum*, FIGURE 13, e-g; *C. teysmannii*, FIGURE 25, l, m) have hairs with one, or sometimes more, basal branch(es); these branches are formed from at least one cell. The apex of the hair sometimes appears to be forked because of a large apical papilla or branch. In the group of taxa related to *C. undulatum*, the branch at the base is often unusually prominent, and the hair may be almost mesifixed (FIGURE 33, q). Some species (e.g., *C. alboramulum*, FIGURE 9, a-d) have several branches or large papillae. In others (e.g., *C. hosei*, FIGURE 26, p, q) the hairs may be almost stellate. It should be emphasized that the distinction between papillae and branches is not clear cut, and species that habitually have strongly papillate hairs will often have a few branched ones as well.

The basal cells of the hairs tend to be narrow, while the distal cells are usually somewhat wider, becoming narrower and longer toward the apex. The basal cells usually have thicker walls than do the other cells; very occasionally, as in *Calophyllum pyriforme* (FIGURE 27, b), all the cells have unthickened walls. In some species, especially those with longer hairs, the occurrence of thin-walled apical cells seems to be an inconstant character, but in others, such as *C. coriaceum* (FIGURE 19, a-c) and *C. tomentosum* (FIGURE 11, l), the apical cells are habitually little thickened. The unthickened,

air-filled cells at the tips of the hairs of *C. costulatum* give the terminal bud a pale color, but in most cases the brown cell contents, probably tannins, make the bud darker.

The transition between the thicker-walled basal cells and the thinner-walled, longer, apical cells is usually gradual. However, in *Calophyllum rubiginosum* the apical cells are much broader, and in shorter hairs "stalk" and "head" are clearly distinguishable. Some hairs of *C. insularum* show an abrupt transition between swollen, rather thin-walled, apical cells and smaller cells with thicker walls. In *C. rufigemmatum*, as well as in *C. ferrugineum* and some of its immediate relatives, the cells toward the base are short, thick walled, and as is usual, slightly birefringent under polarized light; the two apical cells are much elongated, broader, very thick walled, and strongly birefringent (FIGURE 18, k, n). *Calophyllum castaneum* and some of its relatives are similar, although the thickening of the apical cells is less evident.

The cell walls are usually oriented transverse to the long axis of the hair. However, in *Calophyllum cucullatum*, *C. rufigemmatum*, and a few other species, a single cell wall is rather consistently oblique.

Apart from the papillae, the surface of the hair varies from smooth to rugulose. Surface ornamentation is especially prominent in *Calophyllum undulatum* and its relatives, *C. thorelii*, *C. robustum*, and some other taxa. In species such as *C. robustum*, the cell surface may be substriate.

There may be considerable variation in the hairs from a single terminal bud, since they are often densely packed and show variable development. This factor, coupled with the general irregularity of hair structure, can cause every hair on a slide to differ. Some of this variation is taxonomically helpful, since it may suggest a hair type common elsewhere in the species or in a related one (e.g., *Calophyllum goniocarpum*, *C. neo-ebudicum*, *C. leptocladum*, and *C. venulosum*). On the other hand, *C. soulattri* and *C. leleanii*, which have been frequently confused, have basically different hair types, despite occasional reduced hairs found in the former that suggest the hairs of the latter.

I have emphasized the structure of the hairs on the terminal bud, since in many species hairs are not commonly found elsewhere. However, because most species have naked buds (i.e., there are no bud scales), it is perhaps not surprising that relatively little variation is found when different parts of the plant are examined. Although the characteristically bifurcate hairs of *Calophyllum collinum* are more common on the terminal bud than elsewhere, this is a difference of degree only. Some specimens of *C. rubiginosum* have dimorphic hairs—albeit of the same basic type—on the stem; that this dimorphism is not apparent on the terminal bud is probably due to the spatial constraints there. The hairs on the inflorescence are of the same basic type as those on the terminal bud, although they tend to be smaller and less papillate or branched and to have thinner walls (e.g., FIGURE 27, cf. o, p). Hairs on the ovary and stamens are still more simple in structure.

Intraspecific variation in hair type is generally variation on a theme. In some taxa, such as *Calophyllum biflorum* and *C. teysmannii*, the hairs range from a structure similar to a morulus (moruloid) ca. 30 μm . across to distinctive

hair types over 1 mm. long; similar reduced types occur on young plants of *C. euryphyllum* and *C. robustum*. All such moruloid hairs are superficially similar, although there may be differences in the ornamentation of the cell wall.

Despite the problems dealt with above, hair structure basically correlates with taxonomic groupings. In some cases where there is considerable variation in hair type (e.g., *Calophyllum canum*, *C. scriblitifolium*, and perhaps also *C. polyanthum*), the limits of the species are unclear. On the other hand, there is relatively little variation within *C. soulattri*, despite the broad limits adopted here for that species. Species believed to be related on other morphological grounds usually have similar hair structure, and infraspecific variation is not discontinuous. Hair type is thus a valuable aid in the circumscription of taxa, in identification (especially of sterile material), and in suggesting and confirming relationships.

TWIG AND BUD

Characters of the twig, such as thickness, angling, presence of horizontal lines at the nodes (see above; FIGURE 7, a), color on drying, development and persistence of the indumentum, and hair type, are all useful in characterizing a species, although there is considerable variation in many of these characters. The axillary buds are usually small and inconspicuous, although in species such as *Calophyllum rigidum* those that give rise to inflorescences are notably plump. In a few species (e.g., *C. rupicola*), the axillary buds are supra-axillary in position. There are sometimes two buds in the uppermost leaf axils (e.g., *C. euryphyllum*, *C. bifurcatum*); the upper bud of the pair is the larger.

The shape and size of the terminal bud is fairly constant within a species and is of great help in identifying sterile material. The terminal bud is naked in most species and is nearly always densely covered with crustaceous to tomentose indumentum. In *Calophyllum papuanum* and its relatives the bud is strongly flattened since the blades of the leaves forming it are somewhat expanded (FIGURE 4, a). In several species the bud is enclosed by scales that do not expand, and in the imperfectly known *Calophyllum* sp. 73, the scales are clearly decussate and glabrous. The bud may be borne a little way above the uppermost pair of expanded leaves on a short length of stem that develops before growth ceases. This underdeveloped internode is conspicuous in some species, and it becomes of normal length when growth resumes.

In a few species the terminal bud dies. Axillary buds then take over, and branching tends to be profuse. Such nonfunctional terminal buds occur in *Calophyllum pulcherrimum*, in which the axillary innovations have basal scales, and in the very different *C. savannarum*, in which the axillary innovations lack basal scales (FIGURE 4, d); they probably occur in additional species as noted in the descriptions, but field observations are lacking.

The terminal bud and the associated pair of uppermost axillary buds are usually exposed, but they are enclosed and protected by the bases of the

FIGURE 4. Bud and twigs, $\times 3$. a, *Calophyllum papuanum* (NGF 7277), terminal bud. b–d, *C. savannarum* (bb 30477): b, c, node from side and front; d, apex of stem. e, *C. teysmannii* var. *bursiculum* (S 17230), node from side.

surrounding leaves in species with pseudoverticillate leaves. In a few taxa (e.g., *Calophyllum teysmannii* vars. *teysmannii* and *bursiculum*, and *C. paniculatum* variants), the uppermost pair of leaves tends to remain erect, and the terminal bud is enclosed by the space formed by the opposing concave petioles. In *C. savannarum* the terminal buds presumably fall off very early (I have seen no specimens with buds), and the axillary buds are enclosed in a pocket formed by a concavity of the stem, which is swollen at the nodes, and an opposing concavity in the petiole base (FIGURE 4, b, c). This condition also occurs in the related *C. articulatum*, which, however, has functional terminal buds.

LEAF

The leaves are always petiolate, albeit sometimes very shortly so. Many species can be recognized by differences in the dried lamina, but the characters are difficult to describe accurately, and some experience is needed to appreciate them.

Lamina shape is generally fairly useful; many species have basically ovate, obovate, or elliptic leaf blades, with only a moderate amount of variation in the shape of the apex. The base of the lamina may vary considerably; for example, from cordate to acute or cuneate in *Calophyllum soulattri*, *C. pentapetalum* (FIGURE 30, h–o), and *C. venulosum* (FIGURE 30, a–g). Especially in *C. moonii*, *C. venulosum* var. *tenuivenium*, *C. vergens*, *C. calaba* var.

bracteatum, *C. macrocarpum*, *C. rigidum*, and *C. lanigerum* var. *austrocoriaceum*, leaf shape and size may differ considerably between young and adult plants. The general tendency for the leaf blades of the young plant to be longer and narrower than those of the adult is carried to an extreme in the last four taxa mentioned above (to 25 by 2 cm. in *C. calaba* var. *bracteatum*, and 50 by 5.4 cm. in *C. lanigerum* var. *austrocoriaceum*).

Important, but more or less qualitative, characters include the texture of the dried lamina, whether or not the whole blade has dried flat, the way the margins dry, the color of the upper and lower surfaces, and the prominence of the midrib, venation, and sometimes also the latex canals, which are usually hardly visible. These characters often reflect anatomical differences (Stevens, 1974a). Reference is made to the color groups in Dade's chart (as given in Stearn, 1973, pp. 240, 241) matched by the dried blade; Ridgway's (1912) charts were used in the matching process, but the detailed data that were collected for all species are not included here. When measuring venation density, one must take care not to confuse latex canals with veins⁶ (Stevens, 1974a) and not to take measurements on poorly developed or damaged leaves. The course of the marginal vein(s) is usually obscured by thickening, although in some taxa (and to a varying degree) a submarginal vein may be distinguishable, as in *C. tetrapterum* var. *obovale*. In this and other taxa the marginal thickening is often well developed and may be up to 1 mm. wide. In some species, notably *C. garcinoides*, there are obliquely and irregularly ascending latex canals on the lower surface of the blade that are superimposed on the normal series of latex canals that alternate with the veins.

Characters similar to those described above are useful in the identification of living material, although they may then appear different. The midrib in a dried leaf may be angled, although it is rounded in a living leaf; raised venation may be invisible. The young leaves may have a distinctive color; thus those of *Calophyllum enervosum* have a broad, red stripe down the middle, and those of *C. rigidum* are white. Variation in this character occurs within *C. teysmannii* var. *inophylloide*. Such characters are usually not mentioned in the accounts or the discussion, but attention should be paid to them by collectors in order to build up a body of reliable observations.

GALLS

Galls, usually on the leaf but sometimes also affecting the stem, have been described from several species in the genus, but no correlation of gall type with taxonomy has been noticed before. However, different types of gall do not occur randomly. Large, pustular galls (FIGURE 5, g) occur on both *Calophyllum chapelieri* and the related *C. verticillatum*, while disc-shaped ones are found on *C. vernicosum* (all three species from Madagascar). *Calophyllum trapezifolium*, from Sri Lanka, has a spherical gall that is bilabiate

⁶Rameji (1967) studied venation development in leaves of *Calophyllum inophyllum*. He found that the marginal veins formed first; then the secondaries, alternate ones of which differentiated to form the latex canals; and finally the tertiaries, which linked the secondary veins and were usually invisible in the adult leaf.

FIGURE 5. Galls. a, b, *Calophyllum trapezifolium* (Kostermans 23599), apex of twig, $\times 2$: a, from outside; b, transverse section. c, d, *C. teysmannii* cf. var. *inophylloide* (Stevens et al. 275), underside of leaf: c, $\times 0.5$; d, $\times 2$. e, f, *C. whitfordii* (Williams 639), underside of leaf: e, $\times 0.5$; f, $\times 3$. g, *C. chapelieri* (herb. d'Albizette s.n.), underside of leaf, $\times 2$. h, *C. teysmannii* var. *teysmannii* (Meijer 7057), apex of twig, $\times 2$.

at the apex (FIGURE 5, a, b); this gall is also found on not-quite-typical specimens of the related *C. walkeri*. Both varieties of *C. teysmannii* have a distinctive bilabiate gall (FIGURE 5, h) apparently caused by coccids; similar galls occur on *C. aureum* and specimens tentatively, but perhaps incorrectly, assigned to *C. fraseri*. Slitlike galls (FIGURE 5, d) also frequently appear on *C. teysmannii*.

Small, conoid galls probably produced by gall midges occur mainly on several species from Papuasias, the Pacific, and the Philippines (FIGURE 5, f). They are common on *C. whitfordii* in the Philippines, but are extremely rare on *C. blancoi*, with which the former has been confused. On Fiji they are common only on *C. leptocladum*, a species superficially similar to *C. whitfordii*, but are not known from *C. leucocarpum*, the other small-leaved species that occurs there.

Little is known about the organisms causing these galls. Anthony (1976) described the galls and their causative agents on species of *Calophyllum* from Singapore, and there is some additional information in Docters van Leeuwen-Reijnvaan and Docters van Leeuwen (1926, 1941). This subject would undoubtedly repay further study.

INFLORESCENCE

The inflorescence is determinate (cymose) in all species, with both the main axis and any lateral axes being terminated by flowers. Most species that have terminal inflorescences often have additional inflorescences from the upper leaf axils; since branches are subtended by leaves, and flowers by bracts, the distinction between stem and inflorescence may be unclear. Terminal inflorescences tend to have many flowers, but those of *Calophyllum rotundifolium* have only one or two flowers and lack an axis.

Axillary inflorescences show interspecific differences in size, branching, and disposition of flowers along the axis. There may be from one (*Calophyllum insularum*) to numerous (*C. paniculatum*) flowers per inflorescence; an axis is nearly always present, but it may be absent in the poorly known *C. rufinerve* and some specimens of *C. soulattri* from Papuasias. Although the branching of the inflorescence tends to be a variable character, most species have either branched inflorescences, with or without an additional pair of flowers (developed from supernumerary buds) causing the node to have a flabellate appearance, or unbranched inflorescences, usually without additional flowers. In many species with axillary inflorescences, individual specimens have terminal ones. Solitary, axillary flowers occur only exceptionally, as in *C. calaba* var. *calaba* and *C. rubiginosum*; such flowers are larger than those in normal inflorescences.

The variation in the arrangement of flowers along the axis is similar to that of the leaves along the stem, although the two are not always the same in a species. Species with scales at the bases of the axillary innovations have axillary inflorescences, each with a very short basal internode; the flowers at the lowest node are often not developed. The Papuasian *Calophyllum bifurcatum* and *C. insularum* apparently have scales at the base of the innovations (in the latter not always), yet their inflorescences have a well-developed basal internode. Species in which the axillary innovations have a long basal internode have inflorescences with a correspondingly long basal internode, and some species with "whorled" leaves along the stem (*C. chapelieri* and *C. verticillatum*, for example) have flowers in fours along the inflorescence axis, the internode between adjacent pairs of flowers not developing. However, a number of Malesian species tend either to have

flowers in fours along the axis, or to have terminal groups of five flowers (e.g., *C. costulatum*, *C. heterophyllum*, and *C. rigidum*), but these species lack "whorled" leaves on the twigs.

Bracts are usually small and deciduous, but in a few species they are notably foliaceous and persistent. The length of the pedicel and whether or not it is incrassate in fruit both tend to show considerable infraspecific variation, although some species (e.g., *Calophyllum castaneum* and *C. poilanei*) have notably short pedicels, and others (for example, *C. recurvatum* and *C. mukunense*) have pedicels that always become incrassate in fruit.

FLOWER

The flowers of most species of *Calophyllum* from the Old World appear to be hermaphroditic, the exception being those of some species from Papuasia, which are dioecious and/or gynodioecious (Stevens, 1974a). In staminate or pistillate flowers, pistils or stamens, respectively, are usually present, albeit smaller than usual. However, more observations on the distribution of staminate and pistillate flowers—and on all other aspects of reproductive biology—are badly needed.

There has been much discussion in the past as to whether or not one can recognize sepals and petals in *Calophyllum*, or even if there are any sepals at all in some species (see, for example, Choisy, 1823; Wight, 1840; Vesque, 1893). The morphological distinction between the various members of the perianth has generally been admitted to be slight, as Vesque (1893), Engler (1923), Henderson and Wyatt-Smith (1956), and others have noted. Vesque (1893) used the term "sepals" for the parts of the perianth that were in opposite pairs (he thought that there were only two pairs), and "petals" for the parts that were whorled.

Usually only the outer pair of perianth parts is notably thicker than the others, and they completely enclose the bud; however, in a few species (such as *Calophyllum polyanthum* and some of its relatives) the outer pair is much smaller than the others and does not enclose the bud. In all species the outermost pair is the same color as the inner pair(s), although the color may be modified by indumentum. In size, shape, and sometimes even texture, this outer pair is no more different from the next pair than that pair is from the others. Thus, for descriptive purposes, all are called tepals. Although there are usually only four outer tepals arranged decussately in pairs, with any additional inner tepals being in more or less imbricate whorls of four, a few species (e.g., *C. walkeri* and occasionally *C. blancoi*) have three pairs. Such species would have six sepals in Vesque's (1893) terminology.

Tepal number, shape, size, and indumentum are all of some use in characterizing species; all, however, are variable in some species, and their use as diagnostic or differential features is limited by the paucity of material at anthesis and the often considerable distortion that occurs on drying.

The number of stamens varies considerably in some species, and as more flowering material is collected this variability will doubtless be shown to be greater. It is a tedious (but necessary—see Davis & Heywood, 1963) job counting the up to 600 or so stamens that occur in species such as

Calophyllum blancoi and *C. molle*, and stamen number is not much use as an aid in identification, but within rather broad limits many species have characteristic stamen numbers (see the species pairs *C. molle*/*C. rubiginosum*, *C. canum*/*C. lowii*, *C. recedens*/*C. vernicosum*). The filaments are often somewhat connate at the base—notably so in species such as *C. recurvatum*. The phalangiata arrangement of the stamens, common in many Guttiferae, is not marked in *Calophyllum*, although phalangiata stamens have been illustrated or reported (see, for example, J. J. Smith, 1920; Robson, 1976). The tendency of the stamens to be in four groups may be due not so much to differential connation of the filaments as to the removal of the four innermost tepals during dissection of the flower, this causing four areas of weakness in the tissue on which the androecium is borne; however, studies on the floral anatomy of the genus are needed. Anther size and shape is, again within rather broad limits, characteristic for each species. The presence of indumentum on the anthers of some species is an interesting and hitherto unreported character, but this varies infraspecifically in *C. canum*. A single collection from Malaya has hairs on the filaments (see under *C. rufigemmatum*).

Although the ovary is sometimes hairy, it is generally glabrous; the ovule is basal, anatropous, and almost without exception solitary. The style is nearly always glabrous, but in staminate flowers of *Calophyllum vexans*, although the ovary itself is glabrous, there are a few hairs on the style. The stigma is usually more or less peltate and radiate or irregularly lobed, although in a few species it is slightly expanded or more or less infundibular.

FRUIT AND SEED

The fruits of nearly all species of *Calophyllum* are drupaceous when mature, having a skin, a more or less succulent layer, and a stone; inside the stone is a single seed. In those species where there is no stone in the mature fruit (e.g., *C. eputamen* (FIGURE 6, f), *C. parviflorum*), a thin stone is visible in the young fruit. Corner (1976) described the structure of the fruit of *C. inophyllum*; the fruits of all species appear to be similar in structure. The skin and the fleshy layer are both derived from the carpel wall, but the stone (the endocarp of most workers—see, for example, Cambessèdes, 1828; Smith & Darwin, 1974) develops from the outer part of the seed. Inside the stone is aerenchymatous tissue that is strongly developed in the young fruits of apparently all species but is generally not obvious in ripe fruits. However, in *C. inophyllum* and *C. tacamahaca* in particular, the aerenchymatous tissue (the spongy layer of the descriptions below) persists in the ripe fruit.

The embryo fills the cavity of the stone and consists mainly of two large cotyledons that, although closely adpressed, remain readily distinguishable. The minute radicle points to one side of the base of the fruit, as would be expected of a seed developing from an anatropous ovule. Reports of the radicle facing the top of the seed, away from the “micropyle” (e.g., Bentham, 1863; Cambessèdes, 1828, *pl. 17, c*), are incorrect; this mistake is due to confusion of the pointed cotyledonary end of the seed of *Calophyllum inophyllum* with the radicle (see, for example, Miers, 1855). In those few

species known to have polyembryonic seeds, the embryos are of various sizes and are much intertwined. The embryo is usually whitish, but in *C. suberosum* it is a rather frightful purple. Generally, however, collectors have not mentioned embryo color.

Most earlier workers paid little attention to the structure of the fruit, probably because of the paucity of mature fruits. However, there is much useful interspecific variation in size, shape, and surface of the dried fruit (FIGURE 6, e, g, h), as well as in thickness of the various layers and in texture of the fleshy layer when dry. Fruit characters are usually constant within a species; however, there is considerable intraspecific variation in *Calophyllum macrocarpum* (FIGURE 28, g, h) and *C. soulattri*, at least as presently circumscribed.

There are large air spaces in the fleshy layer (mesocarp—the “outer layer” of the descriptions) of some species when dry. These spaces may be under

FIGURE 6. Fruits. a, b, *Calophyllum papuanum* (NGF 10331), stone, $\times 1$: a, from outside; b, longitudinal section. c-e, *C. goniocarpum* (bb 33914), $\times 0.75$: c, stone, longitudinal and two transverse views; d, fruit with stone exposed; e, fruit, from outside. f, g, *C. eputamen* var. *eputamen* (Coode et al. 4243), fruit, $\times 0.75$: f, longitudinal section; g, from outside. h, i, *C. peekelii* (NGF 18330), $\times 0.5$: h, from outside; i, longitudinal section. j, *C. macrocarpum* (FRI 10926), transverse section, $\times 0.5$.

the skin, adjacent to the stone, or throughout the outer layer and completely disorganizing it (FIGURE 6, cf. d, i, j). The development of these spaces in older fruits may result in strikingly different, strongly wrinkled submature and smooth mature fruits, as in *Calophyllum dioscurii* and *C. incumbens*; the skin of fruits with large air spaces under it is, not surprisingly, brittle. However, how the air spaces form is not known, and their taxonomic significance is not always clear, owing to the paucity of material with fully ripe fruits (see especially *C. neo-ebudicum* and *C. vitiense*).

The stone furnishes numerous characters of systematic use. It is angled in *Calophyllum trachycaule* and a few closely related species (FIGURE 6, c); and either rounded or angled (the latter only at higher altitudes) in *C. papuanum*. A number of species have two to four radiate markings coming from the apex of the stone (FIGURE 17, h); these are especially noticeable in the *C. venulosum* complex. However, this character is not always easy to observe, especially in those taxa in which the outer layer does not detach cleanly from the stone. Other useful characters of the stone include apex shape (rounded, pointed, or retuse), surface texture (smooth or rough—FIGURE 6, a), and presence or absence of a basal plug. Compared to the rest of the stone, the basal part is often paler in color and somewhat different in texture in several West Malesian species (e.g., *C. rufigemmatum* and *C. dasypodum*), but a true plug (i.e., a circular area that is demarcated by a line of weakness in the stone and that is pushed out by the radicle during germination) is, except in *C. inophyllum* and *C. tacamahaca*, so far known only from Papuanian and Pacific species. There is infraspecific variation in the presence of a plug in *C. soulattri* as delimited here.

ANATOMY

WOOD. The literature on the wood anatomy of *Calophyllum* is rather scattered, but it appears that interspecific differences are minimal, even when very different species from widely different areas are compared. Authors studying the anatomy of species from the same area have found practically no differences between them (Moll & Janssonius, 1906; Pearson & Brown, 1932). The following description of the wood anatomy has been drawn up mainly from the references cited below (see also Vestal, 1937; Lakhanpal & Awasthi, 1965; Lakhanpal, 1970).

Vessels (lacking to) 2 to 12/sq. mm., 300–1250 by (30–)150–350 μ m. across, usually single, scattered, sometimes in oblique lines, perforation plates simple, pits bordered where adjacent to tracheids and simple or sometimes slightly bordered where adjacent to rays and wood parenchyma, walls ca. 4 μ m. thick; tracheids vasicentric; fibers 450–1680 by 6–20 μ m. across, with walls 2–5 μ m. thick; rays 8 to 15/mm., heterogeneous, with erect central cells and procumbent marginal cells, uniseriate, sometimes partly biseriate or exceptionally triseriate, 140–500 μ m. tall; parenchyma in apotracheal bands, interrupted or not, (1 or) 2 to 9 cells wide, sometimes with crystals, bands varying considerably in density (see Prakash, 1966, for interspecific variation in *C. inophyllum*), paratracheal to almost aliform parenchyma also reported (Fundter & Wisse, 1977).

(Details taken from the following species: *Calophyllum milvum* (Madagascar; Lecomte, 1922); *C. inophyllum*, *C. polyanthum*, *C. soulattri*, *C. calaba* var. *bracteatum*, and *C. apetalum* (India to Burma; Gamble, 1881; Pearson & Brown, 1932; Chowdhury & Ghosh, 1958); *C. calaba* var. *bracteatum* and *C. inophyllum* (Vietnam; Lecomte, 1926); several species of uncertain identity (Malaya; Desch, 1941); *C. inophyllum*, *C. calaba* var. *bracteatum*, *C. dasypodum*, and *C. venulosum* var. *venulosum* (Java; Moll & Janssonius, 1906); *C. canum* and *C. obliquinervium* (Sabah; Burgess, 1966); *C. ?blancoi* and *C. inophyllum* (Philippine Islands; Kanehira, 1924); *C. papuanum* and *C. pauciflorum* (Papuasias; van der Graaff & Baas, 1974); and *C. inophyllum*, *C. insularum*, and *C. ?sil* (Papuasias; Fundter & Wisse, 1977)).

LEAF. Vesque (1889, 1893) illustrated and described the lamina anatomy of the species that he recognized, and Stevens (1974a) gave brief descriptions for the Papuasian species; Schofield (1968) described the petiolar and nodal anatomy of two species; recently D'Arcy and Keating (1979) described the lamina anatomy of species of *Calophyllum* from Panama, including species introduced from the Old World. A number of characters are helpful in delimiting species, including height of the epidermal cells; presence, height, and lignification of the hypodermis; characters associated with the vascular bundles, latex canals, and midrib; width of the marginal thickening, and number of vascular bundles and latex canals that it encloses; and thickening and lignification of the walls of the spongy mesophyll. When most of the spongy mesophyll has lignified walls, the layer of cells adjacent to the lower epidermis often remains unlignified, as in *Calophyllum teysmannii* var. *bursiculum*, *C. garcinioides*, *C. rugosum*, and *C. sakarium*. Additional latex canals may occur: in *C. pauciflorum* (Stevens, 1974a) and in *C. trapezifolium* and related species (Vesque, 1893), they are found in the lignified tissue below the vascular bundles; in *C. garcinioides* they are found adjacent to the lower epidermis; and in *C. sakarium* the vascular tissue in alternate vascular bundles is largely replaced by a large latex canal.

Details of the lamina anatomy are given for a few species below; however, although a general anatomical survey of the genus would be of interest, it is outside the scope of the present study. Anatomical characters often help in delimiting some species (Vesque, 1893; D'Arcy & Keating, 1979), but problems may result from infraspecific variation and the unwitting study of juvenile foliage (Stevens, 1974a).

POLLEN

Erdtman (1971) described the pollen of *Calophyllum inophyllum* as being (2- or) 3-colporate, suboblate to prolate-spheroidal, and with a diameter of about 38 μm . Yi-Zhen (1979) gave palynological details of *C. inophyllum*, *C. membranaceum*, and *C. thorelii* (probably *C. polyanthum*) that agree with Erdtman's account; he described the pollen walls as being finely reticulate and at least weakly 2-layered. Preliminary observations on pollen from species from throughout the range of the genus suggest that there is little variation in basic pollen type, although there appears to be some in details of surface

ornamentation; Anderson and Muller (1975) found the pollen of the different peat swamp-dwelling species of northwestern Borneo to be similar. A more comprehensive survey of pollen is underway (Banerjee & Stevens, in prep.).

CHEMISTRY

Hegnauer (1966) has summarized the early chemical work on the genus. There has also been a considerable amount of more recent work, and species from throughout the range of the genus (America, Madagascar, India and Sri Lanka, Southeast Asia, Malesia, Australia) have been surveyed for many types of compounds. Although the broad picture of the variation of some classes of compounds is becoming apparent, the taxonomic implications of this variation is unclear. Interspecific chemical variation in the species from any one area is unknown, and the amount of infraspecific variation is also practically unknown (see also below) except for that occurring in taxa from Sri Lanka (see Sultanbawa, 1973; Gunesekara *et al.*, 1977).

The esters of fatty acids, and also the free acids themselves, are found in large amounts in the seeds. Oleic, linoleic, stearic, and palmitic acids are the main compounds involved, and they are probably found throughout the genus.

Saponins occur in the leaves of *Calophyllum inophyllum* and *C. brasiliense*, and cyanogenetic glucosides have also been reported. Tannins are fairly general in the genus, especially in the bark, and Ashton (1964) noted that the proteins occurring in gelatin solution were readily precipitated by ground-up leaves of several species of the genus that grow in Brunei. Ethereal oils also occur in the genus.

A considerable variety of xanthenes is found in the wood and also in the bark. (Xanthenes are found in some diversity only in the Guttiferae and Gentianaceae.) One of these, jacareubin, occurs in all but one⁷ of the species of the genus so far analyzed, but is very uncommon elsewhere, being known only from a single species of *Mesua* L. (Carpenter, Locksley, & Scheinmann, 1969). Jacareubin is of interest in being a morellin analogue; morellin is an active principle in gamboge, which comes from *Garcinia morella* Desr. (a member of the Clusioidae – Garcinieae) and other species of that genus. There has been discussion as to whether or not jacareubin always occurs in *Calophyllum inophyllum* and other species, or if it appears only with age (Al-Jeboury & Locksley, 1971; Kumar, Ramachandran, & Sultanbawa, 1976); there may also be infraspecific variation in other xanthenes in *C. inophyllum*. References to other works in which xanthenes have been isolated and characterized may be found in Gunesekara *et al.* (1977) and Bhanu and Scheinmann (1975).

The latex of *Calophyllum* is extremely rich in complex coumarin derivatives: 4-phenyl or 4-alkyl coumarins, hydroxy acids, or cyclohexadienone derivatives with phenyl analogues (Gautier, Kunesch, & Polonsky, 1972). The structures of many substances of this type have been proposed (see Gunesekara *et*

⁷The exception in *Calophyllum* is *C. moonii* (Gunesekara *et al.*, 1977, as *C. soulattri*).

al., 1977, for references). Kawazu, Ohigashi, and Mitsui (1968) found three complex coumarin derivatives in the leaves of *Calophyllum inophyllum* to have piscidial activity, and several 4-*n*-propylcoumarins found in *Mammea americana* L. (Calophylloideae) have considerable insecticidal activity (Crombie *et al.*, 1972).

CYTOLOGY AND BREEDING SYSTEMS

Only a single chromosome number is known from the genus, $2n = 32$ in *Calophyllum inophyllum* (Darlington & Wylie, 1955).

In the majority of species, the flowers appear to be hermaphroditic. However, dioecy or some other type of breeding system occurs in the Papuan species *Calophyllum papuanum* and its relatives and in *C. leleanii* (Stevens, 1974a, the latter as *C. solomonense*). Flowers in the genus are generally reported to be sweetly scented, and to judge by seed set of an isolated tree of *C. papuanum*, the pollen vector may travel 50 meters or so (cf. Stevens, 1974a). The flowers are not obviously adapted to an oligolectic pollinator.

Hybridization may occur; however, close analysis of the situations in which it is suspected is clearly needed. Apparent hybrids between *Calophyllum inophyllum* and *C. paniculatum*, *C. inophyllum* and *C. chapelieri* (both Madagascar), *C. ferrugineum* and *C. teysmannii* (Malaya), *C. teysmannii* and *C. biflorum* (Sarawak), and *C. inophyllum* and *C. caledonicum* (New Caledonia) are discussed under the second-named member of each species pair; see also *C. verticillatum* and *C. parviflorum*.

Polyembryony occurs in three small-seeded species from West Malesia—this is the first report of its occurrence in the genus. It can be recognized by the occurrence of up to six naked embryos forming a close-knit mass in place of the normal single embryo. Polyembryony has been found in *Calophyllum rupicola* (FRI 20873, Malaya), *C. depressinervosum* (SAN 17093, Brunei), and *C. nodosum* (S 25720, Sarawak; Stevens *et al.* 881A, Sabah). In the case of *C. nodosum*, fruits from three adjacent trees were polyembryonic, and up to three embryos were germinating at one time, although one was much larger than the others. The causes of this polyembryony are unknown, but in view of the reports of apomixis elsewhere in the family (see references in Maguire, 1976; also Planchon & Triana, 1862b), apomictic polyembryony is suspected. (It may be noted that polyembryony also occurs in *Mesua*; e.g., in *M. nuda* Kostermans ex T. C. Whitmore—pers. obs.)

From this summary, it is clear that observations on cytology, the breeding system, and hybridization will greatly increase our understanding of the taxonomy and evolution of the genus.

CLASSIFICATION OF THE GENUS

The recognition of taxa in any group in which the members have many characters in common is something of a problem, and the suspicion that some species of *Calophyllum* may be apomictic has not eased the situation. The heightened similarities caused by ecological convergence, particularly

notable in the small-leaved montane species (see *C. clemensorum* and *C. vergens*), make it very easy for one to be misled by superficial resemblances, and misidentifications are numerous in the literature. Specimens cited under a taxon described from Malesia should have been referred to four other taxa, while specimens of a fifth taxon were annotated with the same name but not cited; the five taxa are not closely related. A particularly good example of confusion caused by close superficial similarity is the recognition that two species were included in my original concept of *C. suberosum* (Stevens, 1974a; see *C. persimile* below).

DELIMITATION OF SUPRASPECIFIC TAXA

Vesque (1893), in part following such earlier workers as Choisy (1823, 1824) and Planchon and Triana (1862a), recognized sections and smaller, but informal, groupings in his classification of the genus; these were based mainly on tepal (sepal and petal) number, the presence or absence of a hypodermis, and other details of anatomy, hair structure, and inflorescence type. Anatomical characters, of course, cannot be used by themselves to delimit taxa (but see Vesque's section *Hypodermata*), and none of these characters correlates particularly highly with other ones; nor, indeed, is the distinction between the various states of each character very sharp (see the preceding discussion). Hence supraspecific taxa are not recognized here.

One of the more distinctive groups of taxa is that centered around *Calophyllum pyriforme*. All taxa in this group have similar, stipitate fruits with a fibrous outer layer and a very thin-walled stone, as well as axillary innovations and inflorescences with basal scars. However, these characters are found individually in other species or species groups. Thus, there are two other main groups of species with axillary innovations and inflorescences like those of the *C. pyriforme* group; one is centered on *C. nodosum* and the other on *C. garcinioides*, but neither is otherwise obviously related to the *C. pyriforme* group (for instance, they have very different inflorescences and fruits). Unfortunately, germination, seedlings, and young plants are known in only one of the groups, and here only in two species (*C. nodosum*, *C. pulcherrimum*); when they are more widely known, they may help to delimit these and other groups of related species.

All that can be recognized above the species level are groups of taxa, the members of which are clearly more related to one another than to any other taxa or groups of taxa.

DELIMITATION OF TAXA AT AND BELOW THE RANK OF SPECIES, AND ITS IMPLICATIONS

Studies of any widespread lowland Malesian group that are finished in under a lifetime of field work must necessarily use morphological characters as the main criteria for the recognition of species. Population size and structure is unknown in *Calophyllum*, and it is unlikely that there will be direct evidence bearing on the size of interbreeding populations or the location of intrinsic sterility barriers throughout the genus. It is premature to attempt to circumscribe taxa on the basis of possession of unique, derived characters; not only is the relationship of *Calophyllum* to other genera of the Guttiferae

unclear (see below), but knowledge of the basic morphology of many of the taxa included in the genus is still poor.

A complaint about the morphological species concept is its element of arbitrariness and inconsistency (although similar complaints can be leveled against other species concepts—see, for example, Sokal & Crovello, 1970), and this is perhaps particularly true when one is dealing with taxa that inhabit different areas. At the present level of knowledge of the genus in most of Malesia, it is easier to recognize slight differences that are correlated with geography than comparable differences between plants in a single locality. Hence, the occurrence of not very different, but non-intergrading, taxa at one locality may be overlooked. The ranking of variation that is correlated with geography has been ably discussed by van Steenis (1957), who listed four criteria to help in this endeavor: comparison of the differentiating characters of the taxa under discussion with those of well-established taxa in the same genus; careful observation; comparison of the variation between the allopatric taxa with that in allied species that have a wide, continuous range (“deductive analogy”); and experimental taxonomy.

Only the first criterion helps directly in establishing the rank of such taxa. “Deductive analogy” is difficult in practice, even if one has correctly identified closely related taxa; a wide-ranging species may show variation in characters the extreme states of which, if not connected by intermediates, would define perfectly “good” species. One cannot reliably extrapolate from one case to another. Experimental taxonomy may produce evidence bearing on the genotypic or phenotypic basis of the characters under discussion, and so reinforce the second criterion, but much evidence will concern an event of a type for which it is difficult to predict an outcome—hybridization if the two taxa were to become sympatric.

If two geographically separated taxa that are recognized as subspecies (or varieties, if subspecies are not being recognized) are later found to grow together and yet to remain distinct, the tendency will be for the same two taxa to be called species. A test for a biological species is being applied in an otherwise morphological context. Darwin’s (1859) ideas on evolution did not suggest that the species was more “real” than other taxonomic ranks, nor were his ideas so interpreted by many leading botanical systematists of the day (see Bentham, 1874). Nevertheless, the temptation to treat the rank of species as essentially different from other ranks, or to admit a type of evidence—that is not allowed elsewhere—as deciding specific or infra-specific rank (e.g., van Steenis, 1957; Shelter *et al.*, 1973) has become deeply ingrained in systematics, largely because of the findings of genetics.

As recent work increasingly suggests (see Raven, 1976; Cronquist, 1978; and Levin, 1979, for references), it may be hazardous to assume that the limits of a species that was defined on morphological criteria will correlate with data from ecology, breeding systems, evolution, or geography. However, this does not mean to say that morphology is a biologically inert and meaningless property of an organism; other species concepts face the same problem of non-correlation. A species defined as a group of individuals exchanging genes only within the group has no further *necessary* properties. Suggestions

that a species so defined has properties more like those of an individual than those of a class (philosophically defined—see, for example, Hull, 1978) do not alter this fact. The biological (Mayr, 1969) and evolutionary (Simpson, 1961) species concepts suffer from the same problems, and they, too, are impossible to apply directly to any medium- or large-sized taxonomic group of Malesian plants. The morphological species concept has the virtue of being eminently operational in a situation where the level of knowledge is not far advanced, and of course later on as well.

The species recognized here are delimited by discontinuities in the variation of several of the morphological characters discussed above; varieties show comparable discontinuous variation in only one or two such characters. The extent of the discontinuities and the characters involved affect the rank at which taxa are recognized. Species are often constant over large areas, or if variable, they do not intergrade with others. The limited field observations made suggest that species have relatively invariable and often distinctive bark characters (see also Henderson & Wyatt-Smith, 1956), fruit, germination, and seedling types. Most species have a discrete geographic range (as do varieties), and many have clear ecological preferences. Species that on morphological grounds are thought to be related often differ in both geographic range and ecological preference. Although many species grow together, hybridization is not notably common. Thus, the morphological species in many cases seems to correlate with other types of information, but it must be remembered that morphological evidence has been paramount in species delimitation. As was suggested above, correlations with these other types of information are in a way fortuitous, albeit highly satisfying, but conflicts between the taxon limits that they suggest and those implied by morphological characters must be expected as more becomes known.

The variation in characters of anatomy, fruit, germination and seedling, and bark sometimes may seem not to have been treated satisfactorily. This is not willful inconsistency: in the present state of knowledge of the genus, these characters may be of limited use when unsupported by characteristics that are observable on all, or many, specimens.

As will be clear from the extensive discussion after many species, the rank and even the limits of some taxa remain problematic. Although I have seen over 70 taxa in the field, and the other taxa are delimited by gaps in the variation similar, as far as is possible, to those that separate the taxa that I have seen in the field, such extrapolation is clearly hazardous (cf. Lewis, 1955, quoted favorably by van Steenis, 1959, who suggested that one should somehow allow for "the variation possible" in a species). I have kept doubtfully distinct taxa separate and have fully, but not formally, described taxa that may eventually be worth recognizing but that are poorly known and have no names at present. In all cases, problems are fully discussed, which should make any future adjustments in rank easier (see also Smith, 1979).

Most characters useful in delimiting species nevertheless show considerable infraspecific variation in some taxa; these taxa can still be separated by use of other characters, which themselves break down elsewhere. However,

one cannot argue that, if a given character does not separate a given pair of taxa, or varies at a level below the rank of the taxon under consideration, it therefore cannot be used to separate any taxa at that rank. If such variation is not too frequent, the character may be treated more carefully elsewhere, although not discarded; it is the pattern of variation in the problem under immediate consideration that matters. Many of the vegetative characters (including color of the dry lamina, prominence of venation, and density of indumentum) that make even sterile material fairly easily assignable to a species, especially if the provenance of the specimen is known to within two thousand kilometers or so, are essentially qualitative. Other characters, such as twig thickness and venation density, are quantifiable, but they tend to vary considerably depending on the state of growth of the individual from which the specimen was taken. Although descriptions have been based on plants that can produce flowers, it has not always been possible to exclude specimens from juvenile plants. This may make species boundaries appear to be more vague than they are.

Confirmation that apomixis occurs in *Calophyllum* will be of little help in deciding at which rank to recognize taxa. The types of variation patterns in apomictic groups are as varied as the groups themselves, and they often cannot be incorporated satisfactorily in the normal taxonomic framework. However, it is perhaps unexpected that two of the taxa of *Calophyllum* in which possibly apomictic polyembryony has been detected are closely related, wide ranging, and relatively invariable; they may even grow together on occasion. Systematists working on tropical groups should of course be on the lookout for apomixis, since it may occur quite widely (see Kaur *et al.*, 1978).

These several caveats should be borne in mind when reading the species accounts. It is clear that the inference of evolutionary processes from taxonomic patterns is fraught with problems and with numerous possibilities of circular argument.

EVOLUTION, DISTRIBUTION, AND ECOLOGY

FOSSIL RECORD OF THE GENUS

Prakash (1975) has summarized the literature dealing with the fossil record of the Guttiferae, and that relevant to *Calophyllum* is evaluated here. The record of fruits of *Calophyllum* from the middle Eocene in Rajasthan, India (Lakhanpal & Bose, 1951), must be treated with caution, since although they were compared to those of *C. trapezifolium* (properly *C. austroindicum*), they have no characters that unmistakably mark them as belonging to *Calophyllum*.

Leaves of *Calophyllum*, possibly from the lower to middle Eocene, have been reported from Assam (Bhattacharyya, 1967). Foliar remains of *Calophyllum* have been found in several places in Malesia. *Calophyllum nathorstii* Geyler was found near Palembang, Sumatra, in rocks of the younger Neogene (possibly Pliocene; Krausel, 1929), as well as in Miocene coal of Labuan

(Geyler, 1887; a second, unnamed species that was compared with *C. inophyllum* was also found there). Remains of what is quite possibly a species of *Calophyllum* occur in Tertiary sediments of Java (Göppert, 1854, as *Musophyllum truncatum* Göppert).

The genus *Calophyllodendron* Lakhanpal & Awasthi, based on fossil wood, seems similar to *Calophyllum*. Three species, *Calophyllodendron cuddalorensis* Lakhanpal & Awasthi, *C. eoinophyllum* Prakash, and *C. indicum* Lakhanpal & Awasthi, have been described. Remains of the genus have been found in sediments of Upper Miocene age in Assam (Prakash, 1971), the Mio-Pliocene boundary near Pondicherry, India (Lakhanpal & Awasthi, 1965; the comparison of *Calophyllodendron indicum* with the extant *Calophyllum apetalum* is not justified), and the Mio-Pliocene boundary in Assam (Prakash, 1966; the best record).

Calophyllum pollen of late Miocene age is known from Brunei (Muller, 1972; Anderson & Muller, 1975); the genus was then an important component of the peat swamps, and the flora of these swamps seems to be similar to that of swamps found in the same area today. *Calophyllum* pollen may occur in the Eocene in India (as *Calophyllumpollenites rotundus* Sah & Kar; Sah & Kar, 1974), but the record must be confirmed.

There are few early records of the genus elsewhere. *Calophyllum pliogenicum* Krasser was reported from the Pliocene of Brazil (Krasser, 1903; Krasser thought that it was very close to *C. calaba* (= *C. brasiliense*). *Calophyllum calabiformis* Berry was described from the Miocene of Trinidad (Berry, 1925). Wood possibly comparable with that of *Calophyllum* or *Mesua* has been described from the lower Miocene of Egypt (as *Guttiferoxylon fareghense* Krausel; see Prakash, 1975).

RELATIONSHIPS OF CALOPHYLLUM AND MAJOR PATTERNS OF EVOLUTION IN THE GENUS

The immediate relatives of *Calophyllum* in the Calophylloideae – Calophylleae are *Mammea* L. (including *Ochrocarpus* Thouars), *Paramammea* Leroy, *Mesua* (including *Kayea* Wall.), and *Poeciloneuron* Bedd.; this last genus is rather distinct in details of wood anatomy (Baretta-Kuipers, 1976). Although *Mammea* has been placed in the Clusioideae by Robson (in Heywood, 1978) in the belief that the united cotyledons were a swollen hypocotyl,⁸ it is correctly placed in the Calophylloideae (e.g., Planchon & Triana, 1862b; Brandza, 1909; pers. obs.; unpublished studies by S. W. Jones). All these genera have basal ovules. *Mesua* is an Indo-Malesian genus; *Mammea* extends from Africa and Madagascar (de Wilde, 1956; cf. Kostermans, 1961) to Indo-Malesia, with a single species (*Mammea americana*) in tropical America; *Paramammea* occurs on Madagascar; *Poeciloneuron* includes two species, both from western India. *Mesua* has a mid-Tertiary fossil record (Prakash,

⁸Leroy (1975, 1977) distinguishes *Ochrocarpus* from *Mammea* by its embryo, which lacks any trace of organization, and its latex canals; in both characters *Ochrocarpus* is similar to *Garcinia*. The broad circumscription of *Mammea* adopted here is for convenience only; as Leroy (1977) notes, representatives of this group on Madagascar are still poorly understood.

1975) in India; earlier records of both *Mammea* (Late Cretaceous!) and *Mesua* need to be confirmed. The other tribe in the Calophylloideae is the Endodesmieae (see Engler, 1925), characterized by a single apical ovule. It includes two monotypic, West African genera, *Endodesmia* Benth and *Lebrunia* Staner (Staner, 1934). Some of the characters separating these genera are listed in TABLE 2.

Although it is clear from TABLE 2 that *Calophyllum* is easily distinguishable from the other Calophylloideae by its single basal ovule and its nearly always strictly parallel venation, its exact relationship to any of these genera, including members of the Endodesmieae, is unclear. Most chemical and palynological data are presently restricted to the three larger genera of the Calophylleae, *Calophyllum*, *Mammea*, and *Mesua*, but it is hoped that further studies on the subfamily will permit a resolution of the relationships of all the genera.

Vesque (1889, 1893) placed the species of *Calophyllum* in a more or less evolutionary arrangement. He considered that *C. inophyllum* was "le groupe nodal primaire"—a group lacking obvious epharmonic characters that would adapt it to extreme conditions. However, if the lack of bud scales and the presence of a basal plug in the stone are derived characters, *C. inophyllum* may be a member of a not notably primitive group of taxa that diversified most in eastern Malesia (see also below). Moreover, the members of the various groups of species that Vesque recognized in the Old World often do not seem immediately related. Thus, the members of one of his groups (*C. soulattri* (his *C. spectabile*), *C. walkeri*, *C. cerasiferum*, and *C. sclerophyllum*) have a hypodermis, but little else, in common.

Several methods are currently used to assign evolutionary polarity to characters; that is, to determine which character state is advanced and which is primitive. This is not the place to review the value of such methods, except to note that the one that appears to be by far the most satisfactory, out-group comparison, cannot be used here because it is not yet clear what the sister group of *Calophyllum*—and the sister group of this larger group—is, an all-too-common complaint in botanical systematics (Stevens, unpubl. ms.). To compare variation within the Calophylloideae or Guttiferae as a whole is a less rigorous form of out-group comparison that can be used here *faute de mieux*. The suggestion that the common state of a character can be considered primitive within a group in the absence of other evidence (e.g., Estabrook, 1977) is unacceptable since the commonness of a derived character state in a group depends on the subsequent diversification of the monophyletic line that it characterizes (e.g., Stebbins, 1974; Judd, 1979; Stevens, unpubl. ms.). Functional considerations have been much used, as by Vesque (1893), but there is no reason why a character state that is believed to have some adaptive value should be considered derived when compared with the state that has no apparent adaptive value (e.g., Davis & Heywood, 1963). Nevertheless, derived and primitive states are suggested for some characters in TABLE 3 by using these and other suspect criteria. This table is perhaps most useful in stimulating discussion, especially since no polarity has been suggested for the majority of characters.

It would be premature to suggest detailed relationships of the taxa here.

TABLE 2. Some characters distinguishing genera in the Ca

	<i>Calophyllum</i>	<i>Mesua</i>	<i>Mammea</i>	<i>Paramammea</i>
HAIRS UNISERIATE	+	—	—	?
BUD SCALES PRESENT	—(+)	+	+	+
		(?always)		
VENATION OBVIOUSLY RETICULATE	— (+, very rare)	+	+	+
INFLORESCENCE TERMINAL	—(+)	—, +	— (+, very rare)	—
FLOWERS PERFECT	+ (—)	+	—(+)	—
“SEPAL” NUMBER	4(2)	4	2	2
STAMENS CONSPICUOUSLY CONNATE	—(+)	—	—, +	+
ANTHERS WITH TERMINAL INTRORSE PORE	—	—	—	—
STYLES DEEPLY DIVIDED	—	—	—	+ (—)
STYLES LONG	+ (—)	+	—	+
OVULE, LOCULUS, AND SEED NUMBER	1; 1; 1	4–8; 1,2; 1 or more	4; 1,2,4; 1 or more	6–10; 6–10; up to 8
OVULE POSITION	Basal	Basal	Basal	Basal
PEDICEL FLESHY IN FRUIT	—	—	—	—
FRUIT DEHISCENT	—	—(+)	—(+)	—

*Data from Staner, 1934; Perrier de la Bâthie, 1948; de Wilde, 1956; Spirlet, 1966; Leroy, 1977, and others; data for *Calophyllum* and *Mammea* are from Staner, 1934; data for *Paramammea* are from Staner, 1934, and others.

†The two species of *Poeciloneuron*, *P. indicum* Bedd. and *P. pauciflorum* Bedd., may not be very close relatives. *P. indicum* (Broome 210) has two small, outer, persistent tepals, two large, inner, subpersistent tepals, and locellate (in both species the anthers dehisce, at least initially, by introse, apical pore slits); and there are differences, see Seetharam & Pocock, 1978.

‡*Endodesmia calophylloides* has stipulelike structures.

TABLE 3. Possible primitive and derived states of some morphological characters in *Calophyllum*.

SEEDLING AND YOUNG PLANT	
1.	Seedling leaves separated by well-developed vs. shortened internodes.
2.	Leaves opposite vs. alternate.
3.	Growth orthotropic vs. plagiotropic.
4.	Young plant initially with well-developed vs. shortened internodes.
TRUNK AND BARK	
5.	Trunk lacking buttresses, knee roots, or pneumatophores vs. with these structures present.
LEAF ARRANGEMENT AND SHOOT GROWTH	
6.	Internodes separating expanded leaves all of similar length vs. variation within an innovation.
7.	Scale leaves present vs. absent.
HAIR TYPE	
8.	Hairs adaxially curved, rather short, and papillate at base vs. other types.
TWIG AND BUD	
9.	Terminal bud functional vs. abortive.
10.	Terminal bud strongly flattened (with partly expanded blade) vs. more or less rounded.
11.	Terminal bud not enclosed in petiole bases of last pair of leaves vs. enclosed.
12.	Axillary buds not enclosed in pockets formed by stem and petiole base vs. enclosed.
LEAF	
13.	Acute-cuneate-rounded at base vs. cordate or narrowly attenuate.
14.	Midrib raised vs. broadly depressed.
INFLORESCENCE	
15.	Terminal vs. axillary.
16.	Branched and/or flabellate vs. unbranched and with flowers in pairs.
17.	Flowers many vs. few or one.
18.	Axis present vs. absent.
19.	Internodes of approximately equal length vs. some much shorter than others.
FLOWER	
20.	Perfect vs. staminate or pistillate.
21.	Tepals 8 vs. consistently fewer or more than 8.
22.	Hairs on inside of outer tepals absent vs. present.
23.	Ovary or anthers glabrous vs. pubescent.

TABLE 3 (continued).

FRUIT	
24.	Stone with basal plug lacking vs. present.
25.	Embryo whitish vs. purple.

Groups of taxa that can be recognized are discussed below and in the species accounts. Since there is no obviously "primitive" species of *Calophyllum*, the species accounts start with *C. alboramulum*, a taxon with terminal branched inflorescences and thin-walled stones, neither an obviously specialized character. If the presence of bud scales is considered unspecialized (an interesting suggestion; they are common in the Calophylloideae as a whole), *C. garcinioides* or *Calophyllum* sp. 73 might be also considered taxa with several apparently unspecialized characters.

All these putatively primitive taxa are Indo-West Malesian, but the distribution of "primitive" taxa is not necessarily the same as the place of origin of the genus. The same can be said for the equation of the present area of greatest diversity of the genus (and its immediate relatives), also Indo-West Malesia, with place of origin. Although *Calophyllum* may have originated in the Indo-Malesian tropics—possibly by the late Eocene—and spread from there, this is only a tentative hypothesis and lacks critical support.

GENERAL DISTRIBUTIONAL PATTERNS OF TAXA AND CHARACTERS

The New World species must be mentioned briefly to place the discussion in context.

Vesque (1893) recognized only four species from the New World, and there are clearly not many species there. The variation shown is correspondingly less than in the Old World: there is no variation in the distribution of leaves along the stem; there are no bud scales; the inflorescences are habitually axillary and often branched; dioecy probably occurs in some species—e.g., *Calophyllum brasiliense* (Pennington & Sarukhán, 1968); hair structure is basically similar (Vesque, 1893; pers. obs.); fruit variation is slight, although basal plugs (*Fanshaw* 2439—*C. brasiliense*) and thin areas near the base (*Krukoff* 7268—*C. ellipticum* Rusby) occur. The wood anatomy of New World species (Greene, 1932) is similar to that of Old World species. D'Arcy and Keating (1979) noted that *C. longifolium* Willd., from Panama, was similar to *C. soulattri* in details of lamina anatomy; from the data that they and Vesque (1890, 1893) give, species from the two hemispheres are similar in lamina anatomy. The New World species may be derived from a single ancestor originally from the Old World; *Calophyllum* has been in America at least since the Miocene (see above).

In the Old World, *Calophyllum* has a fundamentally Indo-Malesian distribution pattern, with extensions to Madagascar and Fiji. The genus is basically restricted to humid, closed, lowland to colline or sometimes montane rainforest, although a few species grow in drier or more open habitats. Van Steenis

(1949) noted that in Malesia rather young individuals may flower and fruit when in the open, but there are no early successional species in the genus.

MAP 1 shows the regional distribution of *Calophyllum* species in the Southeast Asian/Australian region; distribution maps of individual species are included in species accounts.

Calophyllum inophyllum is clearly a highly vagile strand species (which sometimes also grows inland), and it occurs throughout the range of the genus in the Old World. It shows a certain amount of geographically correlated variation. The Mascarene endemic *C. tacamahaca* seems to be closely related to it, and is perhaps derived from it (see also below).

The origin and relationships of the other endemic species in Madagascar and the Mascarenes are problematic. Perrier de la Bâthie (1948) thought that the species in Madagascar were derived from *Calophyllum inophyllum*; the adaptive radiation that had occurred suggested to him that *Calophyllum* arrived in the oldest of the seaborne invasions of the island. Raven and Axelrod (1974) consider that the genus arrived there by long-distance dispersal. The species growing in Madagascar and the Mascarenes show a moderate amount of diversity, but I know of no unique character that distinguishes them as a group from the rest of the genus. Although several other taxa have distribution patterns like that of *Calophyllum* (see Perrier de la Bâthie, 1948; Dejardin *et al.*, 1973, for examples), little is known about the causes. *Calophyllum tacamahaca*, from the Mascarenes, is probably a local derivative of *C. inophyllum*, while the affinities of *C. eputamen* and the related *C. parviflorum* are unclear.

India and Sri Lanka have no species in common apart from *Calophyllum inophyllum*, although *C. austroindicum*, from the Western Ghats, may be related to the complex of five species in Sri Lanka centered on *C. trapezifolium*. *Calophyllum polyanthum* occurs in the Western Ghats and in northeastern India and elsewhere, a common distribution pattern. *Calophyllum calaba*, from Sri Lanka, is part of a complex also occurring from Vietnam to Australia; there are numerous similar examples, as a glance at *Flora Malesiana* will show.

Many of the species from mainland Southeast Asia are poorly known. *Calophyllum poilanei* and *C. membranaceum* are distinctive species without obvious relationships; *C. rugosum* is perhaps related to the Malayan *C. rotundifolium*, and *C. parkeri* to *C. fraseri* and *C. garcinioides*, both Malesian. There are a few widespread species, and the local *C. lineare* is very closely related to one of them (*C. pisiferum*). The other species are poorly understood or are members of taxonomically difficult complexes that extend into India (*C. polyanthum*) and, perhaps, Malesia (as *C. symingtonianum*).

The species of *Calophyllum* growing from the Isthmus of Kra in southern Thailand to the Pacific and northern Australia can be considered together.

MAP 1. Distribution of *Calophyllum* in Southeast Asia, Malesia, and Australia. Figures within areas: above line, endemic species; below line, total number of species. Figures on lines separating areas: number of species in common between two areas.

Although Malesia as a phytogeographic unit may not include the area from the Solomon Islands eastward (e.g., van Steenis, 1950), the tropical Pacific flora is basically an attenuated Malesian one (van Balgooy, 1960), and the few Australian species of *Calophyllum* can also be included here; they, too, are tropical taxa. The central part of this region has usually been divided into three provinces (van Steenis, 1949, 1950, 1979; van Balgooy, 1960; van Steenis & Schippers-Lamertse, 1965): South Malesia includes the islands from the Tanimber Islands to Java; East Malesia is bounded on the west by Zolinger's line (i.e., it includes the Celebes and the Kei Islands); and West Malesia includes the rest of Malesia.

However, as is clear from reading van Steenis (1950) and van Steenis and Schippers-Lamertse (1965) in particular, the South Malesian Province is separated because its flora is depauperate, although basically West Malesian, and has an admixture of species that do not grow elsewhere in Malesia but occur further to the north. The East and West Malesian provinces, on the other hand, are defined by the large number of genera that occur in only one province, and by the high species-level endemism in both. Recently, van Balgooy (1976) has proposed combining the West and South Malesian provinces into an extended West Malesian Province (subsequent reference to West Malesia will be in this sense), returning more to the ideas of Merrill (1923) and other earlier workers.

The distribution both of species and of distinctive characters within *Calophyllum* follows this east-west division of Malesia. Only six species (of which *Calophyllum inophyllum* is one) are found in both areas (MAP 1). The variable *C. calaba* var. *bracteatum* grows from Timor westward, and var. *australianum* occurs in Australia; it is clearly a species with wide ecological amplitude that also can grow in drier areas. *Calophyllum soulattri* occurs throughout Malesia; it has small, dark blue to black fruits and is probably dispersed by birds. *Calophyllum laticostatum*, which occurs in New Guinea and possibly also in the Philippines, and *Calophyllum* sp. 129, found on the Moluccas and an island off southwestern Borneo, are related to one another and may have eastern affinities. *Calophyllum wallichianum* var. *incrassatum* is basically West Malesian but may occur on Sulawesi.

Only nine species of *Calophyllum* are recorded from the erstwhile South Malesian Province. *Calophyllum dasypodum*, *C. dioscurii* (known from only a single, sterile specimen in Java), and *C. venulosum* are all restricted to West Malesia. Two species are endemic. *Calophyllum grandiflorum* is related to *C. venulosum*. *Calophyllum archipelagi* is probably related to the predominantly East Malesian *C. laticostatum* and joins the already fairly substantial list of Java-Lesser Sunda Islands endemics (van Steenis, 1979). The widespread, predominantly West Malesian *C. tetrapterum* is known from Bawean and Karimundjawa islands only; the plants of the latter island often have Bornean affinities (van Steenis & Schippers-Lamertse, 1965). *Calophyllum calaba* is predominantly West Malesian; *C. inophyllum* and *C. soulattri* are widespread. Hence, the affinities of *Calophyllum* in South Malesia are predominantly to the north and west. The climate of the Lesser Sunda Islands is rather dry, and Kalkman (1955) showed that the West Malesian floristic

element decreased in importance from west to east in these islands (see also van Steenis, 1979).

The Sulawesi-Moluccas region has more species with affinities to the east than to the west. *Calophyllum celebicum* may be most similar to the West Malesian *C. teysmannii* var. *inophylloide*, but *C. undulatum* and *C. articulatum* are related to eastern species. In addition, six species reach their westerly limit here. However, many species from this crucial area are poorly understood, *C. soulattri* is very variable, and there may be additional undescribed taxa; recent collections from Sulawesi kindly sent to me by G. Musser proved embarrassingly difficult to identify.

Taxa from the Philippines show relationships with those of both West and East Malesia. The relationship with East Malesian taxa, which caused the Dickerson-Merrill modification of Wallace's line so that it passed to the west of the Philippines (e.g., Merrill, 1926), has been emphasized recently by B. L. Burt (e.g., in Ashton & Ashton, 1972, and in R. M. Smith, 1977). *Calophyllum* sp. 121 is perhaps related to the East Malesian *C. neo-ebudicum*. The conoid galls found on the leaves of *C. whitfordii*, in particular, are most common in East Malesian and Pacific species. However, the link with West Malesia is numerically stronger, since five species occur on Borneo and/or Palawan, as well as on that part of the Philippines that has always been insular.

The distribution of five distinctive character states (MAP 2) confirms this basic east-west division and reflects the occurrence of different groups of species in the two areas (cf. Stevens, 1974a). Species that have stones with basal plugs are probably under-recorded. Species with blue to blackish fruits are predominantly East Malesian; about 14 such species occur in New Guinea, but there are only four in West Malesia (*C. polyanthum* and *C. austroindicum*, from southwestern India, may also have blue fruits, but the observations must be reconfirmed). Although it is not known with certainty which character states are derived, none of the "East Malesian" character states is necessarily primitive (see above).

Despite the lack of clear evidence, *Calophyllum* probably moved from West to East Malesia as continental drift brought the Australian plate near Southeast Asia 15 to 20 million years ago (Raven & Axelrod, 1974; van Balgooy (1976) and van Steenis (1979) suggest that there may have been earlier floristic contact). Diversification in East Malesia has been subsequent to this movement.

The difference between the species of *Calophyllum* in the two halves of Malesia may be a partial reflection of this circumstance, East Malesia being colonized by only a few taxa. As has long been known (e.g., Merrill, 1926), many of the islands in West Malesia were interconnected at various times during the Pleistocene, and others were much less isolated then; most of the Philippine Islands remained separate, although Palawan was connected to Borneo. There was a similar extension of land in East Malesia, although islands such as New Britain, Sulawesi, and the Moluccas have always been isolated. Hence, the two halves of Malesia have remained separate, but the greater affinities of the species from Sulawesi and the Moluccas with East,

rather than West, Malesian species and the relationships of those from the Philippines still pose problems.

Within the West Malesian area, 28 species are centered on the Sunda Shelf, occurring on mainland Sumatra and/or Malaya as well as on Borneo, and several others are clearly related to this element. The relationships of the Malay *Calophyllum*-flora are at least as much with that of the relatively distant Borneo as with the closer Sumatra, a not uncommon pattern (Keng, 1970; see also the accounts of *C. alboramulum* and *C. fraseri*). Endemicity is high in Borneo, less high—and mainly in montane species—in Malaya, and low in Sumatra. Within the East Malesia-Pacific region, endemicity is highest in New Guinea, but local endemics occur throughout the area.

Guppy (1906) suggested that *Calophyllum burmannii* (properly *C. cerasiferum*) and *C. spectabile* (properly *C. vitiense*), both from Fiji, were dispersed there by fruit pigeons, rather than being derived from the local *C. inophyllum*, also from Fiji; Smith and Darwin (1974) thought that at least some species in the Fiji-Samoa area might have arisen from *C. inophyllum*. Although *C. vitiense* and *C. cerasiferum* may be derived from a taxon other than *C. inophyllum*, all three taxa have stones with basal plugs; such taxa preponderate in East Malesia and the Pacific, so the origin of *C. inophyllum* itself may have been in this general area. If the suggested relationship of *C. leucocarpum* to Papuan species is correct, there may be three independent lines of the genus on Fiji, probably reaching the archipelago by island-hopping in the general path Solomon Islands–New Hebrides–Fiji (Smith, 1979).

ECOLOGY

Several taxa of *Calophyllum* in Indo-Malesia have wide ecological ranges. These species often, but not always, occupy a wide geographic range, but the amount of morphological variation within the taxa differs. The widespread, predominantly West Malesian *C. pisiferum*, *C. rupicola*, *C. biflorum*, *C. canum*, *C. tetrapterum* var. *tetrapterum*, *C. soulattri*, *C. teysmannii* vars. *teysmannii* and *inophylloide*, and *C. venulosum* show considerable morphological variation, which at least in *C. canum*, *C. pisiferum*, *C. rupicola*, *C. soulattri*, *C. teysmannii* var. *teysmannii*, and *C. venulosum* is partly correlated with ecology. Unfortunately, details of the ecology of the highly variable *C. blancoi* in the Philippines are practically unknown. The Papuan *C. sil* and *C. vexans* also show a considerable amount of infraspecific and ecological variation and likewise inhabit a considerable area; morphological variation is correlated with geography in both species. *Calophyllum* sp. 151 (a local species), *C. depressinervosum*, *C. pulcherrimum* (all basically West Malesian), *C. papuanum*, *C. peekelii*, and *C. neo-ebudicum* (all basically East Malesian) grow in a variety of habitats but show less infraspecific variation.

MAP 2. Distribution of five character states in Malesian species of *Calophyllum*: —, scales at bases of axillary innovations and inflorescences; — X —, terminal inflorescences (to India and possibly the Comores); — XX —, angled stones and/or flattened terminal buds; — · —, plugs at bases of stones (to Fiji and Samoa, excluding widespread *C. inophyllum* and its derivative, *C. tacamahaca*; also in South America).

A few Bornean species (e.g., *Calophyllum hosei*, *C. scriblitifolium*, and perhaps *C. sclerophyllum*) grow both in peat swamps and in the apparently very different kerangas forests on leached, arid sands. Such distributions are rather common (Brunig, 1974) and reflect certain essential ecological similarities, such as extreme oligotrophy, in the at first sight rather disparate environments.

Four out of the eight species (*Calophyllum neo-ebudicum*, *C. peekelii*, *C. soulattri*, and *C. vexans*) from the Solomon Islands have wide ecological tolerances, perhaps a reflection of the depauperate flora there (Whitmore, 1969).

Most Malesian taxa have more restricted ecological ranges. Many grow in more or less well-drained, mixed dipterocarp forest and in its East Malesian equivalent. Within this broadly defined habitat, a few species such as *Calophyllum macrocarpum* seem to prefer stream sides (without being rheophytes); others, like the four species from the Solomon Islands studied by Greig-Smith, Austin, and Whitmore (1967), may show more subtle preferences (but see Stevens, 1974a; also below). *Calophyllum nodosum* occurs most frequently in forests growing on rather acid soils and is locally abundant in extreme kerangas vegetation; it also grows in submontane vegetation. It shows considerable variation in foliar characters but little in those of flower or fruit. *Calophyllum obliquinervium* also grows most commonly in forests on rather acid soils; it grows in a number of other habitats but shows little variation.

Several species (e.g., *Calophyllum collinum*, *C. costatum*, *C. exiticostatum*, *C. incumbens*, *C. milvum*, *C. papuanum*, *C. polyanthum*, *C. symingtonianum*, *C. trapezifolium*, *C. thorelii*, *C. undulatum*, and *C. vitiense*) grow in colline forest up to about 1300 meters in altitude. Another group of species, including *C. cerasiferum*, *C. garcinoides*, *C. hirasimum*, *C. rigidulum*, *C. rotundifolium*, *C. pauciflorum*, and *C. walkeri*, occurs predominantly above 1300 meters. As might be expected, the species that grow at high altitudes tend to have rather short, broad, thick leaves that are not much pointed at the apex. Since most of these taxa in Malesia seem to be independently derived from lowland taxa (cf. Whitmore, 1973), they have little else in common; the species growing at high altitudes in Sri Lanka are closely related to each other. There is no noticeable increase in indumentum with altitude.

Some species grow in other, rather specific habitats. Several West Malesian species (e.g., *Calophyllum ardens*, *C. sclerophyllum*, *C. sundaicum*, *C. scriblitifolium*, and probably also *C. praetermissum*) grow in peat swamps, and others like *C. lowii* and *C. mukunense* grow in "periodically inundated" forest. The only fairly well-collected East Malesian species that habitually grows in swamps or periodically inundated ground is *C. suberosum*. A few species that have restricted distributions grow in forest over limestone or ultramafic rock. *Calophyllum aurantiacum* and *C. calcicola* have been recorded only from the former, while *C. complanatum*, *C. sakarium*, and *Calophyllum* spp. 98 and 143 have been recorded only from the latter. A number of additional species sometimes grow over ultramafic rock. A few species grow in drier forests: *C. calaba* var. *calaba* from Sri Lanka is the best example,

and *C. sil* (from Australasia) is usually found in gallery forest. Three taxa are rheophytes: *C. pisiferum* (not always, and only in mainland Southeast Asia), the closely related *C. lineare*, and the typical form of *C. rupicola*. *Calophyllum inophyllum* is characteristically a strand plant; it shows a certain amount of ecogeographic variation.

In many places, especially swamp forest, well-drained lowland forest, and ridges in lowland to montane forest, several species of *Calophyllum* may grow together (that is, within a few meters of each other), and where two of these habitats abut, even more species may be involved. Such concentrations of species have been observed in the swamp forests of southern Johore (Malaya) and near Kuching (Sarawak); in ridge forests throughout Malesia—notably Malaya, Sarawak, and Sabah (even on ultramafic rock); and in mixed forests in Papua New Guinea (there is a particularly interesting area in lowland forest around Kiunga, where at least 12 species of *Calophyllum* occur) and New Britain.

EVOLUTION

The discussion in the preceding section in a way epitomizes the problems that arise in discussing the evolution of the genus. Although species may have very distinct ecological preferences, this is not always so, and obvious “adaptations,” even to very different habitats, are few. Possible exceptions are the small, broad, thick leaves of the montane species, the narrow leaves of the rheophytic species, and the stilt roots of many of the swamp-dwelling species. There are no major discontinuities in the pattern of morphological variation in the genus (see also van Steenis, 1968), and even if all the species in the genus except for two were unknown, these two would probably still be placed in the same genus. The variation in the genus is almost kaleidoscopic (Cullen, 1968) and on a rather restricted theme, yet numerous taxa can be recognized. These taxa frequently grow together (the “sympatry” of the following discussion) although they do not often hybridize.

It is very difficult to understand both the evolution and the maintenance of this species diversity. Much of the variation appears to be without adaptive significance and so might seem to confirm some of van Steenis's ideas on evolution in the tropics (see van Steenis 1977, 1978, and references therein; Fedorov, 1977, also leans toward such a view). However, this position can be supported only by a much more detailed knowledge of plant groups than is currently available, and the only reasonable position in the absence of such knowledge is that of an agnostic. One cannot expect a revision like the present one to resolve this important issue, but the suggestions made below may bear closer examination.

The morphological variation of the seedling and young plant in *Calophyllum* is considerable; the pigmentation of the young leaves also varies at this stage. Although there is some variation in fruit structure that is connected with germination, there is little variation in embryo morphology. The stem anatomy of the seedling has not been examined, but there is certainly less variation in lamina anatomy at this stage than occurs in the adult (see also

Stevens, 1974a). There is no obvious correlation of the variation of these young stages with ecological parameters.

Unfortunately, few genera have been studied in comparable detail. *Diospyros* shows much variation in germination and seedling, and Wright (1904) keyed out the species from Sri Lanka using characters of fruit and seedling. Maury (1978) studied many aspects of the fruit, germination, and young plants of the Dipterocarpaceae and found extensive variation. However, this variation was mostly at the sectional level and in characters of fruit, germination, and seedling; she noted (1979) that species in some genera can be recognized even when still young plants. De Vogel (1980) does not mention any comparable examples.

There is considerable selection pressure on a plant in the early stages, and the environmental requirements for germination and establishment are often very precise. Grubb (1977) has particularly emphasized the importance of the "regeneration niche" (the environment of the very young plant) in the maintenance of species diversity, even suggesting that species in such genera as *Diospyros*, *Rinorea* Aublet, *Shorea* Roxb. ex Gaertner, and *Eugenia* L. (*Syzygium* Gaertner) may differ by only a single character in the regeneration niche.⁹

However, it might also be argued that relatively little variation is likely at this stage, with physical factors such as temperature and humidity showing relatively less variation during times when germination is possible compared to later stages. Character complexes adapted to the conditions occurring then will not change readily; at least, there will not be a complete reorganization, since a major change would destroy the developmental pattern at a vulnerable stage. Similarly, genes acting late in development will often not show their effects at these earlier stages (Stebbins, 1950, 1974).

Study of *Calophyllum* may produce evidence relevant to this problem. It is possible that some of the characters apparent throughout the life of the plant are important only at the younger stages, being selectively neutral later on. Young plants of *C. pulcherrimum*, *C. robustum*, and *C. rigidum* all have plagiotropic leading axes, and the adults have more or less pendulous branches. One might ask at what stage, if any, this is of functional significance (see Givnish, 1978, for discussion on the possible selective advantage of compound leaves; in some respects a plagiotropic axis is functionally equivalent to a compound leaf). Other characters, like leaf number and disposition in the seedling, and the initial period of slow growth as well as the distinctive leaf shape in the young plant can be of significance only at early stages. In this context, the populations of *C. soulattri* from Manus to the Solomon Islands should be compared with those from elsewhere in Papuasia, since the only major differences between the two appear to be in fruit, seedling, and young plant. Another interesting case is *C. sclerophyllum*, which is sometimes superficially similar to *C. teysmannii* var. *inophylloide*, although

⁹White (1962, 1978) noted that species of *Diospyros* in Africa belong to many sections, and sympatric species are not usually closely related; species in genera like *Shorea* are delimited on characters other than those of the regeneration niche.

the seedlings, young plants, and anatomy of the two are very different. Finally, one of the more important distinctions between *C. persimile* and *C. suberosum* seems to be in the seedling and young plant. Thus, variation in the "regeneration niche" may be of considerable importance in both the development and maintenance of diversity in *Calophyllum*.

In the adult plant, the considerable variation in the disposition of the leaves along each innovation, the branching pattern (monopodial vs. sympodial), and the way the leaves (notably erect in some taxa, such as *Calophyllum peekelii*, but usually spreading to pendent) and branches are held must all affect how leaves intercept light. Again, comparison with other tropical genera is difficult because such characters are not often observed, but similar variation seems to occur in tropical montane Ericaceae (Stevens, 1980a).

In two cases the growth pattern of the plant may be connected with its preferred habitat. The trunk is less strongly orthotropic in *Calophyllum inophyllum* than in other species, and individuals may start to lean when only a few meters tall. This relatively weak orthotropy, doubtless aided by wave action, may cause the trunk to become procumbent on the beach, the branches being more or less erect, but *C. inophyllum* is sometimes an erect tree in closed forest. In open, kerangas vegetation shrubs of *C. nodosum* only 30 cm. tall may bear fruits, the terminal bud is frequently not functional, and branching is profuse. However, like other species with the same branching pattern, *C. nodosum* may also be a sizable tree; species with functional terminal buds may also be shrubs.

The variation in hair type is considerable, although it is variation on a rather limited theme. Hairs seem to protect the resting bud, since in those species in which the buds are covered by thick perulae, or protected in pockets formed from the stem and petiole (e.g., *Calophyllum savannarum*), the buds tend to be glabrous. The brown contents of the hairs, more obvious in some species than in others, are probably tannins—protectants against some generalized herbivores; in some species with notably thin-walled apical cells, the contents may be more readily exposed and so be more effective deterrents. In other species the apical cells seem to be empty. The very thick walls of the apical cells of *C. rufigemmatum* clearly increase the physical protection of the bud, as may the small, but very papillate and thick-walled, hairs of species such as *C. subsessile* and *C. persimile*.

Although the fruit is always drupaceous, variation is considerable. Possible dispersal agents are summarized here; however, careful observations are still sadly lacking. A few species are habitually or occasionally dispersed by water, several are eaten by mammals (bats, squirrels, or monkeys), and others are eaten by birds. Blue-fruited species preponderate in East Malesia, and these may be dispersed by birds. There are few arboreal mammals in this region, and birds are attracted to blue (among other colors), so the diversification of the genus may be connected with an increase in importance of bird-dispersal of the seeds. Unfortunately, I do not know of other groups that have more blue-fruited taxa in East Malesia than in West Malesia.

Closely related species usually differ only slightly in hair type, fruit structure, germination, and young plant. Such species are usually allopatric, and they

may also be ecologically differentiated. Examples are listed in TABLE 4, although this table should really be treated as a list of cases worthy of closer investigation. As noted above, variation within many species shows a pronounced correlation with geography, and the varieties of most species that are so subdivided usually grow in different areas (infraspecific variation in both *C. teysmannii* and *C. tetrapterum* is not quite so clear-cut).

Many of the observations and suggestions made above are compatible with the idea that speciation in *Calophyllum* is basically allopatric; sympatry occurs only after subsequent divergence. Morphological confusion nearly always occurs between allopatric, rather than sympatric, taxa; hybridization between sympatric taxa is not common. Closely related taxa are separated by eco-geographic barriers, whether or not there are also reproductive barriers. This series of generalizations agrees with observations on West Malesian Dipsacaceae (Ashton, 1977, 1978), *Diospyros* in humid tropical Africa (White, 1962, 1978; the sympatric taxa often belong to different supraspecific taxa), and *Drimys* J. R. & G. Forster in Papuasia (Vink, 1970); it disagrees with Fedorov's ideas on speciation (Fedorov, 1966). The four species of *Calophyl-*

TABLE 4. Geographic and ecological preferences of closely related taxa of *Calophyllum*.

MADAGASCAR
<i>C. verticillatum</i> / <i>C. chapelieri</i> . Usually grow in different places, but some overlap; intermediates?
SRI LANKA
<i>C. walkeri</i> / <i>C. trapezifolium</i> / <i>C. cuneifolium</i> / <i>C. thwaitesii</i> / <i>C. vergens</i> . First three have largely different altitudinal limits; <i>C. vergens</i> and <i>C. trapezifolium</i> at least sometimes grow in same general area.
<i>C. calaba</i> var. <i>calaba</i> / var. <i>worthingtonii</i> . Ecological differentiation, but possible rare overlap.
INDIA-CHINA
<i>C. polyanthum</i> / <i>C. touranense</i> / ? <i>C. balansae</i> . Largely grow in different areas; variation within <i>C. polyanthum</i> has pronounced geographic component.
VIETNAM-MALESIA
<i>C. calaba</i> var. <i>bracteatum</i> / var. <i>cuneatum</i> / var. <i>E.</i> / var. <i>australianum</i> . Var. <i>cuneatum</i> ecologically separated; vars. <i>E</i> and <i>australianum</i> geographically separated.
<i>C. pisiferum</i> / <i>C. dispar</i> / <i>C. lineare</i> . Never grow together, but no obvious ecological preferences; taxonomy of group not satisfactory.
WEST MALESIA
<i>C. ferrugineum</i> / <i>C. biflorum</i> / <i>C. sundaicum</i> / <i>C. costulatum</i> . The three varieties of <i>C. ferrugineum</i> grow in different areas, var. <i>orientale</i>

TABLE 4 (continued).

- ecologically differentiated as well; *C. sundaicum* ecologically differentiated; *C. biflorum* largely geographically separated; *C. costulatum* poorly known; *C. ferrugineum* var. *ferrugineum* and *C. biflorum* grow together in hill forest, S. Johore; *C. ferrugineum* var. *ferrugineum*, *C. sundaicum*, and *C. costulatum* (variant) grow together in swamp forest, S. Johore.
- C. wallichianum* var. *wallichianum*/var. *incrassatum*/var. *tahanense*. Vars. *wallichianum* and *incrassatum* basically geographically separated, var. *tahanense* in part ecologically.
- C. gracilipes*/*C. recurvatum*/*C. aurantiacum*. *C. gracilipes* and *C. recurvatum* geographically separated, *C. aurantiacum* ecologically.
- C. roseocostatum*/*C. stipitatum*/*C. elegans*/*Calophyllum* sp. 65/?*C. pyriforme*. No two taxa found in one place, but both *C. roseocostatum* and *C. elegans* occur near Kuching.
- C. venulosum* var. *venulosum*/var. *tenuivenium*/*C. subsessile*/*C. grandiflorum*. No taxa in this complex grow together, yet no major geographic isolation.
- C. nodosum*/*C. depressinervosum*/*C. pulcherrimum*. Usually grow apart, although sometimes not far distant; all grow together at Sabal Tapang, Sarawak; *C. nodosum* often on more acid soil than other two, which differ notably in fruit.
- C. teysmannii*/*C. sclerophyllum*. Largely ecologically isolated; when growing together (swamps, Johore), form of *C. teysmannii* involved is that least similar to *C. sclerophyllum*; varieties of *C. teysmannii* not sympatric.

EAST MALESIA

- C. undulatum*/*C. parvifolium*/*C. caudatum*/*C. novoguineense*/*C. bicolor*/*C. confusum*/*C. bifurcatum*/*C. leucocarpum*. Geographically separated, although *C. novoguineense* and *C. bicolor* grow together near Kiunga.
- C. trachycaule*/*C. goniocarpum*/*C. piluliferum*/*C. heterophyllum*/*Calophyllum* sp. 143/*C. rufinerve*. Largely geographically separated, but *C. trachycaule* and *C. goniocarpum* grow together near Kiunga, *Calophyllum* sp. 143 and *C. goniocarpum* in same area near Buso; taxonomy of group poorly understood.
- C. laticostatum*/*C. insularum*/*Calophyllum* sp. 129/*C. sil*/*C. collinum*. First three geographically separated and closely related; second two less closely related; *C. sil* sensu stricto ecologically differentiated; *C. collinum* and *C. laticostatum* sympatric at Kiunga.
- C. papuanum*/*C. pauciflorum*/*C. vexans*. Largely geographically separated, also ecologically; *C. papuanum* and poorly understood form of *C. vexans* grow together near Kiunga.
- C. suberosum*/*C. persimile*. Ecologically separated; considerable differences in young plants.
- C. neo-ebudicum*/*C. cerasiferum*/*C. vitiense*. *C. cerasiferum* usually at highest altitudes, otherwise no major geographic separation.

lum that Grieg-Smith *et al.* (1967) thought were examples of closely related species having different niches are perhaps better considered as examples of not immediately related species that frequently can grow together. These species—*C. soulattri*, *C. vexans* (their *C. cerasiferum*), *C. neo-ebudicum* (their *C. vitiense*), and *C. peekelii* (their *C. kajewskii*)—quite frequently grow together, as can be seen from the data given by Grieg-Smith *et al.*, and as I have observed in New Britain.

It is difficult to compare the amount of differentiation between allopatric and sympatric taxa within a genus, let alone between different genera (see also below), but in both *Calophyllum* and *Drimys* even sympatric taxa may be rather similar (variation in seedlings and young plants of *Drimys* is not great (pers. obs.)).

However, current knowledge of *Calophyllum*, and of most tropical groups, rather vitiates this type of analysis. As mentioned above, subtle, but discontinuous, sympatric variation may escape recognition because of the small sample size from most localities and the practical limits on field work in the area; geographically correlated variation may be overemphasized because of patchy collecting. The variation of *C. biflorum* and *C. teysmannii* var. *inophylloide* on Gunong Matang, Sarawak, is pertinent here, since the differences between the two “forms” of each of these taxa on this hill are similar to those that characterize allopatric varieties in other species. Although this variation seems to intergrade with that in the rest of the taxa, field experience throughout Borneo might show that all specimens could be referred to these two “forms”; the separation of *C. persimile* from *C. suberosum* was suggested by similar field observations. Hence any explanation of the patterns observed in terms of processes can only be speculative, but one can at least identify areas for future work.

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¹⁰ AAU, B, BISH, BKF, BM, BO, BRI, C, CAL, CANB, CHR, DNA, E, F, G, GH, K, KEP, KLU, L, LY, M, MASS, MAU, MICH, MO, NSW, NY, P, PERTH, PNH, SAN, SAR, SING, SYD, TAI, U, UC, US, W, WRC (abbreviations follow Holmgren & Keuken, 1974).

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SYSTEMATIC TREATMENT

Calophyllum L. Sp. Pl. 1: 513. 1753, Gen. Pl. ed. 5. 229. 1754; Lam. Encycl. Méth. Bot. 1: 552. 1785; Juss. Gen. Pl. 286. 1791; Willd. Sitz-ber. Ges. Naturf. Fr. Berlin Mag. 5: 78. 1811; Choisy, Mém. Soc. Hist. Nat. Paris 1: 228. 1823, in DC. Prodr. 1: 562. 1824; Endl. Gen. Pl. 1028. 1840; Choisy, Descr. Guttif. Inde, 41. 1849; Miq. Fl. Nederl. Indië 1(2): 509. 1859; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 241. 1862; Bentham in Bentham & Hooker f. Gen. Pl. 1: 175. 1862; T. Anderson in Hooker f. Fl. Brit. India 1: 271. 1874; Vesque, Epharosis 2: 6. 1889; King, Jour. Asiatic Soc. Bengal, II. 59: 172. 1890; Vesque in C. DC. Monogr. Phanerog. 8: 529. 1893; Trimen, Handb. Fl. Ceylon 1: 98. 1893; Engler in Engler & Prantl, Nat. Pflanzenfam. 3(6): 220. 1895; Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 316. 1910; Ridley, Fl. Malay Penin. 1: 181. 1922; Engler in Engler & Prantl, Nat. Pflanzenfam. ed. 2. 21: 192. 1925; Gagnep. Fl. Gén. Indo-Chine Suppl. 1(3): 268. 1943; Perrier de la Bâthie, Fl. Madagascar Comores, Fam. 136: 3. 1951; Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 285. 1956; Maheshwari, Bull. Bot. Survey India 2: 139. 1960; Backer & Bakh. f. Fl. Java 1: 384. 1963; A. C. Sm. & Darwin, Jour. Arnold Arb. 55: 216. 1974; P. F. Stevens, Austral. Jour. Bot. 22: 349. 1974. TYPE: *Calophyllum inophyllum* L.¹¹

Ponna Rheede ex Ludwig, Defin. Gen. ed. 3. 239. 1760. *Nomen superfluum*.
Calaba Plum. ex Adanson, Familles 2: 446. 1763. *Nomen superfluum*.

Augia Lour. Fl. Cochinch. 337. 1790, *pro minore parte*.

Balsamaria Lour. *Ibid.* 467. TYPE: *Balsamaria inophyllum* Lour.

Apoterium Blume, Bijd. Nederl. Indië 1(5): 218. 1825. TYPE: *Apoterium sulatri* Blume.

¹¹ *Calophyllum* is usually typified by *C. calaba*, but that species does not agree with the generic description in Linnaeus, Gen. Pl. ed. 5. 229. 1754. Fuller details will be given in a later article.

Evergreen trees or shrubs, sometimes buttressed or with stilt or loop roots; bark often with characteristic diamond-shaped fissures becoming confluent with age; latex present, nearly always colored. Twigs $\pm$ flattened and angled; terminal buds usually naked, sometimes with scales, rarely aborting and not functional; indumentum of uniseriate hairs usually at least on buds. Leaves decussate in adult plants, very rarely alternate in young plants, petiolate; lamina entire, $\pm$ coriaceous, with close parallel venation alternating with and usually more prominent than latex canals. Inflorescences terminal and/or axillary, with (1 to) 3 to numerous flowers, branched or not, axes terminated by flowers; bracts usually deciduous. Flowers pedicellate, usually hermaphroditic; tepals 4 to 16, outer one or two pairs rarely much different from the rest; stamens numerous, at most obscurely fasciated, the filaments usually only slightly connate at base, the anthers small, basifixed, dehiscing by long, lateral slits; ovary unilocular, with single basal, anatropous ovule, the style present, the stigma $\pm$ expanded, often peltate. Fruit drupelike, the pericarp consisting of exocarp and well-developed, fleshy to fibrous mesocarp, the testa consisting of stony layer and usually transient spongy layer; seed single (except in polyembryonic taxa), radicle just to one side of base of fruit, cotyledons large. Germination cryptocotylar, epicotyl short. $2n = 26$ (one species).

About 187 species, 179 in the Old World, predominantly Indo-Malesian, ca. 8 species in the New World, from Mexico and the Caribbean to Argentina. Most species are small to medium sized or sometimes large trees of humid, tropical, predominantly lowland rain forest, but some species grow in mid-montane or more seasonal forest.

The wood of the larger species is used quite often in construction; where *Calophyllum* is abundant (e.g., Malaya, the Solomon Islands), it is an important component of the timber trade. The fruits of a number of species yield an oil that is of some economic use, either as a medicine or in lamps (see especially *C. inophyllum*). *Calophyllum* has been used in canoe manufacture throughout its range, the seaside *C. inophyllum* being particularly prized in this respect, and in the era of sail several species furnished masts and spars. Local names given to the species usually seem to have little specificity; the generic name, "binta(n)gor," is much used in West Malesia, often being qualified (e.g., "bintangor batu" is the local species with hard wood).

GUIDE TO USE OF KEYS AND DESCRIPTIONS

The characters used and their terminology have been extensively discussed in the preceding pages. However, certain aspects bear repeating and expanding here. Venation density should be measured in the middle part of the leaf away from any area of damage. Venation prominence is a qualitative character; however, FIGURE 7, a and c, gives an approximate indication of the extent of the variation. Deciding whether or not the lamina immediately adjacent to the midrib is raised and is thus apparently continuous with the midrib is sometimes not easy; FIGURE 7, c should help. It is easy to overlook the

FIGURE 7. Some characters as shown on dried specimens. a, *Calophyllum rufigemmatum* (FRI 13796), node with transverse line, lamina at lower left, obscure venation. b, *Calophyllum* sp. 65 (S 23854), scars left by scales at base of axillary innovations (arrows). c, *C. pulcherrimum* (Shah & Shukor 2370, leaf on left), midrib proper (tip of arrow) surrounded by raised lamina; *C. tetrapterum* var. *obovale* (S 27894, leaf on right), midrib sharply demarcated from surrounding lamina, thickened lamina margin (double arrow). d, *C. tetrapterum* var. *tetrapterum* (S 23286), nodes lacking transverse lines or markings (arrows).

scales that are sometimes present at the bases of the axillary innovations (FIGURE 7, b).

The species descriptions are generally equivalent. Parentheses enclose less commonly encountered variation. The descriptions of the bark are uneven, with much information having been taken from field labels and should be read with caution; descriptions for the species that I have seen are somewhat more comparable. Measurements were taken from dried specimens, unless otherwise mentioned, although flowers were boiled in water before measurements were taken. It is not easy to see the obscure horizontal lines that occur at most nodes in some species (FIGURE 7, a, d), and they are noted only when they have been seen; since I became aware of them only at a rather late stage in the revision, they are probably underrecorded (as perhaps in the Madagascan taxa). The color of the dried petiole is mentioned only when it contrasts very strongly with that of the stem, and the whitish, probably waxy, covering of the dried leaves of a few species is mentioned only when it occurs. A few species have leaves that dry longitudinally concave, or sometimes boat shaped; this is mentioned only when it is prominent. Unusually well-developed marginal thickening (FIGURE 7, c), prominence of the latex canals, and notably thin petioles or pedicels are mentioned only when they occur. The number of flowers in an inflorescence is usually an uneven one, and the number of tepals in a flower is usually even, but this fact is not mentioned in the descriptions for the sake of brevity. The pedicel generally thickens somewhat in fruit, but in a few species this is exceptionally notable and is mentioned in the descriptions, as are a few cases of possible elongation of the pedicel after anthesis. Unless mention is made to the contrary, it can be assumed that all tepals are fringed with hairs but are otherwise glabrous, that all stamens are glabrous and have filaments that are slightly connate at the base, and that all ovaries are glabrous. Plugs at the base of the stone are recorded only when they occur; these, too, are probably underrecorded.

Full literature citations have been given for each name (except for *Calophyllum inophyllum*) so that the reader can find his way through the often confusing earlier literature. All specimens cited have been seen, unless otherwise indicated. Usually only a single well-distributed specimen has been cited for each locality, exceptions being newly described taxa, where more are listed, and taxa recently treated satisfactorily, where fewer are given. All altitudes and distances have been converted to the metric system, except in the citation of types. Where the collections are part of institutional series, they are cited under the series, not under the collector; the collector's name is added only in the citation of type collections. The abbreviations of these institutional series basically follow those suggested by Jacobs (1968).¹² Local

¹² However, I have cited CF numbers as KEP (Malaya; they are part of the same series) and SF numbers as SFN (Singapore; later labels bear the abbreviation SFN). I may also seem to have been rather overconfident in assigning some collections that were made in Sarawak and Sabah to their respective institutional series (S and SAN). Other abbreviations used here are FHI (Forest Herbarium, Ibadan, Nigeria), SF (Service Forestière) and RN (Resources Naturelles) (both Madagascar), MAU (Mauritius), CP (Ceylon Plants), FHP (Flora of Hassan Project, India), BSI (Botanical

names are usually not given because of the problems mentioned earlier; people interested in such names should write to the author for a list. Herbarium abbreviations follow those in Holmgren and Keuken (1974).

KEYS

The keys presented below have been made as practicable as possible, hence the emphasis on vegetative characters and also the rather frequent keying out of a number of taxa more than once. A single key to all the species recognized has not been presented, since if the characters used were those on the ordinary specimen the key would be so long due to multiple entries that it would be very unpleasant to use. Characters of inflorescence, flower, and fruit, which often most readily characterize a species, are not observable on most specimens, and a key using such characters would allow identification of only a minority of the specimens. A multiple-entry key could be produced, although many characters do not lend themselves readily to the either/or scoring necessary for such a key and many taxa are incompletely known; in addition, its use would be difficult if the user treated it as a key with single character dichotomies, as I suspect would be the case.

Therefore, seven keys are presented. The areas they cover are: 1) Africa, Madagascar, and the Mascarenes; 2) Sri Lanka and peninsular India; 3) mainland Southeast Asia (Burma, Thailand, and the Nicobar Islands, to China); 4) Malaya and Sumatra to the Lesser Sunda Islands; 5) Borneo; 6) the Philippine Islands to the northern Pacific; and 7) Sulawesi to Australia and the southern Pacific.

Survey of India), CCC (Canton Christian College, China), KLU (University of Malaya, Kuala Lumpur), NGBF (New Guinea Biological Foundation), and FDA and FDF (Fiji Departments of Agriculture and Forestry, respectively—see A. C. Smith, 1979). A complete identification list can be obtained from the author.

1. Key to Species of *Calophyllum* in Africa, Madagascar

1. Innovation with terminal 2 (or 3) pairs of leaves almost pseudoverticillate.
 2. Lamina (2-)3-5.3(-8) cm. long; inflorescence usually 5-flowered.
 2. Lamina at least 8.5 cm. long; inflorescence with 7 to 11 flowers.
1. Innovation with each pair of leaves clearly separated by internode.
 3. Lamina rather thinly coriaceous, drying dull greenish brown, closely undulate; flower with 4 tepals [introduced].
 3. Lamina rarely thinly coriaceous, if so then venation density less, otherwise (7 or) 8 or more tepals.
 4. Lamina shallowly cordate at base; petiole almost absent.
 4. Lamina at most rounded at base; distinct petiole usually present.
 5. Axillary innovation with leaves $\pm$ restricted to top half, basal internode less than 7 cm. long, venation usually $\pm$ obscure].
 6. Terminal bud 5-7 mm. long.
 6. Terminal bud 1-4 mm. long.
 7. Lamina broadly rounded at base [stone wall less than 0.3 mm. a.
 7. Lamina cuneate to acute at base.
 8. Fruit $\pm$ spherical, stone wall ca. 2 mm. thick; terminal bud 1
 8. Fruit ovoid, or stone wall less than 0.5 mm. thick, or terminal bud
 5. Axillary innovation with leaves $\pm$ regularly scattered along its length, or others.
 9. Terminal bud 3.5-4 mm. long; lamina 4.3-7.8 cm. long; inflorescence [Comoro Islands].
 9. Usually not this combination of vegetative characters; inflorescence
 10. Terminal bud less than 4 mm. long; lamina usually less than 6 cm. long.
 11. Venation on lower surface of lamina $\pm$ flat to impressed, strongly fibrous outer layer, fibers persisting around stone.
 11. Venation on lower surface of lamina usually $\pm$ raised, e fibers.

12. Lamina 0.9–3.7 cm. long, with 13 to 19 veins/5 mm. .
12. Lamina usually more than 2.5 cm. long, with up to 12 (
13. Lamina 5–11 cm. long, acuminate at apex, angle of

13. Lamina to 6 cm. long, acute to rounded at apex, and
14. Angle of divergence of venation 20–40°; lower
 [fruit unknown].
14. Angle of divergence of venation at least 50°; lower
 cm. long.
10. Terminal bud at least 4 mm. long; lamina often more than 6 cm
15. Lamina obovate to elliptic, with 4 to 8 (to 10) veins/5 mm
 cm. long [usually seaside plant].
15. Lamina usually ovate to elliptic or oblong, with (5 to)
 very clearly raised; pedicel up to 2.5(–3.5) cm. long.
16. Lamina acute to acuminate at apex.
17. Terminal bud 1.1–2.4 cm. long; lamina somewhat r

17. Terminal bud less than 8 mm. long; lamina somewh
18. Lamina acuminate at apex, with 8 to 18 vein
 thick, the stone wall 0.3–0.6 mm. thick, lacking
18. Lamina acute at apex, with (6 to) 8 to 11 ve
 thick, the stone wall 0.9–1.5 mm. thick, with b
16. Lamina obtuse to rounded or retuse at apex.
19. Lamina drying $\pm$ flat, midrib depressed; fruit with
20. Lamina 5.7–17.5 cm. long; twigs 2.5–5 mm. a
 thick.
20. Lamina 2–4.8(–7.5) cm. long; twigs 1.3–3 mm
 thick.
19. Lamina usually drying with recurved margin, ofte
 above usually with at least margins raised; fruit wi

2. Key to Species of *Calophyllum* in Sri Lanka and

1. Inflorescences terminal [lamina at least 6 cm. long].
 2. Lamina rounded to cordate at base; indumentum tomentose.
 2. Lamina acute at base; indumentum puberulent.
1. Inflorescences axillary.
 3. Terminal bud 1.2–2 cm. long; fruit with stone retuse at apex.
 3. Terminal bud less than 1 cm. long; fruit with stone rounded to acute at apex.
 4. Leaves varying greatly in size along each twig [internodes less than 2 cm. long].
 4. Leaves not varying greatly in size along each twig.
 5. $\pm$ Persistent, conspicuous, tomentose indumentum on terminal bud; lamina ovate to elliptic, with 5 to 11 (to 13) veins/5 mm., angle of divergence 45–60°.
 5. Transient to $\pm$ persistent, puberulent to subtomentose (very rarely tomentose), and usually restricted to base of inflorescence axis.
 6. Lamina at least 7 cm. long, with 5 to 8 (to 10) veins/5 mm., venation prominent; stone 1–2 cm. long; stone with basal plug.
 6. Lamina less than 7(–10) cm. long, venation density and prominence variable; stone lacking basal plug.
 7. Twigs strongly flattened; internode often more than 2 cm. long; venation prominent and conspicuous, ca. $\frac{1}{4}$ – $\frac{1}{2}$ length of terminal bud; internodes of inflorescence usually less than 2 cm. long.
 8. Lamina rounded (slightly retuse) at apex, shallowly cordate at base.
 8. Lamina acute to retuse at apex, acute to cuneate (rarely rounded).
 9. Pedicel at anthesis less than 0.5 mm. across, in fruit less than 0.5 mm. across; fruit with thin outer layer becoming $\pm$ disorganized by air.
 9. Pedicel at anthesis more than 0.7 mm. across, in fruit 0.7–1.0 mm. across; fruit with well-developed, compact outer layer.
 7. Twigs usually at most slightly flattened; uppermost pair of axillary branches usually less than 2 cm. long.
 10. Lamina with 3 to 7 (to 9) veins/5 mm., venation prominent; internode of innovation about $\frac{1}{2}$ length of others].
 10. Lamina often with more dense venation, venation prominent; internode of innovation more than (40–)50°.

11. Lamina with up to 6 (rarely 8) veins/5 mm., venation
canals often impressed; inflorescence with 5 to 7 flowers.
11. Lamina with 5 to 14 (rarely to 17) veins/5 mm., venation
on lower, latex canals rarely impressed; inflorescence with 5 to 7 flowers.
12. Twig $\pm$ 4-angled; flower with 10 to 15 tepals; pedicel
less across.
12. Twig strongly 4-angled to subulate; flower with 4
less across.
13. Lamina usually rounded at base, midrib on upper
internodes of innovation approximately same length as
3 cm. long.
13. Lamina usually narrowly cuneate to acute at base,
from base; terminal internode of innovation
3 cm. long.

3. Key to Species of *Calophyllum* in Mainland Southeast Asia and the Nicobar Islands, to China

1. Twigs (1.5-)2.5-5 mm. across, very strongly 4-angled to subulate, $\pm$ nitid [indicated by prominent leaf scars].
2. Twigs with prominent leaf scars; petiole 2-5 mm. long.
2. Twigs lacking prominent leaf scars; petiole at least 10 mm. long.
3. Twigs drying blackish; internode 0.5-2.5(-5) cm. long.
3. Twigs drying brownish; internode 2-7 cm. long.
4. Lamina with 6 to 11 veins/5 mm.; fruit spherical, ca. 1.5 cm. long [indicated by prominent leaf scars].
4. Lamina with 10 to 16 veins/5 mm.; fruit ovoid to ellipsoid, 2.5-3 cm. long [position unknown].
1. Twigs often less than 2.5 mm. across, if more then not strongly 4-angled or subulate.
5. Inflorescences terminal (and sometimes axillary).
6. Lamina retuse to subacute at apex.

7. Twigs 2.5–3.2 mm. across, drying blackish; basal internode of axillary
7. Twigs 1.2–2 mm. across, usually drying brownish or grayish; basal
or more long.
8. Terminal bud 2.5–5 mm. long; lamina with $\pm$ obscure venation usu
8. Terminal bud 1.3–2 mm. long (unknown in *C. balansae*); lamina wi
on upper surface.
9. Lamina flat at margin, angle of divergence of venation 30–55°
9. Lamina $\pm$ undulate and recurved at margin, angle of divergence
6. Lamina acute to acuminate at apex.
 10. Lamina often drying bicolored [gray-olivaceous above, sabelline
by raised blade, indistinct; fruit ellipsoid, usually deeply wrinkled.
 10. Lamina usually not drying notably bicolored, midrib on upper surfac
deeply wrinkled then not ellipsoid.
 11. Venation density on upper surface of lamina apparently twice th
 11. Venation density same on both surfaces of lamina.
 12. Midrib on upper surface of lamina surrounded by raised blad
 13. Terminal bud 3–7 mm. long; lamina with (6 to) 8 to 11 ve
 13. Terminal bud 2.3–4 mm. long; lamina with 4 to 8 veins/5
 12. Midrib on upper surface of lamina not surrounded by raised
 14. Lamina with 9 to 16 (to 21) veins/5 mm., attenuate at
mm. thick].
 14. Lamina with 6 to 10 (to 14) veins/5 mm., acute to cunea
 15. Petiole 0.7–2.5 cm. long; lamina coriaceous, margin
so; fruit finely wrinkled, outer layer 3–5.5 mm. thick
 15. Petiole 0.3–0.9(–1.3) cm. long; lamina thinly coriaceous
wrinkled, outer layer ca. 1 mm. thick.
5. Inflorescences axillary.
 16. Axillary innovation with basal scars; lamina with indistinct venation and
.

16. Axillary innovation nearly always lacking basal scars; lamina with $\pm$ not.
 17. Lamina obovate to elliptic, at least 7 cm. long; pedicel (1.5–)2.5–4.5 mm., stone with basal plug; seaside tree].
 17. Lamina ovate to elliptic (rarely obovate), often less than 7 cm. long;
 18. Lamina narrowly elliptic, ca. 10 times longer than broad.
 18. Lamina broader, less than 5 times longer than broad.
 19. Lamina with 12 to 25 veins/5 mm.
 20. Lamina often more than 7 cm. long, rather closely undulate; outer layer of fruit at least 1 mm. thick.
 20. Lamina often less than 7 cm. long, rather distantly undulate; outer layer of fruit less than 1 mm. thick.
 19. Lamina with up to 12 veins/5 mm.
 21. Lamina drying notably bicolored, coriaceous, latex canaliculate supra-axillary.
 21. Lamina not drying notably bicolored, thinly coriaceous, latex canaliculate supra-axillary.
 22. Lamina rounded to acute at apex; stem often short-tapered.
 22. Lamina acute to acuminate at apex; stem at most persistent.
 23. Terminal bud 2–4 mm. long; lamina ca. 2 times longer than broad; deciduous; flowers with 4 (to 9) tepals.
 23. Terminal bud 3.5–7 mm. long; lamina ca. 3 times longer than broad; persistent; flower with 8 (to 12) tepals.

4. Key to Species of *Calophyllum* in Malaya, Sumatra, and Borneo

1. Axillary innovation with basal scars; twigs less than 3 mm. across [species with basal scars on twigs, key out in second half of couplet].
 2. Lamina with indistinct venation, drying almost completely flat, attenuate at base.
 2. Lamina with $\pm$ distinct venation, often drying definitely undulate and/or revolute at base.

3. Terminal bud glabrous, clearly composed of several pairs of decussate scales.
3. Terminal bud with indumentum, only one pair of reduced leaves or scales.
4. Lamina (5-)8-15 cm. long, latex canals not impressed; terminal bud 2.5-4 cm. long.
 5. Lamina often drying $\pm$ broadly concave, with 10 to 19 veins/5 mm. long.
 5. Lamina not drying broadly concave, with (7 to) 9 to 14 veins/5 mm. long.
4. Lamina 3.2-8 cm. long (rarely to 13 cm., then latex canals on lower surface); terminal bud 4 mm. long.
 6. Midrib on upper surface of lamina usually surrounded by raised blade,
 7. Lamina drying cinnamon-sabelline on lower surface, latex canals not impressed.
 7. Lamina drying umber to sabelline on lower surface, latex canals not impressed.
 8. Lamina usually bluntly acuminate at apex; fruit at least 1.4 cm. long.
 8. Lamina more or less rounded at apex; fruit less than 1 cm. long.
 6. Midrib on upper surface of lamina not surrounded by raised blade,
 9. Twigs less than 2 mm. across; lamina drying bicolored [gray-brown to brown]; fruit less than 1.3 cm. long.
 9. Twigs (1.5-)2 mm. or more across; lamina drying $\pm$ same color; fruit 1.3-2 cm. long.
 10. Lamina retuse to subacuminate at apex, with (9 to) 11 to 17 veins/5 mm. long.
 10. Lamina rather bluntly acuminate at apex, with 8 to 10 veins/5 mm. long.
1. Axillary innovation lacking basal scars, or twigs more than 3 mm. across.
11. Lamina cordate to auriculate at base.
 12. Lamina suborbicular, venation more prominent on upper than lower surface.
 12. Lamina nearly always at least twice as long as broad, venation not prominent; inflorescence with at least (1 to) 3 flower(s).
 13. Lamina 15-36 cm. long; pedicel at anthesis 3-7.5 cm. long.

13. Lamina to 15(–23.5) cm. long; pedicel at anthesis less than 3 cm. l.
14. Twigs up to 1.5 mm. across, drying brown; fruit less than 1 cm.
14. Twigs at least 2 mm. across, drying yellowish to grayish; fruit
15. Midrib strongly depressed only at base of lamina; inflorescences
15. Midrib strongly depressed for at least the lower $\frac{1}{4}$ of lamina
16. Twigs rounded to obscurely 4-angled; basal internode of inflorescence
16. Twigs strongly 6-angled; basal internode of inflorescence
- C. venulosum* from Bogor key out here].
11. Lamina broadly rounded to attenuate at base.
 17. Lamina at maturity tomentose or sparsely tomentose on entire lower surface.
 18. Inflorescences terminal (sometimes also from uppermost leaf axils).
 19. Terminal bud 4–8 mm. long; twigs drying yellowish.
 19. Terminal bud ca. 1.4 cm. long; twigs drying dark brown.
 18. Inflorescences axillary; fruit not furfuraceous.
 20. Lamina with (8 to) 11 to 17 veins/5 mm.; ovary tomentose.
 20. Lamina with (3 to) 5 to 8 (to 11) veins/5 mm.; ovary glabrous.
 17. Lamina at maturity at most puberulent on lower surface.
 21. Inflorescences terminal (sometimes also arising from uppermost leaf axils).
 22. Lamina retuse at apex, 2–5 cm. long; uppermost pair of axillary bracts foliaceous, persistent.
 22. Lamina usually acute to acuminate at apex, at least 3.5 cm. long; bracts short; bracts not foliaceous and persistent.
 23. Lamina 3.5–6.7 cm. long, with (9 to) 11 to 16 veins/5 mm.
 23. Lamina 5–19.5 cm. long, with 5 to 12 veins/5 mm.
 24. Petiole ca. 1 mm. across; lamina ovate to subelliptic, terminal bud
 24. Petiole at least 2 mm. across; lamina elliptic to oblong, terminal bud
 25. Lamina very coriaceous, broadly rounded toward apex; terminal bud
 25. Lamina coriaceous, acuminate at apex; terminal bud

21. Inflorescences axillary (rarely terminal).
 26. Lamina very strongly revolute at margin when dry, thickly coriaceous.
 26. Lamina not very strongly revolute at margin, thickly to thinly coriaceous.
 27. Terminal bud (0.8-)1-3 cm. long.
 28. Lamina drying closely undulate at margin; uppermost branch usually with strong lateral branches.
 28. Lamina not drying closely undulate at margin; uppermost branch usually without strong lateral branches.
 29. Terminal bud (3-)4.5-10(-11) mm. long; lamina with venation notably plump, sometimes supra-axillary.
 29. Terminal bud (0.8-)1-3 cm. long; lamina with venation not notably plump and/or supra-axillary.
 30. Midrib on upper surface of lamina strongly raised from base.
 31. Lamina often drying nitid, with (10 to 15) veins/5 mm.; rarely branched or flabellate; fruit pointed at apex.
 31. Lamina drying dull, with 10 to 15 veins/5 mm.; rarely branched or flabellate; fruit rounded at apex.
 30. Midrib on upper surface of lamina raised (not strongly) near base.
 32. Lamina with 5 to 11 veins/5 mm., venation not strongly raised from base.
 32. Lamina with 11 to 18 veins/5 mm., venation not strongly raised from base.
 33. Inflorescence axis 0.3-1.3 cm. long; hairs short, with stone wall (0.8-)1.3-2 mm. thick.
 33. Inflorescence axis 1.7-7 cm. long; hairs long, with stone wall 0.3-0.8(-1) mm. thick.
 27. Terminal bud less than 0.9 cm. long.
34. Lamina retuse to obtuse at apex.
35. Twigs drying shiny; lamina with 3 to 6 veins/5 mm.; flower with (8 to 12) stamens.

35. Twigs not drying shiny; lamina usually with more than 6 veins/5 mm. rounded at apex.
36. Venation on upper surface of lamina clearly denser than on lower internode of inflorescence (0.2-)1-5 cm. long; inner surface of outer
36. Venation same density on both surfaces of lamina.
37. Midrib on upper surface of lamina surrounded by raised blade, in
 38. Lamina to 6(-8.3) cm. long, coriaceous; tree without stilt root
 38. Lamina 5.7-21 cm. long, very coriaceous; tree with stilt root
37. Midrib on upper surface of lamina not surrounded by raised blade
 39. Lamina with (3 to) 5 to 11 veins/5 mm., usually $\pm$ thinly coriaceous
 40. Indumentum subtomentose, conspicuous on young stems 1-5 cm. long.
 40. Indumentum puberulent, inconspicuous; lamina at least 7 cm. long.
39. Lamina with (8 to) 10 to 18 veins/5 mm., (thinly) coriaceous
 41. Twigs less than 1.5 mm. across; lamina with midrib on upper surface $\pm$ flat; fruit ca. 7 mm. long, smooth.
 41. Twigs usually more than 1.5 mm. across; lamina with midrib on upper surface usually raised; fruit more than 1 cm. long, wrinkled or smooth
 42. Lamina often with either clearly thickened margins or not; fruit smooth or faintly striate.
 42. Lamina not as above; fruit wrinkled.
 43. Lamina with 8 to 12 veins/5 mm., drying grayish green; inflorescence with flowers in pairs.
 43. Lamina with 10 to 18 veins/5 mm., not drying grayish green; with flowers tending to be in groups of four.
 44. Plant with pale brown, tomentose indumentum; fruit 0.5-1.5 cm. long; fruit spherical, drying closely wrinkled
 44. Plant with brown, subtomentose to puberulent indumentum; fruit (0.15-)0.4-1.8 cm. long; fruit ellipsoid, drying smooth
34. Lamina acute to acuminate (rarely cuneate) at apex.

45. Midrib on upper surface of lamina depressed, narrowing gradually from mm.].
45. Midrib on upper surface of lamina with at least margins raised, sometime
 46. Twigs 2.5–7 mm. across, drying blackish or shiny.
 47. Twigs 4-alate, drying blackish (rarely brown); petiole (1.2–)3.5–7
 47. Twigs with raised lines, but not alate, drying brown to yellowish
 46. Twigs less than 3.5 mm. across, if more then drying neither blackish
 48. Lamina thinly coriaceous, often drying greenish brown, closely buds erect, conspicuous; inflorescence branched.
 48. Lamina not as above; uppermost pair of axillary buds rarely erect
 49. Lamina elliptic to oblong, venation on upper surface appare internode of inflorescence (0.2–)1–5 cm. long; inner surface
 49. Lamina variously shaped, the venation on both surfaces usu of inflorescence less than 1 cm. long; inner surface of outer
 50. Twigs drying yellowish, whitish, or grayish.
 51. Petiole (0.8–)1–2.5 cm. long; lamina drying $\pm$ concave
 51. Petiole to 1.5 cm. long; lamina not drying concave, v
 52. Lamina abruptly acuminate at apex; blackish-dr outer layer of fruit 1–1.8 mm. thick.
 52. Lamina acute at apex; petiole and stem not str less than 1 mm. thick.
 53. Lamina with 12 to 20 veins/5 mm.; infloresc
 53. Lamina with 6 to 13 veins/5 mm.; infloresc
 54. Lamina with 6 to 9 veins/5 mm., midri blade; anthers with hairs.
 54. Lamina with 8 to 13 veins/5 mm., midri anthers glabrous.

50. Twigs drying brownish.
55. Lamina usually drying bicolored [olivaceous-sepia above, pale below]; inflorescence axis and pedicel puberulent, the latter incrassate in fruit.
55. Lamina rarely drying bicolored; inflorescence usually glabrous, rarely incrassate in fruit.
56. Midrib on upper surface of lamina narrowing to base; inflorescence axis 3–5.5 cm. long.
57. Hairs curved, papillate on one side.
57. Hairs $\pm$ erect, branched.
56. Midrib not as above; inflorescence axis usually longer.
58. Lamina with (3 to) 5 to 9 (to 11) veins/5 mm.
59. Terminal bud (3.5–)4.5–7 mm. long; lamina 1–2 mm. thick.
59. Terminal bud 2–4.5 mm. long; lamina 3–5 mm. thick.
58. Lamina with at least 7 veins/5 mm., thinly ciliate.
60. Lamina with 10 to 17 veins/5 mm., veins on upper surface as on lower, angle of divergence obtuse; tomentose indumentum.
60. Lamina not as above; terminal bud with glabrous indumentum.
61. Lamina with 12 to 20 veins/5 mm., ciliate.
61. Lamina with up to 14 veins/5 mm., ciliate or with pale margin.
62. Lamina drying bicolored [gray-bronze above, pale below]; often puberulent; bud often clear.
62. Lamina drying bicolored or not; bud supra-axillary; fruit usually spheroid.
63. Terminal bud 4.5–7 mm. long.

- 63. Terminal bud 2–4 mm. long; la
usually pale; fruit less tha
- 64. Twigs 1.2–1.5 mm. across
notably pale; fruit ca. 1.7

5. Key to Species of *Calophyllum* in B

- 1. Lamina at least sometimes cordate or auriculate at base.
 - 2. Midrib on upper surface of lamina depressed; inflorescences terminal and c
internode less than 2 mm. long.
 - 2. Midrib on upper surface of lamina not depressed; inflorescences occasionally
with basal internode more than 3 mm. long.
 - 3. Axillary shoot lacking basal scars; flower usually with 4 tepals; outer lay
.
 - 3. Axillary shoot nearly always with basal scars; flower with 4 or 7 or
or less thick.
 - 4. Lamina 9.5–14.8 cm. long, midrib on upper surface surrounded by ray
.
 - 4. Lamina 1.2–8.5 cm. long, midrib on upper surface not surrounded by
 - 5. Lamina very coriaceous, venation on upper surface rather obscure
.
 - 5. Lamina coriaceous, venation on upper surface prominent; inflor
to) 11 to 13 tepals.
- 1. Lamina broadly rounded to acute or decurrent at base.
 - 6. Terminal bud at least 1 cm. long (if no bud because inflorescence termina
47(1), 48(2), 61(1), and 67(1)).
 - 7. Lamina broadly recurved toward margin [lamina very coriaceous; plant
 - 8. Lamina usually thinly coriaceous and closely undulate at margin; i
and slender; fruit less than 1.5 cm. long.
 - 8. Lamina usually coriaceous, not closely undulate at margin; inflor
long and slender; fruit (where known) usually more than 1.5 cm. long

9. Midrib on upper surface of lamina broadly depressed, narrowing gradually
9. Midrib on upper surface of lamina not broadly depressed, narrowing gradually
10. Hairs with 2 to 4 much-expanded apical cells, the walls birefringent
 11. Lamina not cucullate at base, with 7 to 15 veins/5 mm.; petiole
 11. Lamina slightly cucullate at base, with 11 to 22 veins/5 mm.
 12. Twigs 1.5–3 mm. across; terminal bud to 1.5 cm. long.
 12. Twigs 3.5–5.5 mm. across; terminal bud at least 2 cm. long.
10. Hairs lacking much-expanded apical cells, the walls at most slightly birefringent
 13. Anthers and ovary with hairs; fruit (not yet known in Bolivia; slightly cucullate at base).
 13. Anthers nearly always and ovary always glabrous; fruit without hairs
 14. Lamina often slightly cucullate at base, venation not parallel; cells ($\pm$) papillate.
 14. Lamina not slightly cucullate at base, venation not parallel; cells ($\pm$) papillate.
 15. Twigs 1.8–3 mm. across; margin of lamina ($\pm$) closely ciliate
 16. Hairs papillate at base; lamina not drying notably; flowers with 4 (to 8) tepals.
 16. Hairs strongly branched; lamina drying notably; flowers with 8 to 12 tepals.
 17. Twigs drying brown, puberulent when young
 17. Twigs drying blackish, rather persistently so
 15. Twigs 3–5 mm. across; margin of lamina distantly ciliate
 18. Inflorescence branched; fruit smooth, stone weak
 18. Inflorescence nearly always unbranched; fruit smooth, stone weak

6. Terminal bud less than 10 mm. long.
 19. Twigs with two prominent V-shaped transverse lines at nodes, otherwise
 19. Twigs with at most obscure transverse lines at nodes, flattened and / base.
 20. Uppermost internode of innovation at most half as long as others.
 21. Axillary innovation with (sub)basal scars.
 22. Lamina subacuminate at apex, midrib on upper surface s fruit (?)pointed at apex.
 22. Lamina acuminate at apex, midrib on upper surface not sha fruit rounded at apex.
 21. Axillary innovation lacking basal scars.
 23. Lamina with pale marginal band at least 0.4 mm. wide. . . .
 23. Lamina lacking marginal band.
 24. Lamina acute to acuminate [inflorescence terminal]. . . .
 24. Lamina rounded to retuse at apex.
 25. Inflorescence terminal; venation on upper surface lower.
 25. Inflorescence axillary; venation same density on bo
 26. Twigs drying finely reticulate; lamina with 3 to
 26. Twigs not drying finely reticulate; lamina with 6
 20. Uppermost internode of innovation about same length as others.
 27. Midrib on upper surface of lamina surrounded by raised bla midrib on lower surface depressed or not.
 28. Lamina very coriaceous, often spotted on lower surface; roots].
 28. Lamina coriaceous, usually not spotted on lower surface; f roots rare at most].
 29. Lamina 7–15 cm. long, midrib on lower surface raised,
 29. Lamina up to 8(–10.5) cm. long, midrib on lower sur 13 (to 17) veins/5 mm.

- 30. Lamina drying orange-brown on lower surface, v
leaf, latex canals often $\pm$ impressed above. . . .
- 30. Lamina usually drying grayish brown (rarely orang
in both fresh and dried leaf, latex canals not impre
- 31. Fruit spherical, less than 1 cm. long, stone
.
- 31. Fruit ovoid, more than 1.2 cm. long, stone wa
.
- 27. Midrib on upper surface of lamina not surrounded by raised
lower surface usually raised.
- 32. Lamina usually obovate, or oblong-elliptic, rounded to retu
- 33. Leaf inserted on stem at $\pm$ right angle; lamina very cor
.
- 33. Leaf usually ascending; lamina variable in texture, usu
on at least one surface.
- 34. Lamina with obvious (0.3–1 mm. wide) band of
submarginal vein; trunk often with spurs or stilt roo
- 35. Lamina with discolored margin, veins visibly co
of outer layer striate and usually shiny.
- 35. Lamina with thickened margin, or with subn
margin; fruit smooth or not, the inner surface o
- 36. Twigs less than 2(–2.5) mm. across; term
cm. long, outer layer less than 0.5 mm. thic
- 36. Twigs (1.3–)2.5 mm. or more across; term
than 1 cm. long, outer layer more than 0.5
- 37. Terminal bud enclosed by petiole bas
lowest internode of inflorescence 3–7
absent].
- 37. Terminal bud enclosed by petiole base
mm.; lowest internode of innovation l
often present].

- 38. Older twigs drying rather pale yellow
fruit ovoid, less than 1.7 cm. long
when dry.
- 38. Older twigs not drying notably pale
ellipsoid, at least 1.7 cm. long, round
- 39. Lamina often punctate below,
to 3 m. or so [seedling with o
leaves].
- 39. Lamina not punctate below, dr
or stilt roots lacking [seedling
opposite leaves].
- 34. Lamina lacking obvious thickened or discolored ma
with spurs or stilt roots.
- 40. Axillary shoot with (sub)basal scars; lowest in
than 5 mm. long.
- 41. Lamina 1-4 cm. long; fruit unknown, proba
.
- 41. Lamina more than (2.5-)4 cm. long; fruit m
- 42. Inflorescence terminal and axillary; flower
wrinkled.
- 42. Inflorescence axillary; flower with 4 o
or shallowly wrinkled.
- 43. Lamina with (9 to) 11 to 17 (to
ellipsoid.
- 43. Lamina with 6 to 11 veins/5 mm.;
.
- 40. Axillary shoot lacking (sub)basal scars; lowest in
than 5 mm. long.
- 44. Lamina (2.5-)3.5-6.5(-9) cm. long; termin
either furfuraceous or 1 cm. or less long.
- 45. Twigs and midrib short-tomentose; lam
disappearing ca. 3 mm. below apex.

- 46. Twigs slightly flattened; terminal of lamina only slightly raised.
- 46. Twigs strongly flattened; terminal of lamina strongly raised.
- 45. Twigs and midrib furfuraceous to pubescent; not disappearing below apex.
- 47. Venation on upper surface of lamina [inflorescence terminal].
- 47. Venation same density on both sides
- 48. Lamina $\pm$ cuneate at base, with axis less than 1.7 cm. long.
- 48. Lamina broadly rounded at base and axillary, axis at least 2 cm.
- 44. Lamina usually over 5 cm. long; terminal bud over 1 cm. long.
- 49. Lamina rather thinly coriaceous, with long [usually seaside tree; trunk often m
- 49. Lamina usually coriaceous, with (7 to) cm. long [not seaside tree; trunk usuall
- 50. Venation on upper surface of lamina
- 51. Lamina sharply recurved at m
- 51. Lamina not sharply recurved
- 51. Lamina not sharply recurved
- 50. Venation same density on both sides
- 52. Lamina rather closely undulate; inflorescence with relatively short branches [pedicel notably long, smooth].
- 52. Lamina not closely undulate; brown; inflorescence lacking re

- 53. Indumentum tomentose, co
midrib of lower surface of l
- 54. Lamina 3.8–12.5(–15) c
of hairs notably expand
- 54. Lamina 12.5–18 cm. lo
hairs not notably expan
- 53. Indumentum inconspicuous
- 55. Lamina often obovate; f
clearly from stone. . . .
- 55. Lamina oblong-elliptic;
clearly from stone.
- 56. Lamina drying $\pm$ f
cm. long [usually in
.
- 56. Lamina usually unc
cence (0.35–)0.7–3.
kerangas or mixed
.
- 32. Lamina ovate to oblong-elliptic (very rarely subovate), $\pm$ ac
- 57. Twigs at least 3 mm. across, 4-subalate to alate, dry
or more long.
- 57. Twigs often less than 3 mm. across, rarely 4-alate or dr
- 58. Lamina margin with clear thickening at least 0.3 mm
- 59. Lamina thinly coriaceous; fruit less than 1.5 cm
.
- 59. Lamina coriaceous; fruit over 1.5 cm. long, out
.
- 58. Lamina margin neither clearly thickened nor with d
- 60. Axillary shoot with (sub)basal scars.
- 61. Latex canals irregularly ascending across v
terminal.

- 61. Lamina lacking irregularly ascending latex
- 62. Lamina 11.5–23 cm. long, lower surface
- 62. Lamina less than 11.5(–13) cm. long, lower surface
- 63. Terminal bud and stem tomentose.
- 64. Terminal bud (3.5–)4.5–7 mm. long; fruit (0.5–)1–1.5 mm. thick.
- 64. Terminal bud 2–4.5 mm. long; fruit 0.2–0.5 mm. thick.
- 63. Terminal bud and stem with puberulent hairs
- 65. Venation on both surfaces of lamina; latex canals sometimes impressed above
- 65. Venation on at least one surface of lamina (lower surface of leaf), latex canals not impressed
- 66. Midrib on upper surface of lamina brown; internode 1–5 cm. long
- 66. Midrib on upper surface of lamina brown; internode 1–3.5 cm. long
- 60. Axillary shoot lacking (sub)basal scars.
- 67. Inflorescence terminal, sometimes also from axillary shoot
- 68. Twigs drying yellowish; anthers with hairs
- 68. Twigs drying blackish, brown, or gray; anthers without hairs
- 69. Lamina with 9 to 19 veins/5 mm.;
- 69. Lamina with 4 to 10 veins/5 mm.;
- 70. Lamina drying grayish brown above
- 70. Lamina not drying grayish brown above
- 67. Inflorescence axillary, if exceptionally terminal

71. Lamina often drying yellowish brown, thinly coriaceous, margin closely undulate, fruit smooth.
71. Lamina usually drying other than yellowish brown, often coriaceous, margin venose or flabellate; fruit nearly always wrinkled or furfuraceous.
72. Terminal bud, and sometimes also twigs, with (dark) brown, tomentose indumentum.
73. Lamina coriaceous, margin not undulate, venation on upper surface distinct, fruit 1.2–1.6 cm. long, the outer layer 1–2.5 mm. thick, compact].
73. Lamina (thinly) coriaceous, margin $\pm$ undulate, venation same density as above.
74. Twigs little flattened, strongly 4-angled to subulate; fruit furfuraceous.
75. Lamina strongly recurved at margin; twigs 2.5–3.7 mm. across.
75. Lamina not strongly recurved at margin; twigs 0.6–2.5 mm. across only.
74. Twigs not as above; fruit not furfuraceous.
76. Lamina 9–22 cm. long; fruit at least 1.3 cm. long.
77. Lamina thinly coriaceous, closely undulate at margin; fruit smooth.
77. Lamina coriaceous, not closely undulate at margin; fruit smooth.
76. Lamina less than 13 cm. long; fruit less than 1 cm. long.
78. Terminal bud (3.5–)4.5–7 mm. long; lamina 6–13 cm. long; fruit smooth.
78. Terminal bud 2–4.5 mm. long; lamina 3–7.8 cm. long; fruit smooth.
72. Terminal bud and twigs lacking tomentose indumentum.
79. Lamina coriaceous, often shiny, venation often subobscure below; fruit 2 mm. across in fruit; outer layer of fruit 1–1.8 mm. thick, with air spaces.
79. Lamina coriaceous or not, rarely shiny, venation $\pm$ apparent below; fruit smooth in fruit or not; outer layer of fruit not as above.
80. Twigs drying whitish to yellowish; lamina 3–9(–10.5) cm. long, strongly flattened.
81. Petiole 3.5–6 mm. long; lamina with 12 to 20 (to 28) veins/5 mm.; fruit smooth, young, outer layer developing large air spaces.
81. Petiole 7–18 mm. long; lamina with 8 to 14 veins/5 mm.; fruit smooth.

- 80. Twigs drying brownish to blackish; lamina usually not as above.
- 82. Lamina (3.3-)9-22 cm. long, with 10 to 18 (to 22) veins/5 mm. long; of at least outer pair of tepals puberulent; fruit ovoid.
- 82. Lamina usually less than 12.5 cm. long, with up to 12 (to 15) veins/5 mm. long; axis, pedicel, and back of outer pair of tepals usually glabrous (as in *Calophyllum* sp. 164).
- 83. Lamina drying bicolored, tawny brown below; fruit sphere, free cleanly from stone, 1.3-2 mm. thick, compact.
- 83. Lamina not drying bicolored, other than tawny brown below.
- 84. Terminal bud 1.3-2 mm. long, underdeveloped into fruit; with 13 to 18 veins/5 mm.; anthers less than 0.4 mm. long.
- 84. Terminal bud usually longer, underdeveloped into fruit; with fewer than 12 veins/5 mm.; anthers at least 0.5 mm. long.
- 85. Venation often rather obscure; fruit furfuraceous.
- 85. Venation rather clear; fruit not furfuraceous.
- 86. Lamina ca. 3 times longer than broad, the base of lamina depressed; pedicel and back of outer pair of tepals glabrous.
- 86. Lamina usually less than 2½ times longer than broad; base of lamina base and/or not very wide at base, not depressed; pedicel and back of outer pair of tepals glabrous.
- 87. Lamina thinly coriaceous, clearly acuminate.
- 87. Lamina coriaceous, ± obscurely acuminate.

6. Key to Species of *Calophyllum* from the Philippine Islands and the Northern Pacific

- 1. Axillary innovation with basal scars; axillary inflorescence with basal internode 1-2 mm. long].

1. Axillary innovation lacking basal scars; inflorescence with basal internode usu
2. Terminal internode of innovation nearly always much shorter than others
angle of divergence of venation 35–50°
2. Terminal internode of innovation about same length as others; lamina r
usually more than 50°.
3. Lamina broadly rounded to cordate or auriculate at base; petiole less th
4. Lamina 1.3–2.7 cm. long, with 13 to 17 veins/5 mm.
4. Lamina more than 3 cm. long, if less then with fewer than 13 veins/
5. Inflorescence terminal; outer layer of fruit 0.2–0.4 mm. thick,
up to 5.8(–8) cm. long, margin flat]
5. Inflorescence axillary; outer layer of fruit at least 1 mm. thick, ±
6. Lamina with (3 or) 4 to 8 veins/5 mm., venation clear.
6. Lamina with at least 8 veins/5 mm., venation rather obscure.
7. Uppermost pair of axillary buds less than $\frac{1}{5}$ length of termina
over entire lower surface.
7. Uppermost pair of axillary buds ca. $\frac{1}{3}$ length of terminal
near) midrib on lower surface.
3. Lamina rounded to attenuate at base; petiole often more than 6 mm. lon
8. Lamina broadly rounded and cucullate at base, midrib at first broad
blackish; indumentum tomentose.
8. Lamina rarely broadly rounded and not cucullate at base, midrib
drying blackish to yellowish; indumentum tomentose or various.
9. Lamina 1.4–3 cm. long, very coriaceous, with 13 to 16 veins/5
± depressed.
9. Lamina usually larger, if as small then with fewer than 13 veins
depressed.
10. Lamina thinly coriaceous, closely undulate at margin, with 5
above, obscure below, the latex canals impressed above; inflor
10. Lamina ± coriaceous, otherwise not as above; inflorescence
furfuraceous.

11. Inflorescences terminal (also axillary).
 12. Terminal bud 1–4 mm. long; lamina acute to rounded yellowish.
 12. Terminal bud 2.5–20 mm. long; lamina $\pm$ acuminate (sometimes drying notably yellowish).
 13. Terminal bud 2.5–4.5(–6) mm. long; lamina drying (often with conoid galls).
 13. Terminal bud 6–20 mm. long; lamina usually drying [lamina very rarely with conoid galls].
11. Inflorescences axillary.
 14. Midrib on upper surface of lamina surrounded by raised terminal bud (1.5–)2–3 mm. long, perhaps not functioning
 14. Midrib on upper surface of lamina not surrounded by terminal bud more than 3 mm. long, probably functioning
 15. Midrib on upper surface of lamina narrowing gradually
 16. Twigs strongly angled, short-tomentose.
 16. Twigs rarely strongly angled, inconspicuously
 17. Lamina elliptic, midrib on upper surface d
 17. Lamina ovate to elliptic, midrib on upper
cm. long.
 15. Midrib on upper surface of lamina not narrowing gradually
 18. Terminal bud ca. 4 mm. long; lamina with 5 or more obscure below, the latex canals $\pm$ impressed
flowers.
 18. Terminal bud usually longer than 4 mm.; lamina $\pm$ apparent on lower surface, whether or not
with more than 5 flowers.
 19. Uppermost pair of axillary buds erect, $\frac{1}{3}$ –
undulate at margin; inflorescence usually
lately; flower with 4 tepals; fruit smooth.

19. Uppermost pair of axillary buds less than 4 mm. long; lamina not usually closely undulate at margin; flowers arranged flabellately; flower with (5 to) 10 stamens when ripe.
20. Lamina rounded to retuse or subacute at apex, 2.5–5.5(–9.5) mm. long; 10 veins/5 mm.
20. Lamina acuminate at apex, often drawn out to caudate, 3.4–12.5 mm. long.

7. Key to Species of *Calophyllum* from Sulawesi to Australia

1. Lamina 32–45 by 9–11 cm., with 3 to 5 veins/5 mm.; twigs strongly angled [poorly flattened transversely]; leaf blades clearly visible [hairless].
1. Lamina smaller, usually with less dense venation; twigs usually not strongly angled [poorly flattened transversely]; leaf blades not clearly visible [hairy].
2. Terminal bud strongly flattened transversely, leaf blades clearly visible [hairless].
3. Lamina (2.4–)6.5–17(–22) cm. long; ovary tomentose; outer pair of tepals 2.3–5.5 mm. long.
3. Lamina to 12.5 cm. long; ovary glabrous; outer pair of tepals less than 1.5–2.7 mm. long.
4. Lamina subacute to rounded at apex, 2.5–5.5(–9.5) cm. long; tepals 0.7–1.7 mm. long.
4. Lamina acute to acuminate at apex, 3.4–12.5 cm. long; tepals 4 to 6 mm. long.
2. Terminal bud not strongly flattened transversely, leaf blades not clearly visible [hairy].
5. Terminal bud less than 4 mm. long, or sometimes apparently absent.
6. Terminal bud apparently absent, underdeveloped internode 3–7(–13) mm. long; angle of divergence of venation 45–60°.
6. Terminal bud present, underdeveloped internode inconspicuous; venation not clearly visible.
7. Lamina gradually long-acuminate–caudate at apex.
8. Lamina with 6 to 8 veins/5 mm.; axillary innovation with basal pair of buds.
8. Lamina with (7 to) 9 to 16 veins/5 mm.; axillary innovation lacking.
9. Lamina ± nitid, margin closely undulate, midrib on upper surface.

- midrib on lower surface with $\pm$ depressed edges.
- 9. Lamina dull, margin not closely undulate, midrib on upper surface raised, midrib on lower surface not with depressed edges.
- 7. Lamina retuse to subabruptly acuminate at apex.
 - 10. Lamina broadly rounded to cordate at base.
 - 11. Lamina very coriaceous; axillary bud recessed into stem at base.
 - 11. Lamina coriaceous; axillary bud exposed.
 - 12. Lamina with 4 to 7 veins/5 mm.; pedicel 2.2–3.5 cm. long.
 - 12. Lamina with 12 to 16 veins/5 mm.; pedicel 0.3–1 cm. long.
 - 10. Lamina other than broadly rounded to cordate (an occasional lamina cordate).
 - 13. Lamina with 5 to 9 (to 11) veins/5 mm.; fruit 5–7 mm. long, angled.
 - 13. Lamina with (8 to) 10 or more veins/5 mm.; if fruit less than 0.2 mm. thick, angled.
 - 14. Lamina 2.2–5.5 by 0.5–1.5 cm.; fruit with angled stone.
 - 14. Lamina 2.7–9 by 1.2–4.5 cm.; fruit with rounded stone.
 - 15. Twigs drying yellowish brown; fruit ca. 1.6 cm. long.
 - 15. Twigs drying dark brown to blackish; fruit 2.3–2.8 cm. long.
 - 16. Lamina ca. 2 times longer than broad; fruit 1.5–2.5 cm. long.
 - 16. Lamina ca. 3 times longer than broad; fruit 2–3 cm. long.
- 5. Terminal bud more than 4 mm. long, always present.
 - 17. Midrib on upper surface of lamina raised, often not clearly distinct from surface.
 - 18. Lamina (thinly) coriaceous; twigs up to 3.5 mm. across.
 - 19. Uppermost pair of axillary buds erect; fruit less than 2 cm. long.
 - 19. Uppermost pair of axillary buds spreading; fruit ca. 5 cm. long.
 - 18. Lamina thickly coriaceous; twigs (1.5–)3–7 mm. across.
 - 20. Twigs 5–7 mm. across; lamina ovate, 2–2½ times longer than broad, yellow, sticky.

20. Twigs (1.5-)3-5 mm. across; lamina elliptic to oblong (rarely
trunk without stilt roots, the sap opaque yellow, fluid. . . .
17. Midrib on upper surface of lamina raised or not, clearly distinct from
21. Lamina usually more than 9 cm. long, with (3 or) 4 to 9 (to 11)
axis (1.3-)3 cm. or more long; pedicel (0.4-)1-4.5(-6.3) cm. long
22. Lamina less than 2(-2½) times longer than broad, drying c
even under strong magnification, midrib on upper surface of
.
22. Lamina usually ca. 3 times longer than broad, drying sepia
strong magnification, midrib on upper surface gradually narrow
21. Not as above.
23. Midrib on upper surface of lamina broadly depressed, at le
bud plump, conspicuous.
24. Midrib on upper surface of lamina usually narrowing i
tepals.
24. Midrib on upper surface of lamina narrowing gradually f
25. Lamina narrowly ovate to elliptic, usually drying n
than rest; stone with basal plug.
25. Lamina narrowly elliptic to obovate, midrib and v
stone without basal plug [fruit not known in *C. carr*
26. Lamina obovate, ± retuse at apex, thickened m
.
26. Lamina usually ± elliptic, ± rounded to acute at
known) 4 to 6.
27. Lamina often less than 2½ times longer t
mm. wide at midpoint; terminal bud 0.5-1(-
27. Lamina at least 2½ times longer than broad
at midpoint; terminal bud (0.8-)1-2.7 cm. lo

- 28. Lamina with 6 to 11 veins/5 mm.; p
thin, disorganized by air spaces [flower
- 28. Lamina with (9 to) 11 to 20 veins/5 m
of fruit (?0.5-)1-3 mm. thick, not disorg
- 23. Midrib on upper surface of lamina with raised margins even
- 29. Inflorescence reduced to solitary flower; flower bud ob
on both surfaces [lamina ovate, long-acuminate, with (1
- 29. Inflorescence with more than one flower; flower bud (
- of tepals nearly always glabrous inside.
- 30. Lamina usually broadly rounded to cordate at base;
- 31. Terminal bud to 5.5 mm. long, probably not fu
- lamina acuminate-caudate at apex [flower not k
- 31. Terminal bud at least 5 mm. long, functional;
- acute at apex.
- 32. Uppermost pair of axillary buds $\frac{1}{3}$ - $\frac{1}{2}$ le
- inflorescence branches conspicuous, ca. $\frac{1}{3}$ -
- 1.5 cm. long, stone wall less than 0.3 mm. t
- 32. Uppermost pair of axillary buds shorter, $\pm$ sp
- if any, relatively shorter; fruit more than
- [presently unidentifiable sterile material fro
- 33. Lamina with 4 to 7 veins/5 mm., ver
- plug.
- 33. Lamina with 9 to 17 veins/5 mm., ver
- plug.

30. Lamina rarely broadly rounded at base; petiole often
34. Twigs 3.5–6.5 mm. across, almost square or $\pm$ 4-angled, often drying blackish.
35. Terminal bud 0.7–0.9 cm. long; fruit less than 2.5 cm. long, stone wall
35. Terminal bud 0.9–1.5 cm. long; fruit at least 4.5 cm. long, stone wall 3–5
34. Twigs usually thinner, if as thick then not almost square or angled, usual or not.
36. Lamina retuse to acute at apex.
37. Lamina usually less than 8 cm. long.
38. Tepals 8, outer pair puberulent on back; fruit 2.8–3.5 cm. long [
38. Tepals 4 to 6, outer pair glabrous on back [flowers of *C. ca* cm. long [Papuasia].
39. Lamina with 6 to 11 (to 14) veins/5 mm.; inflorescence with fruit not known, but probably with angled stone.
39. Lamina with 9 to 20 veins/5 mm.; inflorescence with terminal stone.
40. Internode 0.4–2 cm. long; hairs on terminal bud with inflorescence lacking persistent foliaceous bracts; fruit
40. Internode 1–6 cm. long; hairs on terminal bud with at apex; inflorescence usually with persistent foliaceous bracts by air spaces.
37. Lamina usually more than 8 cm. long.
41. Hairs much branched, often $\pm$ persistent over entire lower surface 3–10(–14) mm. long, spreading, conspicuous; fruit 2.8–6 cm. long

41. Hairs rarely much branched, very rarely persistent on lower s
buds erect to spreading, rarely so conspicuous; fruit less than 3.2
42. Lamina with 4 to 10 (to 12) veins/5 mm., venation usually ap
43. Lamina broadly rounded (also apiculate) at apex, margin
ca. 2 cm. long, stone wall less than 0.05 mm. thick. . . .
43. Lamina not broadly rounded at apex, margin slightly rec
than 0.2 mm. thick [not known in *C. heterophyllum*].
44. Terminal bud 0.6-1(-1.2) cm. long; lamina less than 10
± in groups of five.
44. Terminal bud 0.8-2 cm. long; lamina usually more t
flowers in groups of three.
42. Lamina with (6 to) 10 or more veins/5 mm., venation often ±
45. Lamina usually rather thinly coriaceous, margin closely
adpressed to terminal bud, conspicuous; inflorescence
compact outer layer.
45. Lamina not as above; uppermost pair of axillary buds
inconspicuous lateral branches; outer layer of fruit often r
46. Inflorescence lacking axis; fruit ca. 5 mm. long [poor
46. Inflorescence with axis; fruit at least 1.5 cm. long.
47. Inflorescence axis, pedicel, and back of outer tep
fruit with stone neither angled nor with basal plug
47. Inflorescence glabrous or pubescent, back of out
fruit with stone either angled or with basal plug.
48. Flower with 8 to 12 tepals; stone rounded, ba
48. Flower with 4 (rarely 5) tepals; stone angled,
49. Lower surface of lamina subpersistently t
.

49. Lower surface of lamina with inconspicuous
long (to 18 mm. in fruit).
 36. Lamina acute to acuminate at apex.
 50. Terminal bud 1.6–3.3 cm. long; midrib on lower surface of lamina strong
 50. Terminal bud to 1.5 cm. long; midrib on lower surface of lamina round
 51. Lamina usually thinly coriaceous, margin closely undulate; inflorescence
the outer layer thick, compact, the stone thin, unmarked [upper
conspicuous].
 51. Lamina not as above; inflorescence usually unbranched; fruit not
 52. Inflorescence without axis; pedicel pilose; fruit ca. 0.5 cm. long
 52. Inflorescence with axis; pedicel usually glabrous; fruit (0.7–)1
 53. Indumentum dense, tomentose, persisting on terminal bud
inflorescence axis, and pedicel.
 54. Lamina with 4 to 9 veins/5 mm., usually drying biconvex
honey to sabelline below]; fruit less than 1 cm. long.
 54. Lamina with 12 to 20 veins/5 mm., not drying not
.
 53. Indumentum usually other than tomentose, pedicel and
so.
 55. Lamina very coriaceous, margin almost plane, midrib
venation obscure on both surfaces; fruit ellipsoid, stone
.
 55. Lamina not as above; fruit spherical to ellipsoid, stone
 56. Terminal bud 4.5–5 mm. long; lamina with 7 to 9
impressed below; pedicel at anthesis 1–3 mm. long
 56. Terminal bud usually longer than 5 mm.; lamina
± apparent, latex canals not impressed below; pedicel
3 mm. long.
-

- 57. Flower (where known) with 8 or more tepals and/or petals.
- 58. Terminal bud 2–5 mm. long; lamina with
- 58. Terminal bud (0.4–)0.6–1.6 cm. long; lamina wide at midpoint.
- 59. Midrib on upper surface of lamina rather
- 59. Midrib on upper surface of lamina broad
- 60. Twigs not often drying coarsely striate and nitid, midrib and veins notably
- 60. Twigs soon becoming coarsely striate; veins not discolored.
- 57. Flower (where known) with ca. 4 tepals and/or petals.
- 61. Lamina with 12 to 22 veins/5 mm.; outer veins clearly angled.
- 61. Lamina with (6 to) 8 to 12 (to 16) veins/5 mm.; air spaces, stone at most obscurely angled
- 62. Petiole 0.6–0.8 mm. across; lamina 1.5–2 mm. wide at midpoint; fruit with outer layer 1–1.5 mm. thick.
- 62. Petiole 1–1.5 mm. across; lamina with 12–22 veins/5 mm.; fruit with outer layer 1–1.5 mm. thick.
- 63. Lamina drying dark auburn above; fruit 1.8–2.7 cm. long.
- 63. Lamina drying sepia to sabelline above; fruit 1.8–2.7 cm. long.

SPECIES ACCOUNTS

1. *Calophyllum alboramulum* P. F. Stevens, sp. nov.

FIGURE 8, a.

Calophyllum sp. 23, M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 327. pl. ID, 13. 1956; Kochummen, Malayan Forest Rec. ed. 2. 17: 214. 1965; T. C. Whitmore, Tree Fl. Malaya 2: 195. 1973.

A speciebus aliis *Calophylli* in ramulo in siccitate albescenti, folia plus minusve elliptica circa 8.5–16 cm. longa venulis lateralibus subdistantibus prominentibus e costa (60–)65–75° divergentibus, inflorescentia terminali, et fructu subsphaerico circa 2.5 cm. longo in siccitate albescenti reticulato-rugosoque putamine parietibus minoribus quam 0.1 mm. crassis, differt.

Tree 12–33 meters tall, d.b.h. to 120 cm.; trunk without buttresses, but sometimes with spurs; outer bark gray to yellowish, more or less smooth, cracked or with lenticels in lines, inner surface orange; under bark greenish or dark green-red; inner bark pale red; latex yellow, opaque, sticky.

Twigs flattened, 2.5–3.7 mm. across, rounded or obscurely 4-angled, drying blackish and pruinose when young, yellowish brown to whitish yellow when older, transiently brown-farinose; axillary innovations lacking basal scars; internodes 1–4.5 cm. long; upper pair of axillary buds ± rounded, 1–3 mm. long, erect; terminal bud plump, 6.5–10 mm. long, with crustose, brown

FIGURE 8. a, *Calophyllum alboramulum* (Stevens et al. 81), terminal bud, $\times 3$. b–d, *C. touranense*. b, c, fruit (Clemens 4162), $\times 0.75$: b, from outside; c, longitudinal view. d, terminal bud (Poilane 7179), $\times 3$. e, *Calophyllum* sp. 9 (bb 5467), terminal bud, $\times 6$. f, *C. vergens* (Kostermans 24469), terminal bud, $\times 6$. g–i, *C. austroindicum*. g, h, fruit (Kostermans 26139), $\times 0.75$: g, longitudinal section; h, from outside. i, terminal bud (Kostermans 26264), $\times 3$.

indumentum (hairs, FIGURE 9, a-d), underdeveloped internode to 4 mm. long. Petiole 1.8–3.5 cm. long, more or less concave above, convex below, glabrescent; lamina elliptic to oblong- or obovate-elliptic, (6–)8.5–16(–19.5) by (2.2–)3.5–8.2 cm., acuminate (rarely subrounded) at apex, cuneate to subacute at base, slightly undulate and not recurved to slightly so at margin, coriaceous, drying olivaceous above and sabelline-olivaceous below, farinose on midrib below when young, the midrib above gradually narrowed from base, at first subdepressed, 0.2–0.45 mm. wide at midpoint, becoming raised toward apex, below strongly raised and striate, the venation on both sides apparent, raised, 5 to 19 veins/5 mm., angle of divergence (60–)65–75°. Inflorescences terminal and from adjacent foliate axils, with numerous flowers, the axis to 10 cm. long, branched, flabellate, sparsely puberulent, lowest internode ca. 3 cm. long; bracts unknown; pedicels 5–7 mm. long, puberulent. Flower (?)hermaphroditic; tepals 8, the outer pair broadly ovate or oblong, 3.7–4.3 by 3.5–4.3 mm., puberulent on back toward base, the next pair elliptic, 7–7.5 by 4.5–5 mm., sometimes subfarinose toward base, the inner ones oblong-elliptic, 8.5–9.5 by 4–4.7 mm.; stamens ca. 250, the filaments to 7 mm. long, the anthers suboblong, (0.5–)0.7–1 mm. long, retuse at apex; ovary ca. 2.5 mm. long, the style ca. 5 mm. long, the stigma subpeltate, ca. 1 mm. across, obscurely 3-radiate. Fruit spherical to subobovoid, 2.3–2.5 by ca. 2 cm., rounded to apiculate at apex, drying whitish to yellowish, shallowly and closely reticulate; outer layer not detaching cleanly from stone, 1.2–1.5 mm. thick, compact; stone subspherical, ca. 1.8 by 1.7 cm., rounded at apex, the walls less than 0.1 mm. thick, smooth, (?)unmarked; spongy layer thin.

TYPE: Brunei, Andalau Hills F.R., 250 feet [75 m.], 22 July 1954, *KEP 80090* coll. *Wyatt-Smith* (holotype, *KEP*).

DISTRIBUTION. Southern Malaya (Johore), northwestern Borneo (MAP 3).

SELECTED SPECIMENS SEEN. **Malaya.** JOHORE: Jemaluang F.R., 9 m., *KEP 73459* (*KEP*); Lenggong F.R., 35 m., *Stevens et al. 55* (A); G. Arong F.R., 15 m., *Stevens et al. 81* (A), 30 m., *KEP 84581* (*KEP*); Endau Road, 30 m., *KEP 70059* (*KEP*, SING); Mersing, Sungei Sarah, 45 m., *KEP 92167* (*KEP*). **Borneo.** SARAWAK. 1st Division: G. Buri, Ulu Semunjan, 150 m., *S 36738* (SAR), 300 m., *S 36746* (SAR). 4th Division: Lambir Hills, Miri, *Ashton 6000* (A). 5th Division: Ulu Medamit, Limbang, 305 m., *S 32348* (BO, L, SAN, SAR, SING). BRUNEI: Andalau Hills F.R., 75 m., *KEP 80089* (?*KEP*); Belait, *S 1642* (*KEP*, L); Kuala Belalong, 305 m., *Ashton s.n.*, Oct. 1959 (SAR). Sine loco [?Brunei], *KEP 32579* (K, *KEP*).

ECOLOGY. Locally common in fairly well-drained, mixed dipterocarp forest, to 305 m. alt. Flowering in September (flower scented); fruiting in July (fruit green at first, turning glaucous purple).

GERMINATION AND YOUNG PLANT. The radicle almost certainly breaks through the stone to one side of the base. The seedling has three pairs of leaves separated by rather short internodes 0.5–1.5 cm. long; the lowest pair of

leaves often falls off well before the others. Internodes produced during subsequent growth are long (soon becoming 7 cm. or more), the terminal bud is functional, and the plant is erect. (*Stevens et al.* 55.)

Calophyllum alboramulum is a very distinctive species with its pale-drying twigs, rather large, elliptic leaf blades with relatively distant venation, terminal inflorescences with puberulent indumentum, and sharply wrinkled and pale-drying fruits with thin-walled stones. The olivaceous leaves with their sabel-line-colored margins are also distinctive, as are the white twigs of the young plants. The fruits of the type specimen are reported to be glaucous purple, but this should be confirmed; purple-fruited *Calophyllum* species are uncommon in West Malesia. The epithet *alboramulum* alludes to the whitish color of the twigs, as does the Malay name for this species, "bintangor puteh."

The specimens cited from Borneo and Malaya are very similar, and the distribution of the species is almost a textbook illustration of a type of Borneo-Malaya affinity (cf. MAP 3 with Keng, 1970, *figs.* 3, 4). Henderson and Wyatt-Smith (*loc. cit.*) were loath to describe this species formally since they had only sterile material from Malaya; however, Wyatt-Smith had unknowingly collected fruiting material (the type) in Brunei! Fertile material of *Calophyllum alboramulum* still has not been collected in Malaya.

KEP 80089 (from Brunei) is included in *Calophyllum alboramulum* only with hesitation. It has leaf blades rounded at the apices and petioles up to 3.5 cm. long, and its latex was reported as being brown and clear.

2. ***Calophyllum blancoi*** Planchon & Triana, *Ann. Sci. Nat. Bot.* IV. 15: 262. 1862; Vesque in C. DC. *Monogr. Phanerog.* 8: 598. 1893; Merr. *Philip. Jour. Sci. C.* 3: 420. 1908; Whitford, *Philip. Bur. Forestry Bull.* 10 (Forests Philip. 2): 60. *pl.* 55. 1911; Merr. *Enum. Philip. Fl. Pl.* 3: 78. 1923; Keith, N. *Borneo Forest Rec.* ed. 2. 2: 314. 1952 ("sp. cf. *blancoi*"); Perry, *Med. Pl. E. SE. Asia*, 174. 1980. TYPE: Philippine Islands, 1857, *Llanos s.n.* (holotype, G).
- C. racemosum* Merr. *Philip. Jour. Sci. C.* 5: 198. 1910; *Enum. Philip. Fl. Pl.* 3: 80. 1923. TYPE: Philippine Islands, Leyte, between Ormoc and Dolores, 100 m., *FB 12620* coll. *Rosenbluth* (isotypes, K, US).
- C. glabrum* Merr. *Philip. Jour. Sci. C.* 7: 92. 1912; *Enum. Philip. Fl. Pl.* 3: 79. 1923. TYPE: Philippine Islands, Luzon, Bontoc subprovince (Mountain Province), Bauco, ca. 1650 m., 13 June 1911, *Vanoverbergh 1251* (n.v.).
- C. ferrugineum* Merr. *Philip. Jour. Sci. C.* 10: 324. 1915, non Ridley, 1910; Merr. *Enum. Philip. Fl. Pl.* 3: 79. 1923. TYPE: Philippine Islands, Luzon, Laguna Province, near San Antonio, Feb. 1913, *BS 20545* coll. *Ramos* (isotypes, K, US).
- C. flavocorticum* Elmer, *Leafl. Philip. Bot.* 7: 2682. 1915 ("*C. flavo-cortica*"). TYPE: Philippine Islands, Mindanao, Agusan, between Duros and Cabadbaran (Mt. Urdaneta), Cawilanan, 3500 feet [1067 m.], Sept. 1912, *Elmer 14311* (isotypes, A, BISH, BM, BO, C, E, F, FI, G, GH, K, L, LY, MO, NY, P, U, US, W).
- C. mindanaense* Elmer, *Leafl. Philip. Bot.* 7: 2684. 1915; Merr. *Enum.*

- Philip. Fl. Pl. 3: 80. 1923. TYPE: Philippine Islands, Mindanao, Davao del Sur Province, Todaya (Mt. Apo), trail to Mt. Calelan, 3750 feet [1143 m.], May 1909, *Elmer 10597A* (lectotype, A; isolectotypes, BISH, BM, BO, E, F, FI, G, GH, K, L, LY, MO, P, US, W).
- C. megistanthum* Quis. & Merr. Philip. Jour. Sci. 37: 170. 1928. TYPE: Philippine Islands, Luzon, Isabel Province, San Mariano, 335 m., 15 March 1926, *BS 47137* coll. *Ramos & Edaño* (isotypes, A, B, K, UC, US).
- C. changii* Robson in H.-L. Li *et al.* Fl. Taiwan 2: 621. 1976. TYPE: Formosa, Botel Tobago, 22 April 1962, *Chang 2737* (holotype, TAI; isotype, L).
- C. wallichianum* auct., non Planchon & Triana; Vidal, Rev. Pl. Vasc. Filip. 54. 1886; Vesque in C. DC. Monogr. Phanerog. 8: 599. 1893, *pro parte*; Merr. Philip. Bur. Forestry Bull. (Rep. Invest. Java) 1: 40. 1903, Philip. Jour. Sci. 1(suppl.): 97. 1906; *C. pseudowallichianum* Engler in Engler & Prantl, Nat. Pflanzenfam. ed. 2. 21: 196. 1925, *nomen*.
- C. spectabile* auct., non Willd.; A. Gray, U. S. Expl. Exped. 15(1): 218. 1854, *pro parte*; Merr. Philip. Jour. Sci. C. 3: 78. 1908.
- C. whitfordii* auct., non Merr.; Merr. Enum. Philip. Fl. Pl. 3: 81. 1923, *pro minore parte*.
- C. sp. aff. borneense* Vesque and *C. sp. ?canum* Hooker f.; Keith, N. Borneo Forest Rec. ed. 2. 2: 314. 1952.
- ?Calophyllum sp.* Merr. Philip. Bur. Forest Bull. (Rep. Invest. Java) 1: 40. 1903.

Tree 5–40 meters tall, d.b.h. to 40 cm.; trunk without buttresses; outer bark yellowish (dark gray-brown), hoop marked or not, with vertical lines of lenticels or rather distant boat-shaped fissures, flaking or not, inner surface mottled yellow-orange; under bark deep red; inner bark red to (?)yellow; latex opaque yellow, not sticky.

Twig $\pm$ flattened, 1.2–4.5(–5) mm. across, 4-angled, sometimes with additional raised lines, drying brown to yellowish, farinose to tomentose when young, often glabrescent; axillary innovations lacking basal scars; internodes (0.4–)1–6 cm. long; uppermost pair of axillary buds rounded, to 3 mm. long, suberect, inconspicuous; terminal bud plump, 0.6–2 cm. long, with subcrustose to tomentose, grayish to brown indumentum (hairs, FIGURES 9, e–g; 10, b–f), underdeveloped internode to 2(–5) mm. long. Petiole 0.5–4 cm. long, often rather narrowly but deeply concave above, convex below, sometimes with persistent indumentum; lamina elliptic to suboblong, rarely obovate, (3–)4.7–25(–30) by (1–)1.8–8.2 cm., acuminate at apex, acute to cuneate or often abruptly attenuate at base, $\pm$ undulate and recurved at margin, coriaceous (rarely very coriaceous), usually drying bicolored (e.g., $\pm$ olivaceous-buff—frequently with grayish, waxy covering—above, usually sabelline below) (rarely nearly concolorous), glabrous, transiently farinose on midrib below, or subpersistently tomentose on entire lower surface, the midrib above usually rather abruptly narrowed at or near base, flat to depressed at first, becoming raised, sometimes narrowing gradually from base and $\pm$ depressed, 0.1–0.4 (–0.5) mm. wide at midpoint, below raised, striate, the venation above and below $\pm$ apparent, raised (very rarely impressed), 5 to 18 (to 22) veins/5 mm., angle of divergence (50–)60–80(–85)°. Inflorescences terminal and/or

axillary, with 9 to numerous flowers, to twice branched and flabellate when terminal, the axis (1-)2-16 cm. long, puberulent to tomentose (rarely glabrous toward top), lowest internode (0.4-)1-8 cm. long; bracts to 1.5 cm. long, subpersistent; pedicel 0.6-4 cm. long, puberulent to tomentose (rarely glabrous). Flower (?)hermaphroditic; tepals 8 to 16, the outer pair broadly ovate, (1.2-)4-11.5 by (1-)4-9.5 mm., usually puberulent to short-tomentose on back, at least toward base, the inner ones elliptic to obovate, 5-25 by 2-15 mm., with the outer pair sometimes puberulent to short-tomentose on back, when many tepals outer pair broadly ovate-elliptic, next pair suboblong and largest, inner ones oblong-obovate, smaller; stamens (105 to) 140 to 620, the filaments 2-6 mm. long, the anthers elliptic to oblong, 0.5-2.2 mm. long, $\pm$ retuse at apex; ovary 1.5-5 mm. long, the style 2-10 mm. long, the stigma $\pm$ peltate, 0.5-2.5 mm. across, 3- or 4-radiate. Fruit ovoid to subspherical, 1.25-2.2 by 1-1.7 cm., acute to apiculate, drying brown to blackish, rather closely and sharply wrinkled; outer layer usually not detaching cleanly from stone, 0.3-1 mm. thick, compact (rarely with large air spaces developing); stone ellipsoid to subspherical, 1.1-1.8 by 0.9-1.4 cm., rounded to apiculate at apex, the walls 0.05-0.3 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Taiwan (Lanyu Islands), the Philippine Islands, and northeastern Borneo (MAP 3).

SELECTED SPECIMENS SEEN (letters refer to discussion in text below). **Taiwan.** LANYU ISLANDS: Taitung, *Chang* 2737 (g) (L, TAI). **Borneo and adjacent islands.** SABAH. Kudat: Banggi Is., 60 m., *SAN* 25769 (f) (K, KEP, L, SAN, SAR, SING); Karakit Tg., 15 m., *SAN* 69427 (f) (SAN). Ranau: inside Sabah Natl. Park, Lohan, Kinabalu, 1372 m., *SAN* 44643 (e) (K, L, SAN, SAR); Mile 55 $\frac{1}{4}$, Poring Road, Ranau, 1431 m., *SAN* 44734 (e) (K, L, SAN, SAR); Mt. Tamboyukan, 1889 m., *SAN* 68554 (e) (SAN); Kg. Paranchangan, 457 m., *SAN* 76707 (e) (K, SAN, SAR); Bukit Kulong, 457 m., *SAN* 49764 (e) (K, L, SAN, SAR). Labuk & Sugat: Mile 92 $\frac{1}{2}$, Telupid, near Sg. Meliau, *SAN* 61520 (e) (A, SAN); Sungei Sapi, *SAN* 36306 (e) (A, K, L, SAN, SING); Mile 53 $\frac{1}{4}$, Sabah Foundation logging area, *SAN* 75808 (e) (SAN). Sandakan: Sepilok F.R., *A* 2564 (e) (A, BO, K, KEP, L, P, SING, US); Sungei Dagat 1961 logging area, *SAN* 27855 (e) (SAN); Segaluid, Teck Fatt logging area, Mile 6, 24 m., *SAN* 76377 (e) (SAN); along Sibuga Road, *SAN* 35794 (e) (K, KEP, L, SAN, SING); Bettotan, 48 m., *SAN* 4536 (e) (A, K, SING); outside plantation area, Gum-Gum, *SAN* 81205 (e) (SAN). Lahad Datu: Lumanggas Is., 3 m., *A* 141 (f) (BO, BRI, K, KEP, L, P, SING, US); Sungei Panyang, 8 km. SW. of Lahad Datu, 15 m., *SAN* 16129 (e) (K, KEP, SING); Kennedy Bay, 180 m., *SAN* 33394 (e) (K, L, SAN, SING); Silam, Block 24, Mile 10, *SAN* 59247 (e) (SAN). Semporna: Pulau Gaya, *SAN* 48802 (f) (K, L, SAN); Selangan Is., F.R., *A* 2441 (f) (BO, K, KEP, L, SING). **KALIMANTAN.**

FIGURE 9. Hairs (on terminal bud, unless otherwise stated). a-d, *Calophyllum alboramulum*: a-c, *Stevens et al.* 81; d, *S* 1642, axillary bud. e-g, *C. blancoi*: e, *BS* 26407; f, *BS* 47295; g, *PNH* 78233. h-k, *C. thorelii*: h, *Poilane* 9600, axillary bud; i, j, *Kerr* 9556; k, *Poilane* 6245. l, m, *C. dryobalanoides*: l, *Poilane* 16740; m, *Pierre* 22. n, *C. balansae*, *Bon* 2074, axillary bud. o-r, *C. touranense*: o, *Poilane* 27759; p-r, *Poilane* 27748. s-u, *C. aff. thorelii*: s, u, *Poilane* 23733; t, *Chevalier* 38687. Scale = 60 μ m.

MAP 3. Distribution of *Calophyllum alboramulum* (squares), *C. blancoi* (circles), *C. thorelii* (triangles), *C. touranense* (solid stars), *C. balansae* (semicircles), *C. symingtonianum* (stars in solid circles), and *Calophyllum* sp. 9 (open stars) in Malesia.

Timur: Boelongan, Mara, 100 m., *bb* 10834 (e) (BO). **Philippine Islands.** PALAWAN: Mangsi Is., *Wright s.n.* (?e) (US); Palawan, sine loco, *BS* 587 (a) (BO, GH, LY, NY, US). BATANES. Itbayat Is.: sine loco, *PNH* 79430 (?g) (PNH). Camiguin Is.: Mt. Malebsing, 427 m., *BS* 79250 (?g) (NY, SING); Balatubat, 366 m., *BS* 79263 (?g) (NY). Calayan Is.: sine loco, 47 m., *PNH* 79825 (d) (PNH). LUZON. Ilocos Norte: Burgos, *BS* 27348 (a) (F, MO). Ilocos Sur: sine loco,

FIGURE 10. Hairs (on terminal bud, unless otherwise stated). a, *Calophyllum dongnaiense* (notably birefringent, *Pierre* 3644). b–f, *C. blancoi*: b, *PNH* 10549, apical ca. 230 μ m. of large, collapsed cells not drawn; c, *A* 141; d, *BS* 47137, base of inflorescence and stem; e, *PNH* 10549, base of inflorescence, hair ca. 720 μ m. long; f, *FB* 25321, sometimes papillate. g, *C. aff. thorelii* (*Poilane* 23891), hair ca. 470 μ m. long. h, i, *C. dongnaiense* (*Pierre* 3644), hair to 640 μ m. long. j, *C. aff. dongnaiense* (*Poilane* 32327), apex only, basal part with thick-walled, epapillate cells (hair to ca. 1060 μ m. long). Scale = 60 μ m.

FB 7130 (a) (MO, US). Mountain: Bontoc, *Vidal 2122* (a) (K); Bontoc subprov., *Vanoverbergh 1251* (i) (C, G, GH, L, MO, P, W). Ifugao: Banaue, Mt. Taggutu, *PNH 72412* (i) (A, L), Liwang, Poitan, 457 m., *PNH 97519* (i) (L, PNH), Bayninan, 1219 m., *PNH 80554* (i) (A, L). Benguet: Benguet, *FB 29788* (?a) (BM, UC); Baguio, *Elmer 8852* (g) (A, BO, E, F, FI, G, K, NY, US), *FB 21293* (i) (US); sine loco, *Merrill 1745* (i) (BM, BO, G, GH, MO, NY, P, SING). Cagayan: Mt. Babatngin, 610 m., *BS 79434* (?i) (BO, NY, SING); Peñablanca, *BS 76932* (i) (K, MICH, NY, SING); sine loco, *FB 26885* (?d) (NY). Isabela: Mt. Moises, *Clemens 16936* (i) (BM, NY, UC), 1036 m., *BS 47295* (?g) (A, K, NY, SING, UC, US); Sierra Madre, San Mariano, 150 m., *PNH 78163* (d) (A, BO, SING), 335 m., *BS 47137* (c) (A, B, K, UC, US), Sangcad, 945 m., *PNH 78233* (d) (A, L). Aurora: Baler, Principe, *Merrill 1039* (?a) (K, NY, US). Zambales: Subig, *Merrill 1760* (a) (K, NY, US); Botolan, *Merrill 2991* (?d) (BM, K, US); sine loco, *FB 27834* (b) (A). Nueva Ecija: Mt. Umingan, *BS 26407* (i) (A, P, US); sine loco, *FB 22382* (a) (G, MO), *FB 22396* (?g) (US). Bataan: Lamao, *FB 350* (a) (A, LY, P, UC, US); Lamao R., Mt. Mariveles, *Williams 544* (a) (A, NY, SING). Rizal: Montalban, *Loher 12958* (?g) (BM, M, UC), *12501* (?a) (A, UC); Morong, Antipolo, *FB 452* (a) (K, NY, US), Bosoboso, *FB 1174* (a) (BM, BO, F, G, K, NY, P, SING, US); San Mateo, Manila, *Vidal 54bis* (a) (K); Mt. Lumutan, *BS 29754* (i) (A, NY, US); sine loco, *Loher 13384* (d) (M, UC). Laguna: San Antonio, *BS 20556* (?g) (BM, P, US), *BS 20545* (b) (K); Pangil, 270 m., *PNH 74253* (g) (PNH); Mt. Makiling, *PNH 8180* (a) (A); Santa Maria, *FB 10113* (a) (BO, LY). Quezon: Guinayangan, *Vidal 643* (a) (A, FI, K); Llavac, Real, 270 m., *PNH 41784* (equals *Lagrimas s.n.*, 29 March 1961) (b) (L, PNH); Kinatakutan, *FB 30661* (g) (NY, SING, UC); 100 m., *FB 30677* (a≤b) (NY); sine loco, *BS 1274* (i) (BM, BO, G, GH, MO, NY, P, SING). Camarines: Sipaco, Lagonoy, 495 m., *FB 30311* (a) (NY, UC); Pasacao, *Ahern 122* (a) (US); sine loco, *FB 21743* (b) (US), *FB 21685* (i) (K, US). Sorsogon: Irosin (Mt. Bulusan), *Elmer 15586* (d) (A, BM, BO, C, F, FI, G, GH, K, MO, NY, P, U, US), *Elmer 15621* (g) (A, BM, BO, C, F, FI, G, K, NY, P, U, UC, US, W). SAMAR: San Jose, Catubig R., 50 m., *Sablaya 19* (h) (A, F, K, MO, P); Catarman, *Vidal 634bis* (h) (A); sine loco, *BS 17532* (d) (K, US). LEYTE: Ormoc, Lake Danao, *PNH 11924* (d) (A, BO, SING, US); sine loco, *Wenzel 780* (h) (A, BM, F, G, GH, MO). PANAY: Capiz, Mt. Macosolon, *BS 30757* (?d) (A, UC); sine loco, *FB 25362* (?a) (A, BO, K, UC). MINDANAO. Surigao: Mt. Kabatuan, 768 m., *PNH 10549* (coriaceous a) (A, L, PNH). Agusan: Cabadbaran (Mt. Urdaneta), 305 m., *Elmer 13268* (?d) (A, BISH, BM, BO, C, E, F, FI, G, K, LY, MO, NY, P, U, US, W); Tungao, San Mateo, Butuan, 300 m., *PNH 42532* (d) (L, SING); Diuata Mts., 1036 m., *BS 83715* (d) (NY). Bukidnon: Quilayong, 610 m., *FB 29621* (?d) (UC); Mt. Camates, *BS 38692* (?a) (A). Davao del Sur: Todaya, Mt. Apo, 1143 m., *Elmer 11749* (?d) (A, BISH, BM, E, F, FI, G, GH, K, LY, MO, NY, US, W). Lanao: Cristina Falls, *Ebala 1188* (d) (A, PNH, SING); Siggapod, 40 m., *FB 31186* (d) (NY); Kulasinan, *FB 31190* (d) (MICH, NY); Lake Lanao, *Clemens 1009* (d) (F, G). Zamboanga: Sax R., 150 m., *Williams 2346* (d) (GH, K, NY, US); Port Banga, *FB 9415* (d) (LY, SING); sine loco, *FB 9491* (?i) (NY, US). SULU ARCHIPELAGO. Tarawakan: Tawitawi, *PNH 38806* (?a) (A, BISH, SING, K).

ECOLOGY. Usually in well-drained forests (sometimes in swampy forests in Sabah), to 1900 m. alt. Flowering February to June, rarely in January, August, September, November, and December; fruiting throughout the year, no month predominating (fruits of group "f" black or bluish, those of group "e" green).

From the Philippine Islands, *Ahern* 53, a close match with the type, has galls on the lower surface of the lamina; these galls are small, conical swellings ca. 1.5 mm. tall; similar galls occur on *BS* 79263 (?group b).

GERMINATION AND YOUNG PLANT. The radicle almost certainly breaks the stone to one side of the base. The seedling has two pairs of leaves separated by an internode ca. 1 cm. long (*SAN* 27855). Internodes produced during subsequent growth are well developed, the plant is erect, and the terminal bud is functional. (Pers. obs.; all details from form "e".)

LOCAL USES. In the Philippines the latex is used to treat wounds, boils, tumors, and other swellings, and to alleviate asthma (Perry, *loc. cit.*).

Calophyllum blancoi is quite a variable species, but it can be recognized by its plump, often quite long, terminal bud and its medium-sized to large leaf blades that are often clearly attenuate at the base and that dry more or less bicolorous. Its inflorescences are often terminal, and the flowers have 8 to 16 tepals. The fruits dry sharply and closely wrinkled, the outer layer does not usually detach cleanly from the stone and is less than 1 mm. thick, and the stone walls themselves are less than 0.3 mm. thick. The hairs are usually erect and notably branched (FIGURES 9, e-g; 10, b-f). The epithet commemorates F. M. Blanco, who wrote the first flora of the Philippine Islands.

The above description of the bark is based primarily on the form common in Sabah (see below). Limited data from the Philippine Islands suggest that the bark of *Calophyllum blancoi* there is similar.

Calophyllum blancoi is similar in a number of respects to *C. thorelii*. However, in *C. thorelii* the hairs are papillate rather than branched (see FIGURE 9, e-k), the midrib on the upper surface of the lamina is surrounded by raised blade, there are only eight—or rarely ten—tepals, and the outer layer of the fruit detaches cleanly from the 0.4–0.5 mm. thick stone. However, this similarity may be only superficial and needs further examination. (The differences between the taxa are summarized in TABLE 5.)

Several species of *Calophyllum* from the Philippine Islands were described as being close to *C. blancoi*; they were separated on details of leaf shape, size, and indumentum, inflorescence position, and tepal number and size. Although a number of groups can be delimited within *C. blancoi*, some being the basis of these early names, the characters separating the taxa are minor, most overlapping between groups or varying within a single collection or between collections that are similar in all other respects. Specimens intermediate between the groups are also common. At first sight it seems ridiculous to include *C. megistanthum*, which has leaf blades up to 30 cm. long and dried flowers up to 4 cm. across (as large as those of any other species in the genus), in the same species as specimens like *BS* 47295 (placed in group "g"), which has leaf blades less than 7.5 cm. long and flowers less than 1 cm. across, but no other conclusion seems possible at present. Of greater concern, the specimens of *C. blancoi* from northeastern Borneo form two very distinct groups that I would not have hesitated to describe as separate species had I been working on Bornean material alone; one group (e) has

green fruits, while the other (f) has blue. The two groups are apparently independently related to the *C. blancoi* complex on the Philippine Islands.

The groups recognized within *Calophyllum blancoi* are briefly characterized below, and pertinent details of nomenclature given. The lower case letters refer to the list of specimens cited.

GROUP a (*Calophyllum blancoi* sensu stricto; *C. wallichianum* auct., non Planchon & Triana).

Twigs drying brown (yellowish), short-tomentose when young. Lamina 7.5–21 by 3–5(–6) cm., cuneate at base, slightly undulate and recurved at margin, drying bicolored, subglabrous when mature, midrib raised above, (10 to) 12 to 16 veins/5 mm. Inflorescences usually terminal and axillary (rarely only axillary), axis usually short-tomentose; bracts not noticeable. Tepals (8 to) 12; stamens 190 to 480, anthers 1–2.2 mm. long. Fruit sharply wrinkled; outer layer lacking air spaces.

The common form on Luzon. Elsewhere uncommon and specimens often atypical.

Specimens such as *Merrill 1760*, *FB 8467*, and *FB 25362* have well-developed and subpersistent indumentum on their leaf blades as in group “b”. *PNH 10549* (from Mindanao) has very coriaceous leaf blades, and although its indumentum is not well developed, the axillary inflorescences are like those of *C. ferrugineum*, having a long basal internode. *PNH 38806* (from the Sulu Archipelago) in facies and indumentum is rather like group “e”, but it has over 400 stamens, about double the number in that group. *BS 38692* (from Mindanao) is intermediate between groups “a” and “i”, although the typical form of neither group is known from Mindanao.

GROUP b (*Calophyllum ferrugineum* Merr.).

Twigs drying brown or yellowish, tomentose at least when young. Lamina 8.5–21 by 4–7.5 cm., cuneate to $\pm$ attenuate at base, undulate and recurved at margin, drying bicolored, with subpersistent, tomentose indumentum on lower surface, midrib raised above, 8 to 15 veins/5 mm. Inflorescences terminal and axillary, axis tomentose; bracts to 1.5 cm. long, deciduous shortly before anthesis. Tepals 11 to 16; stamens ca. 620, anthers 1–1.5 mm. long. Fruit sharply wrinkled; outer layer lacking air spaces.

Known only from southern Luzon.

FB 21743 and *BS 20545* have leaf blades only up to ca. 10 by 5 cm.; there are only 5 to 9 veins/5 mm., and they tend to be impressed. Other specimens have larger leaves and more dense venation that tends to be raised.

GROUP c (*Calophyllum megistanthum*).

Twigs drying yellowish, subglabrous. Lamina 16–30 by 5.2–8.2 cm., cuneate at base, narrowly recurved and slightly undulate at margin, drying bicolored, $\pm$ glabrous when mature, midrib raised above, 8 to 10 veins/5 mm. Inflorescences axillary and terminal, axis subglabrous; bracts unknown, not persistent. Tepals 14 to 16; stamens at least 550, anthers ca. 1.7 mm. long. Fruit unknown.

Known from only a single collection from Luzon.

The inflorescence axis of the type specimen of *Calophyllum megistanthum*

TABLE 5. Comparison of *Calophyllum blancoi*, *C. thorelii* sensu stricto, *C. polyanthum*

	<i>C. blancoi</i>	<i>C. thorelii</i>	<i>C. polyanthum</i>
HAIRS HABITUALLY BRANCHED	+	—	—
TWIGS 4- OR 6-ANGLED	4 (6)	6	6
BASE OF LAMINA ATTENUATE	+ (—)	— (+)	—
LAMINA DRYING BICOLORED	+ (—)	+	—
MIDRIB ON UPPER SURFACE SURROUNDED BY RAISED LAMINA	—	±	—
VENATION DENSITY (veins/5 mm.)	5 to 18 (to 22)	9 to 16	9 to 16
TEPAL NUMBER	8 to 16	8 to 10	(7 to 10)
FRUIT COARSELY RETICULATE	+	+	—
THICKNESS OF OUTER LAYER (mm.)	0.3–1	ca. 1	—
OUTER LAYER DETACHING CLEANLY FROM STONE	—	+	—
THICKNESS OF STONE WALL (mm.)	0.05–0.3	0.4–0.5	—

is up to 23 cm. long, although there are only 9 to 15 flowers. Like those in specimens of group "b", the lowest flowers are borne some way (at least 3 cm.) from the base of the inflorescence. The "six-merous flowers" to which Quisumbing and Merrill (*loc. cit.*) drew attention are like those of some specimens of groups "a" and "b", in which three successive pairs of tepals enclose one or more whorls each usually of four tepals. Despite the size of the flowers, the pollen is the same size as that in other members of the *C. blancoi* complex.

GROUP d (*Calophyllum racemosum*; *C. flavocorticum*, ?*C. mindanaense*).

Twigs usually drying yellowish, subglabrous. Lamina (6-)13-22 by (2.5-)5.3-9.5 cm., usually attenuate at base, undulate and sharply and strongly recurved at margin, often drying bicolored, subglabrous when mature, midrib raised above, (5 to) 9 to 15 (to 22) veins/5 mm. Inflorescences axillary (terminal), axis without prominent indumentum; bracts small, not persistent. Tepals 8 to 12; stamens (175 to) 300 to 400, anthers 0.7-1.5 mm. long. Fruit sharply wrinkled; outer layer lacking air spaces.

Throughout the Philippine Islands.

Although many specimens of this group are quite distinctive, some are more or less transitional to groups "a", "g", and "i". The leaf blades of specimens from Rizal Province, Luzon, are more notably coriaceous than those of the others.

I have not seen the type specimen of *Calophyllum racemosum*; that of *C. flavo-corticum* (Elmer 14311) is very similar to *Clemens 1009*. Merrill (*loc. cit.*) thought that the latter was a particularly robust specimen of *C. racemosum*. The specimen of Elmer 10597A at the Arnold Arboretum is designated the lectotype of *C. mindanaense*, since Elmer (*loc. cit.*) considered that number to be the more typical specimen of the two that he cited (the other was Elmer 11749). In their rather depressed midribs, and their terminal as well as axillary inflorescences, both specimens perhaps approach group "i".

GROUP e.

Twigs drying brown, puberulent when young. Lamina 8-17 by 2.3-5 cm., attenuate at base, rather closely undulate and slightly recurved at margin, drying bicolored, glabrous when mature, midrib raised above, 9 to 14 veins/5 mm. Inflorescences axillary, axis puberulent; bracts soon deciduous. Tepals 8 (to 12); stamens 130 to 230, anthers 0.8-1 mm. long. Fruit sharply wrinkled; outer layer lacking air spaces.

Common in northeastern Borneo.

Nearly forty numbers of this form have been collected, but despite the considerable altitudinal (almost sea level to ca. 1900 meters)—and, to a lesser extent, geographic—range over which they have been collected, there is little variation.

GROUP f.

Twigs drying blackish, $\pm$ tomentose. Lamina 7.5-18.3 by 1.8-4.3 cm., cuneate to acute at base, strongly and closely undulate, slightly recurved

at margin, drying bicolored, indumentum not conspicuous, midrib raised above, 9 to 19 veins/5 mm. Inflorescences terminal, axis puberulo-tomentose; bracts small, deciduous. Tepals 10; stamens 250 to 270, anthers 0.5–0.7 mm. long. Fruit smooth; outer layer with large air spaces.

Known only from islands off northeastern Borneo.

Specimens of group "f" are perhaps most similar to groups "a" and "d"; in the latter group *FB 9415* (from Mindanao) is perhaps the closest match with group "f".

GROUP g (?*Calophyllum changii*).

Twigs drying brown to yellow, the indumentum inconspicuous. Lamina (3.5–)5.7–12.5 by 2.7–4.9 cm., attenuate at base, moderately undulate and recurved at margin, often drying bicolored, indumentum not persistent, midrib raised, 6 to 14 veins/5 mm. Inflorescences usually axillary, axis with inconspicuous indumentum; bracts small, deciduous. Tepals 8 to 10; stamens ca. 215, anthers 0.8–1.2 mm. long. Fruit sharply wrinkled; outer layer without air spaces.

Known only from Luzon.

A very heterogeneous group. *Elmer 13268* and *BS 30757* (both cited under group "d") are more or less intermediate between that group and group "g". Other specimens from the northern part of the Philippine Archipelago, such as *BS 79434*, are like *Calophyllum balansae*, since their leaf blades do not dry notably bicolored. However, they have branched hairs, yellowish-drying twigs, coriaceous leaves, and larger inflorescences, and the resemblance appears to be superficial only. Some of the smaller-leaved specimens placed in group "g" have been confused with *Calophyllum whitfordii* (q.v.).

GROUP h.

Twigs drying brown to yellowish, the indumentum inconspicuous. Lamina (4.7–)6.3–14 by (1.6–)2–4.9 cm., more or less attenuate at base, undulate and recurved at margin, drying bicolored, indumentum inconspicuous, midrib raised above, (10 to) 12 to 19 (to 22) veins/5 mm. Inflorescences terminal, axis with inconspicuous indumentum; bracts small, deciduous. Tepals (8 to) 10 (or 11); stamens 140 to 180, anthers 0.5–0.7 mm. long. Fruit sharply wrinkled; outer layer without air spaces.

Known only from Samar and Leyte.

Flowering specimens of this group are superficially similar to the form of *Calophyllum polyanthum* (*C. elatum* sensu stricto) from the Western Ghats of India. The branched hairs of group "h" have almost completely unthickened cell walls; the unbranched, but papillate, hairs of *C. polyanthum* have thickened cell walls.

GROUP i (*Calophyllum glabrum*).

Twigs drying brown, the indumentum inconspicuous. Lamina (4.5–)6.3–11 by (1.3–)1.8–4 cm., cuneate to subattenuate at base, subundulate and narrowly recurved at margin, often drying bicolored, midrib above depressed for most of its length, 14 to 22 veins/5 mm. Inflorescences axillary or terminal, axis with inconspicuous indumentum; bracts inconspicuous, deciduous. Tepals

8 to 14; stamens 145 to 410, anthers 0.6–1.2 mm. long. Mature fruit unknown.

Known only from Luzon.

Specimens of group "i" from Cagayan and Quezon provinces tend to have a less depressed midrib than the others. *BS 1274* (Quezon) has flowers with only eight tepals, the outermost pair of which is not notably smaller than the others.

Calophyllum glabrum was described as having quite glabrous inflorescences; however, there is short but definite indumentum on the inflorescence axes of the specimens seen. The specimen number of the type of *C. glabrum* is *Vanoverbergh 1251*; specimens with this number seem to have been collected on three different dates. Merrill (*loc. cit.*) gives the date of collection as June 13, 1911, but also mentions that a specimen in young fruit was collected in August of that year. The duplicates seen of *Vanoverbergh 1251* were collected on April 28, 1914.

3. *Calophyllum thorelii* Pierre, Fl. Forest. Cochinch. 1: pl. 103. 1885; Vesque in C. DC. Monogr. Phanerog. 8: 601. 1893; Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 322. 1910; Craib, Fl. Siam. Enum. 1: 122. 1931; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 269. 1943; Phạm & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. *bang 62bis E.* 1960; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 2: 301. *fig.* 1970. TYPE: Cochinchine [Vietnam], in montibus Dinh ad Baria Galliae, 300 m., Mars 1867, *Pierre 34* (lectotype, P; isolectotypes, BM, K).

?*C. thorelii* Pierre var. *oxycarpum* Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 270. 1943. *Nomen invalidum.*

Tree 6–20 meters tall, d.b.h. to 25 cm.; trunk without buttresses; outer bark fissured; latex yellow.

Twigs slightly flattened, 2.5–3(–4.5) mm. across, $\pm$ 6-angled, drying blackish, grayish puberulent when young; axillary innovations lacking basal scars; internodes 1–3.5 cm. long; uppermost pair of axillary buds rounded, ca. 1.5 mm. long, subspreading; terminal bud plump, ca. 1.3 cm. long, with short, grayish indumentum (hairs, FIGURE 9, h–k), underdeveloped internode ca. 1 mm. long. Petiole 1.7–3.6 cm. long, broadly concave to V-shaped above, convex below, usually glabrescent; lamina elliptic to ovate or oblong, (7.5–) 10.5–17 by (2.5–) 3.2–6.5 cm., acute to acuminate at apex, acute to cuneate or attenuate at base, strongly undulate but not recurved at margin, marginal thickening up to 0.4 mm. wide, coriaceous to very coriaceous, drying gray-olivaceous above with margins and midrib $\pm$ sabelline, sabelline below, glabrous when mature or subpersistently gray-puberulent on midrib on both surfaces, the midrib above narrowing $\pm$ quickly near base, subdepressed to subraised (surrounding lamina $\pm$ raised), 0.2–0.6 mm. wide at midpoint, below raised, angled toward apex, striate toward base, the venation above and below apparent, raised, 9 to 16 veins/5 mm., angle of divergence 65–70(–80)°. Inflorescences terminal and from adjacent foliate axils, with numerous flowers, often flabellate, once- (rarely twice-) branched, with branches to 3 cm. long, the axis to 12 cm. long, densely puberulent, lowest internode 0.5–3 cm. long; bracts ovate to elliptic, 0.4–1.8 cm. long, not

persistent; pedicels 1–1.5 cm. long, puberulent. Flower (?)hermaphroditic; tepals 8 to 10, the outer pair ovate to orbicular, 4.5–6.5 by 4.5–5.5 mm., puberulent on back, the inner ones obovate-oblong, 8–11 by 2–7.5 mm., with the two outer puberulent in strip down back; stamens 140 to 275, the filaments to 6 mm. long, the anthers elliptic to suboblong, 0.7–1.3 mm. long, retuse at apex; ovary 1.5–2.5 mm. long, the style 5–5.5 mm. long, the stigma peltate, 1–1.5 mm. across, $\pm$ radiate. Fruit ovoid to ellipsoid, 2–3 by 1.1–1.6 cm., $\pm$ acute at apex, drying blackish to pruinose-vinaceous brown, deeply wrinkled or $\pm$ deeply substriate; outer layer detaching $\pm$ cleanly from stone, 0.4–1 mm. thick, compact; stone $\pm$ ellipsoid, 1.7–2.5 by 1–1.4 cm., $\pm$ apiculate, the walls 0.4–0.5 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Vietnam to Thailand (MAP 3).

SELECTED SPECIMENS SEEN (letters refer to discussion in text below). **Vietnam:** Nhatrang, Massif du Hòn Bà, "au Rotins," 1000 m., *Chevalier* 38687 (?s) (A, P); Haut Donnai, Pnomh Sapoum près de la station Agricole de Blao, 1000–1100 m., *Poilane* 23733 (s) (K, P), *Poilane* 23734 (o) (P); Braian près de Djiring, 1700 m., *Poilane* 23891 (o) (A, BO, K, P), 1500 m., *Poilane* 24270 (P); Phu Thoc, Giang Dong, *Pierre* 1393 (BM, K, P); presq̃île Nui Hon Heo, près de Nhatrang, 700 m., *Poilane* 6399 (K, P); Phanrang, Ca-na, 700 m., *Poilane* 9395 (P, SING); Lagi, SE. reserve Cay Sangh, *Evrard* 2281 (P); Annam, Din Thuan, *Magnein* 38 (P). **Cambodia:** Sama Piphek, *Hahn* 26 (P); Pnomh Penh, *Béjaud* 463 (P); Nord Kampok, *Poilane* 14774 (P). **Laos:** Vientiane, Ban Sa Phan Meuk, *J. E. Vidal* 1389 (P); environs de Vientiane, *J. E. Vidal* 793B (P). **Thailand:** Chantaburi, Kao Sabap, 50 m., *Kerr* 9556 (A, K, L, P); Lem Sing, 50 m., *Kerr* 9638 (C, K, P); entrance to Chantaburi R., on path leading to Prachadu (Pagoda), 12 m., *Collins* 563 (K, US); Pra Chedi Mt. Kow Kleo Park, 325 m., *Maxwell* 75-210 (AAU); Nong Ta kroom, Sriracha Forest, *Collins* 1127 (C, US); Koh Chang Is., *Maxwell* 74-404 (AAU).

ECOLOGY. Lowland or colline forest, 12–700(–1500) m. alt. In Cambodia, a component of annually burned savannah vegetation; in Thailand in evergreen (or bamboo) forest. Flowering January to April, occasionally in November (flower scented); fruiting in March and April.

LOCAL USES. The wood is generally useful in construction, including that of boats and masts, apparently being resistant to the attacks of borers (*Pierre, loc. cit.*). The "flowers [are] very fragrant & used by the ladies" (*Collins* 1127).

Calophyllum thorelii can be recognized by its leaves that dry bicolored (gray-olivaceous with more or less sabelline margins and midrib above, and sabelline below), its terminal, puberulent inflorescence, its flowers with eight to ten tepals, and its fruits that dry wrinkled and have an outer layer ca. 1 mm. thick that detaches cleanly from the 0.4–0.5 mm. thick stone (but see below). The epithet *thorelii* commemorates Dr. C. Thorel, a French doctor.

Calophyllum thorelii seems to be most closely related to *C. blancoi* and perhaps also to *C. polyanthum*; the differences between these species are listed in TABLE 5.

Two groups of specimens are included in *Calophyllum thorelii* only provi-

sionally; they have not been incorporated into the description. Specimens marked "o" in the list above have terminal buds ca. 5 mm. long, four-angled stems, shortly tomentose indumentum with hairs clearly of a structure different from those of *C. thorelii* sensu stricto (FIGURE 10, g), petioles 6.5–1.3 cm. long, and fruits with an outer layer having a shiny inner surface. The invalid name *C. thorelii* var. *oxycarpum* was based on specimens of this type. Specimens marked "s" in the list have terminal buds 5–7 mm. long, twigs slightly angled and only 1.3–1.7 mm. across, leaf blades not drying notably bicolored and having latex canals on the upper surface almost as prominent as the veins, and fruits having stones with walls 1.2–1.5 mm. thick; the hairs (FIGURE 9, s–u) are not notably different from those of the typical form. Flowers of neither group are known. However, it is probable that the groups will have to be recognized formally when better known. At Pnomh Sapoun specimens referable to groups "s" and "o" seem to grow in close proximity, while the typical form and group "o" both grow near Braian.

Within *Calophyllum thorelii* sensu stricto there is some variation in leaf texture and in inflorescence and flower size; for example, the specimens from Laos are robust and have very coriaceous leaf blades. However, in all specimens the hair type, leaf venation and midrib, and inflorescence and flower are similar; the color of the dried lamina is the same; and the distribution of the indumentum is also similar, although there is some variation as to the degree of its development.

Calophyllum thorelii has been lectotypified by the sheet of *Pierre 34* at Paris. This is the only fruiting specimen of the three numbers that *Pierre* (*loc. cit.*) cited (*Pierre 34* (also given as 384), 1393, and 2097). Although *Pierre's* notes at Paris are attached to the sheet of *Pierre 2097*, *Pierre 34* also clearly agrees with the description, and since characters of the fruit are important in separating *C. thorelii* from related taxa, lectotypification by a fruiting specimen is appropriate.

4. ***Calophyllum polyanthum*** Wall. ex Choisy, *Descr. Guttif. Inde*, 43. 1849, *Mém. Soc. Phys. Hist. Nat. Genève* 12: 423. 1851; Wall. *Catal.* 4844. 1831, *nomen*; Planchon & Triana, *Ann. Sci. Nat. Bot.* IV. 15: 278. 1862; Bedd. *Fl. Sylvat.* 3: xxii. 1871; T. Anderson in Hooker f. *Fl. Brit. India* 1: 274. 1874; Kurz, *Jour. Asiatic Soc. Bengal*, II. 43: 88. 1874, *Forest Fl. Brit. Burma* 1: 95. 1877; Gamble, *List Trees Darjeeling Distr.* 7. 1878; Theobald, *Burma* 2: 636. 1883; Vesque, *Epharmosis* 2: t. 6. 1889, in C. DC. *Monogr. Phanerog.* 8: 555. 1893; Prain, *Bengal Pl.* 1: 246. 1903; Brandis, *Indian Trees*, 54. 1907; A. M. & T. M. Cowan, *Trees No. Bengal*, 17. 1929; Craib, *Fl. Siam. Enum.* 1: 121. 1931; Kanjilal *et al.* *Fl. Assam* 1: 114. 1934; Sastri *et al.*, *Wealth India* 2: 19. 1950; Maheshwari, *Bull. Bot. Survey India* 2: 144. 1960; Dutt *et al.* *Indian Forester* 100: 65. 1974. TYPE: India, Assam, Sillet, 1832, *Wallich dist.* 4844 (holotype, G; isotypes, BM, FI, G, GH, K, P).

C. amoenum Choisy, *Descr. Guttif. Inde*, 41. 1849, *Mém. Soc. Phys. Hist. Nat. Genève* 12: 421. 1851, *excl. spec. cit.* TYPE: sine loco [?India], *Griffith s.n.* (lectotype, G).

- C. elatum* Bedd. Fl. Sylvat. 1: pl. 2. 1869, *ibid.* 3: xxii. 1871; Someren, Forest Trees Mysore Coorg, 4. 1879; Brandis, Indian Trees, 54. 1907; Gamble, Fl. Pres. Madras 1: 76. 1915; Sastri *et al.* Wealth India 2: 18. 1950; Maheshwari, Bull. Bot. Survey India 2: 146. pl. 3. 1960; Somasundaram, Handb. Trees So. States, 54. 1963; Troup, Silv. Indian Trees. ed. 2. 1: 227. 1975. TYPE: India, Anamallays, *Beddome* 35 (lectotype, CAL, n.v.).
- C. smilesianum* Craib, Kew Bull. 1924: 84. 1924; Kerr, Fl. Siam. Enum. 1: 122. 1931; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 270. 1943. TYPE: Siam, Kao Keo Kang, Dan Sui, ca. 1300 m., April 1922, *Kerr* 5792 (holotype, K; isotypes, E, P).
- C. smilesianum* Craib var. *lutea* Craib, Kew Bull. 1924: 86. 1924; Kerr, Fl. Siam. Enum. 1: 122. 1931; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 271. 1943. TYPE: Siam, Doi Pahom Pok, Mg. Fang, ca. 1600 m., 1 April 1921, *Kerr* 5180 (holotype, K).
- C. williamsianum* Craib, Kew Bull. 1924: 86. 1924; Kerr, Fl. Siam. Enum. 1: 122. 1931; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 270. 1943. TYPE: Siam, Nan, Doi Tiu, ca. 1100 m., 8 March 1921, *Kerr* 5038 (holotype, K; isotypes, E, P).
- C. angustifolium* auct., non Roxb.; Dalzell & Gibson, Bombay Fl. 32. 1861; Cleghorn, Forests Gardens S. India, 11. 1861; Drury, Handb. Indian Fl. 1: 143. 1863.
- C. bracteatum* auct., non Thwaites; Bedd. Trans. Linn. Soc. 25: 211. 1865.
- C. tomentosum* auct., non Wight; T. Anderson in Hooker f. Fl. Brit. India 1: 274. 1874, *pro parte*; Vesque in C. DC. Monogr. Phanerog. 8: 552. 1893, *pro parte*; Cameron, Forest Trees Mysore Coorg, 17. 1894; Talbot, Trees Bombay Pres. ed. 2. 30. 1902; Bourdillon, Forest Trees Travancore, 27. 1908; Cooke, Fl. Pres. Bombay 1: 80. 1909; Talbot, Forest Fl. Bombay 1: 100. 1909; Bor, Man. Indian Forest Bot. 202. 1953.
- C. balansae* auct., non Pitard; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 271. 1943, *pro parte*; Phạm & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. *bang* 57bis A. 1960; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 22: 302. fig. 1970, *pro parte*.
- C. thorelii* auct., non Pierre; Hu *et al.*, Bull. Fan Mem. Inst. Biol. Bot. 8: 338. 1938; Auctt., Ic. Corm. Sin. 2: 883. 1972.

Tree 7–45 meters tall, d.b.h. to 160 cm.; trunk without buttresses; outer bark yellowish, gray to brown, or black, deeply fissured, with oblong flakes; inner bark yellow, reddish, or reddish brown with whitish bands; latex white, amber colored, or clear brown.

Twigs slightly to strongly flattened, 1.5–3(–4.5) mm. across, obscurely to sharply 4-angled, drying brown to blackish, puberulent when young; axillary innovations lacking basal scars; internodes 0.5–4(–5) cm. long; uppermost pair of axillary buds $\pm$ rounded, to 1.5 mm. long, suberect, inconspicuous; terminal bud plump, 7–10(–14) mm. long, with subcrustaceous to puberulent, gray to brown indumentum (hairs, FIGURE 11, d–k), underdeveloped internode to 2.5 mm. long. Petiole 0.7–1.8(–2.2) cm. long, broadly concave above, convex below, soon glabrescent; lamina ovate to elliptic, 5–16(–19) by 1.8–6 cm., acuminate at apex, (abruptly) attenuate to acute at base, narrowly recurved and undulate at margin, coriaceous, drying dark olive-buff to sepia above and umber or sabelline to sepia below, sparsely puberulo-farinoe on midrib

below when young, the midrib above usually gradually narrowed from base, raised, or at least margins raised, 0.2–0.5 mm. wide at midpoint, below raised, striate, the venation above and below apparent, raised, 9 to 16 (to 24) veins/5 mm., angle of divergence (65–)70–85°. Inflorescences terminal and from adjacent foliate axils, with many flowers, flabellate, to twice branched, the axis to 16 cm. long, puberulent, lowest internode 0.5–3 cm. long; bracts soon deciduous, not seen; pedicels 0.4–1.2(–1.8) cm. long, puberulent. Flower (?)hermaphroditic; tepals 8 (rarely 7, 10, or 12), the two outer ovate to orbicular, 2–4(–5) by 2–3.5(–4.5) mm., $\pm$ puberulent on back, the inner ones ovate to obovate, 4–8 by 3.5–6 mm., or in flowers with 12 tepals, inner four sometimes only 3.5 by 1.2 mm., sometimes puberulent toward base; stamens (100 to) 140 to 320, the filaments 2.5–4 mm. long, connate for up to 0.5 mm., the anthers $\pm$ elliptic and 0.4–1 mm. long, or oblong and to 1.7 mm. long, retuse (rounded) at apex; ovary 1.2–2.5 mm. long, the style 2–3 mm. long, the stigma peltate, 0.7–1.2 mm. across, 2- or 3-lobed. Fruit ovoid to subobovoid, 2.4–3.4 by 1.8–2.3 cm., $\pm$ acute to beaked at apex, drying dark brownish, smooth to finely wrinkled or substriate; outer layer not detaching cleanly from stone, 1.5–3 mm. across, compact; stone obovoid to ellipsoid, 1.9–2.6 by 1.5–1.8 cm., rounded at apex, the walls 0.4–0.7 mm. across, smooth, unmarked; spongy layer thin.

DISTRIBUTION. India (Western Ghats and northeastern India) to Thailand and southwestern China (MAP 4).

SELECTED SPECIMENS SEEN. **India.** MYSORE: Coorg, *Dehra Dun Herb. no.* 33622 (A), 33627 (G), 33628 (NSW); Anamallays, *Beddome 418* (BM). TAMIL NADU: Karien Shola (Top Slip) near Coimbatore, 1000 m., *Kostermans 25231* (L). WEST BENGAL: Kurseong, 1219 m., *Gamble 1624A* (K); Chunbali, 914 m., *Gamble 605A* (K); Siohe Hills, 610 m., *Gamble 7569* (K); Bereith, Teesta, 305 m., *Gamble 1644A* (K); Mungpoo, *Prain's collector s.n.*, May 1900 (G, GH, P); Terai, *Clarke 28014* (K); above Tendhara, *Cave s.n.*, 23 May 1912 (E); Anwee, 610–1524 m., *Hooker & Thompson 2385* (K); Peque & Sikkim, up to 914 m., *Beddome 417* (BM); Khalumpong Div., 1067 m., *Gamble 10004* (K). ASSAM: near Nokrek, Garo Hills, 1219 m., *Koelz 24573* (L); Khasia, 610–1524 m., *Hooker & Thompson s.n.* (BM, C, FI, G, GH, K, L, M, P, US, W); Hmuntha, Lushai Hills, 1524 m., *Chand 4390* (L); Rungtong, 914 m., *Clarke 14690A* (K), *14690B* (BM). **Bangladesh:** Chittagong, Pharsa, *Gamble 6689A* (K); Sitapahar, *Cowan 11* (E). **Burma:** SE. Shan States, Keng Tung territory, between Pang Hoi Hpi and Peng Sai, 1341 m., *Rock 2205* (A, US, W); Sedashegus, *Mrs. Muller s.n.*, Feb. 1858 (E); Amherst Distr., Mikhalein Chaung, Dawna Range, 610 m., *Lace 4759* (E, K); Pu Bia, 1700 m., *Kerr 21009* (BM, P). **China.** YUNNAN: Meng-soong, Dah-meng-lung, Che-li Hsien, 1800 m., *C. W. Wang*

FIGURE 11. Hairs (from terminal bud, unless otherwise stated). a, *Calophyllum* sp. 9 (*bb 5467*). b, c, *C. symingtonianum* (*SFN 32904*). d–k, *C. polyanthum*: d, e, *Rock 2205*, from axillary bud; f–h, *Griffith 879*; i, *Poillane 10212*; j, *DD 33623*, from inflorescence; k, *Winit 1375*. l, *C. tomentosum* (*Kostermans 25008*). m–o, *C. walkeri*: m, o, *Kostermans 25100*; n, *CP 1170*. p, q, *C. trapezifolium*: p, *Kostermans 24138*, in life more adpressed; q, *Kostermans 24414*, very common hair type. Scale = 60 μ m.

MAP 4. Distribution of *Calophyllum polyanthum* (circles), *C. dryobalanoides* (squares), and *C. dongnaiense* (star) in India-Southeast Asia.

78356 (A); Lan Tsang Hsien, 1800 m., *C. W. Wang* 76468 (A). **Vietnam:** Quang Tri, Dent du Tigre, 800–1000 m., *Poilane* 10242 (?) (K, P, SING); Ba Na, près de Tourane, 1200–1500 m., *Poilane* 29222 (?) (A, P). **Laos:** Pu Bra, 1700 m., *Kerr* 21009 (K). **Thailand:** Kao Kradang, Udawn, 450 m., *Kerr* 8752 (E, K, L, P); Me Chem, *Kerr* 2691 (K); Doi Pah Kao, *Kerr* 2608 (K); Chiangmai, Doi Kā, *Winit* 1375 (K), Doi Nang Kā, *Put* 3785 (BM, K, L), Doi Chiengdao, 100 m., *Smitinand et al.* 7787 (BKF); Phitsanulok, foothill of Puh Mieng mountain, 1300 m., *Larsen et al.* 938 (AAU); Loei, Phu Kradueng National Park, 1250 m., *Smitinand* 11780 (BKF); Van Saping, Pakadong, Lowi, *anon.* 706 (*BKF* 12385) (BKF); Kaolong, Nakorn Sri Tamara, *anon.* 624 (*BKF* 10145) (BKF); Nakorn Sri Thamrad, Kiriwong, *anon.* 1662 (*BKF* 31492) (BKF); Peninsula, Trang, Chawng, 200 m., *Smitinand* 4106 (BKF).

ECOLOGY. Tree of sometimes considerable size; usually in colline or lower montane rainforest, (200–)400–1800 m. alt. Flowering January to July (in Peninsular India apparently in January and February (Talbot, *loc. cit.*, as *C. tomentosum*) or March and April (Bourdillon, *loc. cit.*)); flower scented. Fruiting March, June, July, September, and November (India); late January (Burma); March, April, July, September, and November (Thailand); and April (Laos). Fruits of Western Ghats specimens reported (e.g., Bourdillon, *loc. cit.*, as *C. tomentosum*) to be bright yellow or dark purple.

GERMINATION AND YOUNG PLANT. The radicle probably breaks through the stone to one side of the base. The seedling has three pairs of leaves separated by well-developed internodes; the lowest pair of leaves may either persist or drop off well before the others (*Gamble* 7569, *Clarke* 15130A).

LOCAL NAMES AND USES. In southwestern India *Calophyllum polyanthum* is the well-known poon spar or sirpoon tree. Wood of this tree furnished the poon spars used for masts, spars, and other parts of ships, and good trunks were much valued, as much as 2000 rupees being paid for single trunks in the nineteenth century. The wood has also been used for bridge building, general construction, and furniture making.

Calophyllum polyanthum can be recognized by its moderate-sized leaf blades that are markedly attenuate at the base, have a midrib that narrows gradually above the base, and are the same color on both surfaces, often drying greenish brown. The terminal inflorescence has numerous flowers; the flowers themselves usually have eight tepals, the outermost pair of which is markedly smaller than the rest. The fruit dries smooth or finely wrinkled, with a compact outer layer 1.5–3 mm. thick, and stone walls 0.4–0.7 mm. thick. The epithet *polyanthum* refers to the inflorescences, which have numerous flowers.

Calophyllum polyanthum is apparently related to *C. thorelii* and *C. touranense* (both from Vietnam, the former also found in Thailand), and perhaps also to *C. blancoi* (centered in the Philippine Islands). The differences between these species are listed in TABLE 5.

The specimens cited above from Vietnam are included in *Calophyllum polyanthum* only with some hesitation; they had previously been identified as *C. balansae*. The specimens are either in bud or just past flowering; they have rather small (lower limits of measurements given) leaf blades that are more or less cuneate at the base. Specimens collected by Kostermans near Coimbatore have leaf blades with strongly undulate margins and dense (upper limits of measurements given) venation. The leaf blades are somewhat more coriaceous than those of the other specimens, including the other specimens cited from Peninsular India, and the fruits are beaked.

The typification of *Calophyllum amoenum* is discussed under *C. calaba*. The type specimens of *C. smilesianum* and *C. smilesianum* var. *lutea* cannot be distinguished morphologically from the other specimens of *C. polyanthum*. However, the type specimen of *C. williamsianum*, Kerr 5038, differs somewhat from the other specimens in having large terminal buds and leaf blades (upper limits of measurements given), and robust inflorescences, the flowers tending to be congregated toward the ends of the inflorescence branches. The midrib on the upper surface of the lamina is rather abruptly narrowed at the base. However, in general details of venation, terminal bud, indumentum, and flower (except the rather long (1.4–1.7 mm.) anthers), Kerr 5038 agrees with the other specimens of *C. polyanthum* and so is included here. The outer pair of tepals are very much smaller than the inner ones, as is characteristic of *C. polyanthum*. Kerr (*loc. cit.*) considered both *C. williamsianum* and *C. smilesianum* to be close to *C. polyanthum*.

Calophyllum elatum is reduced to synonymy under *C. polyanthum* without much hesitation, although there seems to be some confusion over fruit color (see above). The specimens cited agree well with the illustration of *C. elatum* in Beddome (1869, *pl.* 2), except that the indumentum on the tepals is less prominent than in the illustration. They differ from specimens collected in

northeastern India only in their somewhat longer petioles and pedicels, but there is no absolute difference even in these characters. Maheshwari (*loc. cit.*) lectotypified *C. elatum*.

There are other specimens of *Calophyllum* from the Western Ghats and vicinity (e.g., *Bourdillon 1505*, at Kew) that seem to be neither *C. polyanthum* nor *C. tomentosum*, with which *C. elatum* has been confused. *Calophyllum tomentosum* itself has much more steeply ascending venation than *C. polyanthum*, its tomentose indumentum is conspicuous, and its inflorescence is axillary. *Bourdillon 1505* and the other specimens approach *C. tomentosum* in the first and last characters, while in the second they are close to *C. polyanthum*; their leaf blades are less than 9 by 3.9 cm.

5. *Calophyllum touranense* Gagnep. ex P. F. Stevens, sp. nov.

FIGURE 8, b-d.

C. touranense Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 271. 1943; Phạm & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. *bang 62bis* C. 1960; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 2: 302. *fig. 1970*. *Nomen invalidum*.

C. balansae auct., non Pitard; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 271. 1943, *pro parte*.

A speciebus aliis *Calophylli* in foliis mediocris venulis lateralibus prominentibus 6 ad 10 (ad 14) per 5 mm., et fructu in siccitate reticulo crebero minute elevato interdum striato, strato exteriori crasso (circa 3-5.5 mm. in transverso), differt.

Tree 7-20 meters tall; trunk and bark unknown; latex yellow.

Twigs slightly flattened, 0.8-2.3 mm. across, $\pm$ 4- or 6-angled, drying black, puberulent when young; axillary innovations without basal scars; internodes 0.5-3.5(-4.5) cm. long; uppermost pair of axillary buds rounded, 1-1.5 mm. long, erect; terminal bud plump, ca. 5 mm. long, with short, brown to grayish indumentum (hairs, FIGURE 9, o-r), underdeveloped internode to 3.5 mm. long. Petiole 0.7-2.5 cm. long, $\pm$ strongly concave above, convex below, glabrous at maturity; lamina elliptic to ovate, (3.3-)4.2-7.2 by (1.4-)2.2-4.6 cm., acuminate at apex, cuneate to narrowly attenuate at base, slightly undulate and not recurved or slightly so at margin, coriaceous, drying bay to olivaceous above and sepia below, glabrous at maturity, the midrib above gradually narrowed from base, flat to slightly elevated, 0.1-0.3 mm. wide at midpoint, below narrowly raised, $\pm$ angled, the venation apparent below and usually above, raised, 6 to 10 (to 14) veins/5 mm., angle of divergence 60-75°. Inflorescences terminal and from adjacent foliate axils, with numerous flowers, branched, the axis ca. 5 cm. long, puberulent when young, basal internode ca. 1.3 cm. long; bracts narrowly ovate, to 4 mm. long, caducous; pedicel (2-)3-5.5 mm. long, puberulent, in fruit 1-1.5 cm. by 2-3 mm. thick. Flower (?)hermaphroditic; tepals 9 to 13, the outer pair suborbicular, 3-3.7 by 3-4 mm., the next pair suborbicular, 4-6 by 4.5-7 mm., the inner ones more or less elliptic, 8-9.5 by 4-7 mm., in inner whorl to 10.5 by 4.5 mm.; stamens

ca. 400, the filaments to 4 mm. long, the anthers suboblong, 0.6–1 mm. long, $\pm$ rounded at apex; ovary ca. 1.5 mm. long, the style ca. 3 mm. long, the stigma not peltate, ca. 0.5 mm. across. Fruit ellipsoid to obovoid, 2–3.7 by 1.2–2.3 cm., rounded to acute at apex, drying brown to blackish, finely and closely reticulate to striate; outer layer adhering to stone, 3–5.5 cm. thick, compact; stone ovoid-ellipsoid, 1.3–2.6 by 0.7–2 cm., rounded at apex, the walls (0.3–)0.6–1.1 mm. thick, smooth, not marked; spongy layer thin.

TYPE: Indochina [Vietnam], Annam, Hoi Mit, 40 km. N. of Tourane, 10 July 1927, *J. & M. S. Clemens* 4162 (holotype, A; isotypes, K, NY, P).

DISTRIBUTION. Thailand and Vietnam (MAP 3).

ADDITIONAL SPECIMENS SEEN. **Vietnam:** Col des Nuages, près de Tourane, 450 m., *Poilane* 7956 (K, P, US); Ba Na, près de Tourane, 1100 m., *Poilane* 7179 (A, K, L, P), 300 m., *Poilane* 7341 (P), 200–300 m., *Poilane* 29303 (A, P); sommet du Nui Bach Ma, sud de Hue, 1400–1500 m., *Poilane* 27748 (L, P), 1400–1500 m., *Poilane* 27759 (BM, P, US), *Poilane* 29973 (A, P). **Thailand:** Nakhon Ratchasima, Khao Yai Natl. Park, Khao Kieo, 1200 m., *Beusekom & Charoenpol* 1724 (A).

ECOLOGY. Rocky or stony ground, 200–1500 m. alt. Flowering in April; fruiting July to October (almost ripe fruit brownish green).

LOCAL USE. The wood is used in house construction (Hue, Vietnam).

Calophyllum touranense can be distinguished from other species in the genus by its elliptic to ovate leaf blades that have prominent, rather distant venation, its terminal inflorescence, its flowers with 9 to 13 tepals, the outer pair being notably smaller than the rest, and its rather large fruit with a thick outer layer that dries minutely wrinkled. The type specimen was collected at Tourane (now Da-nang), hence the specific epithet.

Calophyllum touranense is possibly close to *C. polyanthum*, the two having similar inflorescences, and flowers in which the outermost pair of tepals is much smaller than the others. *Calophyllum polyanthum* differs most obviously in having closer venation and fruit with both the outer layer and the wall of the stone thinner (see TABLE 5). A variant of *C. polyanthum* and *C. touranense* both grow near Ba Na, Da-nang. *Calophyllum touranense* has been confused with *C. balansae*; for the differences between the two, see *C. balansae*.

Specimens of *Calophyllum touranense* from Hue are very similar to those from around Da-nang, although the fruit of the former tends to dry blackish, rather than brown, and to be somewhat smaller. The description of the flowers is taken from *Poilane* 29973, from Hue. A specimen in very young bud from near Da-nang (*Poilane* 7179) had 9 to 11 tepals, but the flowers were too young to confirm the size differences between the successive pairs and whorls of tepals so marked in *Poilane* 29973. The specimen cited from Thailand is similar to those from Vietnam. It differs slightly, however, in having less apparent venation on the upper surface of the lamina and a stone with a somewhat thinner wall. Other specimens from the same locality have fruits

with an outer layer ca. 2 mm. thick and leaves with as few as four veins/5 mm. *Calophyllum* is reported to be the dominant tree in parts of the Khao Yai National Park, and further collections from those areas are much needed.

Gagnepain's description of *Calophyllum touranense* is invalid, since it is in French.

6. ***Calophyllum balansae*** Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 320. 1910; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 2: 302. 1970, *pro parte*. TYPE: Tonkin [Vietnam], Ke-so, 6 May 1886, *Balansa* 4346 (lectotype, P).

Small tree; bark unknown.

Twigs slightly flattened, 1.5–2.5 mm. across, obscurely 4-angled, drying brown, sparsely puberulent when young; axillary innovations lacking basal scars; internodes 0.4–3.3 cm. long; uppermost pair of axillary buds and terminal bud unknown (hairs, FIGURE 9, n). Petiole 3.5–8.5(–13) mm. long, $\pm$ deeply concave above, convex below, glabrous; lamina obovate to subelliptic, 3–7 cm. long, 1.5–4.3 cm. across, bluntly subacuminate to obtuse (rarely rounded) at apex, cuneate at base, somewhat undulate and recurved at margin, subcoriaceous, drying umber to brick color above and umber to sepia below, glabrous, the midrib above narrowed gradually from already narrow base, somewhat depressed at first, soon becoming $\pm$ level, 0.2–0.4 mm. wide at midpoint, ultimately raised, below raised, striate, the venation above and below apparent, raised, 6 to 10 veins/5 mm., angle of divergence 60–70°. Inflorescences terminal and from adjacent foliate axils, with numerous flowers, sometimes flabellate, branched, branches 5-flowered, to 3.7 cm. long, the axis to 15 cm. long, $\pm$ puberulent near base (glabrous above), lowest internode 1.5–4 cm. long; lower bracts foliaceous, subpersistent, persistently puberulent on and near midrib below, upper bracts not seen; pedicels (0.5–)1–2 cm. long, glabrous or puberulent. Flower (?) hermaphroditic; tepals 8 to 12, glabrous or almost so, the outer two suborbicular, 3.5–6 by 4–5.5 mm., the next pair orbicular to broadly ovate, 6–7.5 by 5.5–6.5 mm., the inner ones obovate, 8–10 by 3–6 mm.; stamens 195 to 265, the filaments to 6 mm. long, the anthers elliptic to oblong, 0.5–0.9 mm. long, $\pm$ retuse at apex; ovary 1.3–2 mm. long, the style 3–7 mm. long, the stigma subpeltate, ca. 0.5 mm. across. Fruit ellipsoid, 2–2.2 by 1.55–1.75 cm., $\pm$ sharply pointed at apex, drying brown, with shallow, sharp, rather dense wrinkles; outer layer detaching $\pm$ cleanly from stone, ca. 1 mm. thick, compact; stone ellipsoid, ca. 1.6 by 1.3 cm., apiculate, the walls 0.3–0.5 mm. thick but somewhat thicker at base, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Vietnam (MAP 3).

ADDITIONAL SPECIMENS SEEN. **Vietnam:** Hao Nho, in monte Crucis, *Bon* 781 (P); in monte Lan Mat, *Bon* 2115 (P), *Bon* 2074 (P).

ECOLOGY. Probably in colline or lower montane forest in Vietnam; reported on calcareous rocks (*Balansa* 4346). Flowering March to May; fruiting in October.

Calophyllum balansae can be recognized by its rather small leaf blades that are at most subacuminate at the apex and that characteristically dry almost concolorous, and by its copious terminal inflorescences. Its subspherical, pointed fruits dry wrinkled, the outer layer of the fruit being ca. 1 mm. thick; the stone wall is ca. 0.5 mm. thick. The epithet commemorates the collector, Benjamin Balansa.

The status and relationships of *Calophyllum balansae* are unclear; it is similar to *C. polyanthum* and its relatives (TABLE 5), but when it becomes better known its specific rank may not be maintainable. Its terminal buds are unknown, but the hairs on the axillary buds are similar to those of *C. polyanthum*, *C. touranense*, and *C. thorelii* (FIGURES 9, 11).

Gagnepain (1943) cited specimens here placed in *Calophyllum touranense* and *C. aff. polyanthum* under *C. balansae*. *Calophyllum touranense* is rather similar to *C. balansae* in general leaf type (although the blade is more coriaceous) and in inflorescence and flower, but in fruit the two differ. The fruit of *C. touranense* dries finely wrinkled, the outer layer is at least 3 mm. thick, and the stone wall is 0.6–1.1 mm. thick. The specimens of *C. aff. polyanthum* that were cited by Gagnepain as *C. touranense* have inflorescences with flowers in young bud. The flowers have eight tepals and a peltate stigma, and the leaf blades have 11 to 14 veins/5 mm.

Calophyllum balansae and *C. symingtonianum*, from Malaya, have similar fruits; the differences between these two taxa are discussed under the latter species.

Calophyllum balansae has been lectotypified by Balansa 4346 at Paris. This specimen is in flower and agrees well with the original description. Pitard (*loc. cit.*) noted that Balansa collected this specimen on "monte Lan Mat"; this seems to be an error. Pitard did not describe the fruits: "fruit inconnu, monosperme d'après Bon." However, there are fruits in a packet on the sheet of Bon 781 that appear to belong to the specimen.

7. ***Calophyllum symingtonianum*** M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 338. *pl. 18*. 1956, *pro majore parte*; Kochummen, Malayan Forest Rec. ed. 2. **17**: 222. 1965; T. C. Whitmore, Tree Fl. Malaya **2**: 192. 1973, *pro parte*. TYPE: Malaya, Pahang, Cameron Highlands, Boh Plantation, 4000 feet [1219 m.], 12 April 1937, SFN 32633 coll. Nur (holotype, SING; isotypes, A, K, KEP, L, MO, P, UC, US).

Tree 12–39 meters tall, d.b.h. to 95 cm.; trunk at least sometimes with low, thick spurs or small buttresses; outer bark gray-brown to yellowish, with boat-shaped fissures, or with loose, elongate scales and narrow, square-section fissures between scales; inner bark pink; latex clear and almost colorless, free-flowing to sticky, or yellow and clear to opaque.

Twigs flattened, 1–1.5 mm. across, (weakly) 4-angled when young, soon becoming $\pm$ rounded, drying mid-brown to blackish, puberulent when young; axillary innovations lacking basal scars; internodes 1–3 cm. long; uppermost pair of axillary buds $\pm$ pointed, to 1.5 mm. long, spreading; terminal bud plump, 3–7 mm. long, with grayish to brownish, subcrustaceous indumentum

(hairs, FIGURE 11, b, c), underdeveloped internode 1.5–3.5 mm. long. Petiole 0.6–1.4 cm. long, narrowly concave above, convex below, usually slender, blackish when dry, subpersistently puberulent or not; lamina ovate to subelliptic, 5–9 by 1.4–3 cm., gradually acuminate at apex, cuneate (acute) at base, $\pm$ closely and narrowly undulate but not recurved or only slightly so at margin, coriaceous, drying umber above—often with grayish covering—and sepia below, glabrous, the midrib above gradually narrowed from base, $\pm$ flat, surrounding lamina obscurely raised, 0.2–0.3 mm. wide at midpoint, below slightly raised, obscurely angled, the venation on both surfaces subobscure to apparent, slightly raised, (6 to) 8 to 11 veins/5 mm., angle of divergence 70–85°. Infructescences terminal and from adjacent foliate axils, with scars of 11 to many flowers, sometimes with branches to 4 cm. long and with scars of up to 11 flowers, the axis 4–5 cm. long, puberulent, lowest internode 1.3–2.5 cm. long; bracts unknown; pedicels in fruit 0.6–1 cm. long, subpersistently puberulent. Flower unknown. Fruit ellipsoid to ovoid, 1.7–2 cm. long, 1.5–1.6 cm. across, $\pm$ rounded at apex, sometimes with stipe to 2.5 mm. long, drying brown, with dense, shallow, sharp wrinkles, or $\pm$ smooth; outer layer not detaching cleanly from stone, 0.5–0.8 mm. thick, $\pm$ compact; stone ellipsoid, ca. 1.5 by 1.3 cm., rounded at apex, the walls ca. 0.4 mm. thick, smooth, unmarked; spongy layer unknown.

DISTRIBUTION. Malaya, possibly also Thailand (MAP 3).

SELECTED SPECIMENS SEEN. **Thailand:** Trang, Kachong, 150 m., 30 May 1943, anon. 183 (BKF). **Malaya.** KEDAH: G. Inas F.R., 975 m., *FRI 9346* (KEP); Langkawi Is., G. Raya F.R., 305 m., *KEP 71194* (KEP, SING). KELANTAN: G. Stong, 762 m., *FRI 12481* (A, K, KEP, L, SING). PAHANG: Cameron Highlands, Bow Plantation, 1219 m., *SFN 32904* (K, KEP, L, LAE, SING); Ringlet Valley, *KEP 12980* (KEP); Ulu Sungei Uri, *KEP 33748* (KEP).

ECOLOGY. Colline and lower montane forests, 150–1220 m. alt. (lower altitudes in northern part of range). Fruiting in April.

LOCAL USE. The tree has hard wood that is used for making houses.

Calophyllum symingtonianum is an imperfectly known species that can be characterized by its rather small and relatively long-acuminate leaf blades borne on slender petioles, and by its terminal inflorescences bearing medium-sized, wrinkled fruits; its flowers are unknown. The specific epithet commemorates C. F. Symington, the Malayan botanist.

Calophyllum symingtonianum appears to be related to *C. dryobalanoides*. For the differences between the two species, see *C. dryobalanoides*.

The specimen cited above from Thailand is sterile; its identification is not certain.

There has been much confusion in Malaya between sterile material of *Calophyllum symingtonianum*, *C. ferrugineum* var. *oblongifolium*, *C. calaba* var. *bracteatum*, and *C. soulattri*. Fertile material of these species can be distinguished without difficulty, since there are considerable differences in inflorescences and fruits. The dissimilarities between sterile specimens are given below in TABLE 6.

TABLE 6. Comparison between sterile specimens of *C. symingtonianum*, *C. ferrugineum*, *C. bracteatum*, and *C. soulattri* in Malay

	<i>C. symingtonianum</i>	<i>C. ferrugineum</i> var. <i>oblongifolium</i>
TERMINAL BUD INDUMENTUM	Subcrustaceous	Tomentose
TWIG THICKNESS (mm.)	1-1.5	1-2
LEAF BLADE		
LENGTH (cm.)	5-9	4-10(-11)
SHAPE	Ovate to elliptic	Elliptic, rare oblong
TEXTURE	Thinly coriaceous	Coriaceous
MARGIN	Undulate	Nearly always
VENATION DENSITY (veins/5 mm.)	(6 to) 8 to 11	(13 to) 15 to
VENATION APPARENTLY TWICE AS DENSE ABOVE AS BELOW	No	Yes

Henderson and Wyatt-Smith (*loc. cit.*) included some specimens from Perak in *Calophyllum symingtonianum*. However, these specimens have more regularly elliptic leaf blades and stouter petioles; the fruits are twice as large as those of the type specimen and have a stone wall ca. 1 mm. thick. These specimens are included here in *C. fraseri*. The size of the fruits of *C. symingtonianum* as here delimited is more in line with the size of the leaf blades (cf. Henderson & Wyatt-Smith, *loc. cit.*).

KEP 71194 (Langkawi Island) was included in *Calophyllum floribundum* (= *C. tetrapterum*) by Henderson and Wyatt-Smith (*op. cit.*, p. 333). However, small buttresses are mentioned in the field notes of this specimen, the petioles are slender, and the terminal bud is like that of *C. symingtonianum*, to which species this specimen should be referred.

8. ***Calophyllum dryobalanoides*** Pierre, Fl. Forest. Cochinch. 1: pl. 106. 1885; Vesque in C. DC. Monogr. Phanerog. 8: 601. 1893; Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 319. 1910; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 274. 1943, *pro minore parte*; Phạm & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. 1960; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. 2: 302. fig. 1970. TYPE: Cochinchina [Vietnam], in montibus Dinh ad Baria Gallieae, Oct. 1866, *Pierre 83* (lectotype, P; isolectotypes, A, K, L, P, SING).

Tree 8–30 meters tall, d.b.h. to 45 cm.; trunk (?) without buttresses; outer bark red (*vide* Pierre), fissured.

Twigs slightly flattened, 1–1.3 mm. across, obscurely to strongly 4-angled, drying blackish, puberulent when young; axillary innovations lacking basal scars; internodes (0.5–)1–2 cm. long; uppermost pair of axillary buds $\pm$ pointed, ca. 1 mm. long, erect or slightly spreading; terminal bud plump to subconical, 2.3–4 mm. long, with short, grayish, subadpressed indumentum (hairs, FIGURE 9, l, m), underdeveloped internode to 1 mm. long. Petiole 0.5–1.3 cm. long, rather sharply concave above, convex below, slender, ca. 1 mm. across, glabrous at maturity; lamina ovate, 2.3–9.3 by 1.2–3.2(–4) cm., acuminate at apex, acute to cuneate at base, slightly undulate and somewhat recurved at margin or not, rather thinly coriaceous, drying olivaceous above (midrib sometimes reddish) and sabelline below, glabrous at maturity, the midrib above gradually narrowed from base, $\pm$ flat, surrounding blade raised, 0.2–0.35 mm. wide at midpoint, below narrow, slightly depressed or raised, striate, the venation on both surfaces $\pm$ apparent or not, slightly raised (impressed on upper surface), 4 to 8 veins/5 mm., angle of divergence 60–75°. Inflorescences terminal and from adjacent foliate axils, when terminal with 13 to numerous flowers (with 3-flowered branches ca. 8 mm. long), when axillary with 5 to 9 flowers, the axis 2–2.7 cm. long, puberulent, lowest internode 1–1.3 cm. long; bracts not known; pedicels in fruit 0.5–1.3 cm. long, puberulent. Flower (?) hermaphroditic; tepals 8, the outer pair suborbicular, 3–3.5 by 2.7–3.5 mm., the next pair broadly ovate, ca. 5 by 4.5 mm., the inner ones elliptic to obovate, ca. 6.5 by 3.3 mm.; stamens (?70 to) 105 to 115, the filaments to 3.5 mm. long, the anthers oblong, 0.7–1 mm. long, subretuse

at apex; ovary ca. 1.7 mm. long, the style ca. 2 mm. long, the stigma peltate, ca. 0.9 mm. across, 3-radiate. Fruit spherical to broadly ovoid, 1.8–2.3 by 1.75–2.1 cm., rounded at apex, drying vinaceous-brown, finely and rather sharply wrinkled; outer layer detaching cleanly from stone or not, 2–2.5 mm. thick, compact; stone subspherical, to 1.9 by 1.7 cm., rounded at apex, the walls 0.4–0.6 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Vietnam, Cambodia, and eastern Thailand (MAP 4).

SELECTED SPECIMENS SEEN. **Vietnam:** montibus Dinh ad Baria Gallieae, *Pierre* 3647 (K, P); in monte Lapoo, *Pierre* 88 (K); Bienhoa, Nui Chua Chan, 750 m., *Poilane* 19445 (P). **Cambodia:** Kampot, cascade Pokpok Vil, 1000 m., *Martin* 1213 (P). **Thailand:** Krat, Baw Bai, 200 m., *Kerr* 9462 (?) (K, L).

ECOLOGY. Colline forest, 200–1000 m. alt. Flowering January, February, and June (flower scented); fruiting in October.

LOCAL USES. *Calophyllum dryobalanoides* is used for small articles, the bark is used for pails, baskets, and partitions (Vietnam: *Pierre*, *loc. cit.*). Katûng yields a fragrant oil used in hair dressing (Cambodia).

Calophyllum dryobalanoides is a poorly known species recognizable by its rather short terminal bud, ovate leaves with relatively distant venation, often terminal inflorescences, and relatively large, spherical fruits. The epithet alludes to the leaves, which are rather like those of *Dryobalanops* Gaertner f. (Dipterocarpaceae).

Calophyllum balansae and *C. symingtonianum*, two additional rather poorly known species, may be related to *C. dryobalanoides*. *Calophyllum balansae* has obovate to subelliptic leaf blades with six to ten veins/5 mm., more robust (1.5–2 mm. across) twigs, more profuse inflorescences, and larger flowers. The fruits of the two species are similar, but the terminal buds of *C. balansae* are unknown. Compared with *C. dryobalanoides*, *C. symingtonianum* also has larger inflorescences, a longer (3–7 mm.) terminal bud, more densely veined ((6 to) 8 to 11 veins/5 mm.) leaves, and fruit with a thinner outer layer and stone. Flowers of *C. symingtonianum* are not yet known. The differences between the three species, especially those between *C. symingtonianum* and *C. dryobalanoides*, are not great, and further collections may change the rank of the taxa involved.

A sheet of *Pierre* 83 at Paris is designated the lectotype of *Calophyllum dryobalanoides*, since *Pierre* clearly based his description of the fruit on this specimen. *Pierre* (*loc. cit.*) also cited *Pierre* 22 and 3647, which are in flower or just past flowering; his notes are attached to the latter specimen. In vegetative characters all three specimens are similar.

9. *Calophyllum* sp.

FIGURE 8, e.

Tree 23–25 meters tall, d.b.h. ca. 50 cm.; trunk and bark unknown; latex yellow.

Twigs slightly flattened, 1.2–1.5 mm. across, rather weakly 4-angled, drying brown, sparsely puberulent when very young; axillary innovations lacking

basal scars; internodes 0.6–3 cm. long; uppermost pair of axillary buds rounded, less than 0.5 mm. long, spreading; terminal bud rather plump, 2–3 mm. long, with grayish to brown, subcrustaceous indumentum (hairs, FIGURE 11, a), underdeveloped internode to 3 mm. long. Petiole 5–9 mm. long, deeply concave above, convex below, glabrous; lamina elliptic to suboblong, 4.3–8.8 by 1.4–2.9 cm., acuminate at apex, narrowly cuneate (acute) at base, fairly closely but shallowly undulate and not recurved at margin, thinly coriaceous, drying brown or greenish brown above and buff below, glabrous or almost so even when young, the midrib above narrowing gradually from base, raised, 0.15–0.25 mm. wide at midpoint, below raised, angled toward apex, striate toward base, the venation apparent above, apparent to subobscure below, raised, (5 to) 8 to 12 veins/5 mm., angle of divergence 65–75°. Infructescences from foliate axils, with scars of ca. 7 flowers, unbranched, the axis ca. 1.2 cm. long, puberulent at least toward base, lowest internode 1.5–4 mm. long; bracts ovate, ca. 1.5 mm. long, deciduous; pedicels in fruit 0.8–1.4 cm. by 1.5 mm., glabrous. Flower unknown. Fruit subspherical, ca. 1.7 by 1.5 cm., $\pm$ apiculate, drying yellowish brown, closely but shallowly wrinkled; outer layer detaching $\pm$ cleanly from stone, ca. 1.3 mm. thick, compact; stone spherical, ca. 1.2 by 1.15 cm., rounded at apex, the walls 0.2–0.3 mm. thick, smooth, unmarked; spongy layer initially thick.

DISTRIBUTION. Sumatra (MAP 3).

SPECIMENS SEEN. **Sumatra and adjacent islands.** ATJEH: Eiland Bereas, bij Toaping, 200 m., *Koorders 10623* (?) (BO). BARAT: Painan, Loeboek Ganggo, 600 m., *bb 5467* (A, BO); Painan, Baroeng Baroeng Balantan, *SWK/I=1* coll. *Babak* (BO).

Calophyllum sp. 9 can be recognized by its slender twigs, short terminal bud, rather narrowly elliptic to suboblong leaf blades, axillary inflorescences, and relatively large, shallowly and closely wrinkled fruits with a well-developed, compact outer layer.

Although *Calophyllum* sp. 9 appears similar to *C. symingtonianum*, the latter species differs in such characters as its longer terminal bud and its terminal inflorescences.

Koorders 10623 is included here with some hesitation; it has rather distant venation (the measurements given in parentheses in the description above).

10. ***Calophyllum dongnaiense*** Pierre, Fl. Forest. Cochinch. 1: pl. 108. 1885; Vesque in C. DC. Monogr. Phanerog. 8: 601. 1893; Pitard in Lecomte, Fl. Gén. Indo-Chine 1(4): 324. 1910; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 268. 1943, *in clavis*; Phạm & Nguyễn, Cây-Cổ Miền Nam Việt-Nam, 179. 1960; Phạm, Cây-Cổ Miền Nam Việt-Nam. ed. 2. 2: 300. fig. 1970. TYPE: [Vietnam], in montibus Chiao Chang ad septentr. prov. Bien Hoa, 26 March 1877, *Pierre 3644* (holotype, P).

Tree ca. 20 meters tall, d.b.h. to 50 cm.; outer bark yellowish.

Twigs slightly flattened, (1.5–)2.5–3.5 mm. across, subalate, drying brown,

tomentose when young; axillary innovations (?always) lacking basal scars; internodes 2–7 cm. long; uppermost pair of axillary buds unknown; terminal bud bluntly conical, ca. 5 mm. long, tomentose (hairs, FIGURE 10, h–j), underdeveloped internode lacking. Petiole 1–2.2(–2.9) cm. long, concave above, convex below, glabrous when mature; lamina elliptic to suboblong, 11–24.5 by 3–6.6 cm., acute at apex and base, more or less undulate and recurved at margin, thinly coriaceous, drying sepia above and sepia to umber below, transiently subtomentose on midrib below, the midrib above $\pm$ gradually narrowed from base, raised, 0.2–0.3 mm. wide at midpoint, below raised, striate, the venation above and below apparent, raised, 6 to 10 veins/5 mm., angle of divergence 80–90°. Infructescences (?)terminal and from uppermost foliate axils, with 5 to 7 flowers, unbranched (?always), the axis 3.5–6 cm. long, $\pm$ tomentose, lowest internode 0.7–3.5 cm. long; bracts unknown; pedicels 0.9–1.7 cm. long, glabrescent. Flower unknown. Submature fruit spherical, ca. 1.5 cm. long and across, drying pruinose-brown, deeply wrinkled; outer layer detaching $\pm$ cleanly from stone, ca. 1 mm. thick, with some air spaces; stone crushed, the walls ca. 0.3 mm. thick, smooth; spongy layer unknown.

DISTRIBUTION. Vietnam (MAP 4); known only from the type.

ECOLOGY. Fruiting in March.

Calophyllum dongnaiense is a poorly known species recognizable by its subulate twigs that dry a shiny brown, rather large leaf blades with relatively distant and distinct venation, and probably terminal inflorescences. At least the twigs, terminal bud, and lower part of the inflorescence are tomentose when young. The epithet is derived from the locality of the type specimen: “entre l’affluent de Daoué et la montagne Bartroum, d’où sortirait le Son cai ou Dong nài” (Pierre, *loc. cit.*).

The type specimen of *Calophyllum dongnaiense*, Pierre 3644, consists of a single sheet. The submature fruits are broken, as is the terminal bud, and the type and position of the inflorescence are not clear. Although Poilane 32327, from Kontum, Vietnam, is similar in its twigs, tomentose indumentum, and leaves, it differs in a number of characters and hence is not included here. The lamina is more coriaceous, dries bicolored (cf. *C. thorelii* group “o”), and has more distinct venation; the petiole is flat, not channeled, above; the inflorescences are clearly axillary; the hairs have many elongated cells (in the type only the terminal few cells are much elongated; FIGURE 10, cf. i and j); and the lower surface of the lamina has tomentose indumentum (it is less conspicuous in the type).

Gagnepain (*loc. cit.*) keyed out *Calophyllum dongnaiense* because its flowers were in pairs, those of the other species being numerous and “en grappes” (larger, more complex inflorescences?). The type specimen of *C. dongnaiense* cannot be distinguished from other specimens of *Calophyllum* from the Vietnam/Cambodia region in this way.

11. *Calophyllum tomentosum* Wight, Ic. Pl. Indiae Orient. 1: pl. 110. 1839, Illus. Indian Bot. 1: 128. 1840; Walp. Repert. Bot. Syst. 1: 397. 1842;

Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 269. 1862; Bedd. Fl. Sylvat. 3: xxii. 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 274. 1874, *pro parte*; W. Ferguson, Timber Trees Ceylon, 23. 1881; Vesque, Epharmosis 2: tt. 4, 5. 1889, in C. DC. Monogr. Phanerog. 8: 552. 1893, excl. syn.; Trimen, Handb. Fl. Ceylon 1: 101. 1893; Lewis, Descr. Catal. Ceylon, 21. 1902; Worthington, Ceylon Trees, 35. 1959; Maheshwari, Bull. Bot. Survey India 2: 146. pl. 4. 1960. TYPE: Ceylon, Col. Walker s.n. (κ, herb. Wight. prop.).

C. spectabile auct., non Willd.; Choisy, Mém. Soc. Phys. Hist. Nat. Genève 12: 423. 1851, *pro parte*.

Tree 12–30 meters tall, d.b.h. to 100 cm.; trunk sometimes with small buttresses; outer bark very thick, red-brown with gray panels, to gray or yellowish, rather broadly and shallowly fissured, inner surface dull orange-straw; under bark reddish; inner bark red to red-brown; latex clear yellow, sticky. Branchlets subpendulous.

Twigs somewhat flattened, 1.7–2.5 cm. across, 4-angled, drying blackish, subpersistently brown-tomentose; axillary innovations lacking basal scars; internodes 0.6–3 cm. long; uppermost pair of axillary buds rounded, to 1(–2.5) mm. long, subspreading; terminal bud plump, 5–10 mm. long, with short, brown, tomentose indumentum (hairs, FIGURE 11, 1), underdeveloped internode to 1(–3) mm. long. Petiole 0.9–2 cm. long, flat to concave above, convex below, subpersistently tomentose, especially below; lamina ovate to (narrowly) elliptic, or subobovate, 6–12.8(–15) by 2–4.5(–6.2) cm., acute to acuminate at apex, narrowly cuneate to acute at base, undulate but not recurved at margin, coriaceous, drying sepia above and sabelline below, ± tomentose over entire surface when young, indumentum persisting on and near midrib beneath (also on midrib above), the midrib above gradually narrowed from base, flat at first, becoming slightly raised, 0.2–0.5 mm. wide at midpoint, below raised, slightly striate, the venation above ± apparent, raised, 5 to 11 (to 13) veins/5 mm., angle of divergence 45–65°. Inflorescences from foliate (rarely defoliate) axils, with 5 to numerous flowers (lower flowers flabellately arranged, or 5-flowered branches to 2 cm. long), the axis (0.7–)2–6 cm. long, ± persistently tomentose, lowest internode (0.3–)1–3 cm. long; bracts ovate, 1.5–2.5 mm. long, deciduous; pedicels 0.6–2.3 cm. long, sparsely tomentose to tomentose. Flower (?)hermaphroditic; tepals 8 (rarely 4 or 10), the two outer ovate to suborbicular, 4–6 by 4–4.5 mm., the next pair obovate to elliptic, 7–9 by 4.5–6 mm., the inner ones elliptic to obovate, 6.5–11 by 2.5–5 mm.; stamens 80 to 190, the filaments to 3.5 mm. long, the anthers oblong, 0.8–2 mm. long, rounded to retuse at apex; ovary 1.5–2 mm. long, the style to 2.5 mm. long, the stigma peltate, 0.6–0.7 mm. across, slightly radiate. Fruit ± spherical to ellipsoid, 1.8–2.3 by 1.6–2 cm., rounded at apex, drying brown, almost smooth or with broad, rounded wrinkles; outer layer adhering to stone, ca. 1 mm. thick, air spaces developing; stone spherical to ellipsoid, 1.5–1.7 by 1.3–1.5 cm., rounded at apex, the walls ca. 0.3 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Sri Lanka (MAP 5).

SELECTED SPECIMENS SEEN. **Sri Lanka:** Rakwana, 600 m., *Kostermans* 25008 (A, E, K, L, US); Matele Distr., 200 m., *Kostermans* 24495 (A, AAU, K, L, US); Sinharaja forest, Beverley, Deniyaya, 610 m., *Worthington* 2611 (A, BM); Omeragalla Kurumajola 21 miles, 240 m., *Worthington* 4029 (BM); Road Belihuloya-Balangoda, 300 m., *Kostermans* 25015 (A, E, US); Halgale forest above Belihuloya, 700 m., *Kostermans* 23620 (AAU, G, NY); upper road Rassagalla-Ratnapura, 800 m., *Kostermans* 24646 (US); Uva Prov., Badulla Distr., Talpitigala, Uma Oya, 427 m., *Balakrishnan & Jayasuriya* 848 (K, US); Kandy, *Moon* 380 (BM); 18th Mile Kandy-Amapparai Road, *Kostermans* 24848 (G); Amparawa, near Gampola, 600 m., *Kostermans* 25345 (K, L); Panilkande, 671 m., *Worthington* 6623 (L); Peradeniya, *Jayaweera* 1524 (cult.) (A). **Java. BARAT:** Bogor, cultivated (from Sri Lanka), Hort. Bog. VI C 125 (BO, NY, US).

ECOLOGY. Colline rainforest or sometimes intermediate forest, 200–800 (–1220) m. alt. Flowering March and June, reported November and April (Trimen, *loc. cit.*); fruiting March and June (fruit acidic).

MAPS 5–7. Distribution of *Calophyllum* in Sri Lanka. 5, *C. tomentosum* (solid stars), *C. walkeri* (open stars), *C. thwaitesii* (triangles), *C. bracteatum* (open circles), and *C. calaba* var. *calaba* (solid circles). 6, *C. trapezifolium* (triangles) and *C. calaba* var. *worthingtonii* (circles). 7, *C. cuneifolium* (stars), *C. vergens* (circles), and *C. moonii* (triangles).

GERMINATION AND YOUNG PLANT. The radicle breaks the stone wall to one side of the base. The seedling usually has two pairs of leaves separated by a short internode 2–4(–10) mm. long. Two of the fifteen seedlings seen had a longer (ca. 2 cm. long) internode. Subsequent internodes produced are longer, the terminal bud is functional, and the plant is erect. (*Stevens* 745, tree cultivated in Bogor.)

LOCAL USES. The wood is used in building. Oil (“kenna tel”) that is extracted from the seeds is used for skin diseases.

Calophyllum tomentosum can be recognized by its rather narrowly elliptic lamina that has steeply ascending venation (the angle of divergence from the midrib is less than 65°) and subpersistent, tomentose indumentum on the midrib below. The inflorescences are slender and axillary; the flowers usually have eight tepals, and the dried fruit is broadly wrinkled. The epithet *tomentosum* refers to the conspicuous tomentose indumentum of the plant.

Calophyllum tomentosum is not obviously close to other species of the genus.

Wight (1840, *loc. cit.*) mentioned that there were two varieties of *Calophyllum tomentosum*, one having oval leaves ending in a short, blunt acumen, and the other having long, rather narrow, lanceolate leaves tapering to a fine point at each end and very slightly undulate. The illustration given by Wight (1839, *loc. cit.*) is of this second form, which seems to be the common one. *Kostermans* 24585 may be the first form; it has leaf blades up to 6.2 cm. wide that are somewhat more sharply acuminate than usual. However, it is not possible to recognize variants of *C. tomentosum* based on leaf shape.

Calophyllum tomentosum has been reported from India, but these reports seem to be incorrect (see *C. polyanthum*); I have not seen any material of the species from that country. Conversely, the reports of *C. elatum* (= *C. polyanthum*) from Sri Lanka (see Alston, 1931, for a summary) are probably incorrect, but I am not sure to which species they refer.

12. *Calophyllum walkeri* Wight, Illus. Indian Bot. 1: 128. pl. 45. 1840; Walp. Rep. Bot. Syst. 1: 397. 1842; Choisy, Mém. Soc. Phys. Hist. Nat. Genève 12: 423. 1851; Thwaites, Enum. Pl. Zeyl. 51. 1858; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 291. 1862; Bedd. Fl. Sylvat. 3: xxii. 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 275. 1874; Vesque, Epharmosis 2: t. 31. 1889; Trimen, Handb. Fl. Ceylon 1: 104. 1893; Vesque in C. DC. Monogr. Phanerog. 8: 584. 1893; Lewis, Descr. Catal. Ceylon, 22. 1902; Sastri *et al.* Wealth India 2: 30. 1950; Worthington, Ceylon Trees, 37. 1959. TYPE: Ceylon, *Col. Walker* (κ, herb. Wight. prop.).

Tree 4–7 meters tall, d.b.h. to 40 cm.; outer bark yellowish, cracked or fissured; inner bark brownish red or light red.

Twigs not flattened to slightly (rarely strongly) so, (1.5–)2–4 mm. across, ± 4- (rarely 2-)angled, drying dark brown to blackish, glabrous or sparsely puberulent when young; axillary innovations lacking basal scars; internodes

0.3–2(–3) cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, spreading; terminal bud plump, (2.5–)3.5–6 mm. long, shortly brownish tomentose (hairs, FIGURE 11, m–o), underdeveloped internode to 2 mm. long. Petiole 3–7 mm. long, flat above, convex below, glabrescent; lamina obovate to cuneiform or trapeziform (rarely suborbicular or elliptic), (1.7–)2.1–4.6 by 1.1–4.3 cm., rounded to retuse (obtuse) at apex, cuneate to acute (rarely rounded) at base, slightly undulate or not and not recurved at margin, very coriaceous, drying olivaceous-honey above and sabelline to sepia below, subpersistently puberulent on midrib below or not, the midrib above gradually narrowed from base, $\pm$ flat (rarely depressed at base), 0.25–0.5 mm. wide at midpoint, below raised, rounded to striate, the venation subobscure above, subobscure to subapparent below, 5 to 14 (to 17) veins/5 mm., angle of divergence 60–70°. Inflorescences from foliate axils, with 11 to 19 flowers, unbranched (with 3-flowered branches to 1 cm. long), the axis 3–7.2 cm. long, $\pm$ puberulent at least when young, lowest internode 0.3–0.8(–2) cm. long; bracts obovate, sometimes foliaceous and to 2 cm. long, persistent; pedicels 1–2.5 cm. long, glabrous (rarely puberulent), (2–)2.5–5 mm. thick in fruit. Flower (?)hermaphroditic; tepals 10 to 15, the two outer usually broadly ovate to orbicular, 5–7 by 4–6 mm. (sometimes broadly triangular, ca. 1.5 by 2.5 mm.), the inner ones obovate to oblong, 6–8(–11) by 2.5–6.5 mm.; stamens 130 to 190, the filaments to 3.5 mm. long, the anthers oblong, ca. 1.3 mm. long, $\pm$ retuse at apex; ovary 1.5–2 mm. long, the style 2–3 mm. long, the stigma peltate, 0.8–1 mm. across, 3-radiate. Fruit subspherical, 1.6–2.7 by 1.6–2.4 cm., subobtuse to rounded at apex, drying grayish brown, usually with broad, rounded wrinkles; outer layer detaching cleanly from stone or not, 1.2–2.5 mm. thick, compact or with air spaces developing; stone subspherical to ellipsoid, 1.6–2.2 by 1.4–1.7 cm., rounded to minutely pointed at apex, the walls 0.1–0.5 mm. thick, smooth, unmarked or obscurely 4-radiate; spongy layer thin.

DISTRIBUTION. Sri Lanka (MAP 5).

SELECTED SPECIMENS SEEN. **Sri Lanka:** Horton Plains, beside road to World's End, 2400 m., *Cramer & Tirvengadam 3951* (US); road from Horton Plains to Ohiya, *Nowicke & Jayasuriya 270* (F, K, US); Newera Ellia, 1829 m., *CP 1170, pro parte* (BM, BO, FI, G, GH, P, US, W); Corbet's Gap, 1219 m., *Worthington 3604* (BM); Madulkele, 1433 m., *Worthington 1957* (BM); Elk Plains near Ambawela, *Kostermans s.n.*, May 1969 (A, AAU, E); Ramboda area, above Protoaft Estate, 2000 m., *Kostermans 25100* (A, G, K, US).

ECOLOGY. Sometimes dwarfed upper montane forests and thickets, (1220–) 1600–2400 m. alt. Flowering February and May (perhaps only once every few years—Wight, *loc. cit.*); fruiting June and September (fruit dirty green, acid in taste).

Terminal galls ca. 1 cm. across and bilabiate at the apex occur at the ends of the twigs (*Worthington 1957, 3604*; neither specimen quite typical, see below).

LOCAL USES. The wood is used in construction and joinery; the oil from the seed is used for lighting.

Calophyllum walkeri can be recognized by its slightly flattened twigs that are almost square in cross section and have short internodes. The lamina is very coriaceous, usually rounded to retuse at the apex, and it has a midrib that is more or less flat on the upper surface and rounded or striate on the lower. The inflorescence has several flowers and usually a rather short lowermost internode; the flowers have at least ten tepals. The subspherical, broadly wrinkled fruit has a fairly thick outer layer and a thin-walled stone. The specific epithet commemorates Colonel G. W. Walker, who collected the type specimen.

There is some infraspecific variation in *Calophyllum walkeri*. The leaves of a few specimens are acute at the apex (e.g., *Worthington* 3604, 5474, 5484 (from Corbet's Gap), 1957 (from Madulkele); *Moon s.n.*); such specimens may be saplings or are perhaps wrongly identified. The bracts may be foliaceous and persistent (e.g., *Kostermans* 25087, 25100, where they are just like leaves), but they are normally smaller and deciduous. Wight, in his original description of *C. walkeri*, thought that it could be characterized by the very small outer pair of tepals; these outer tepals may also be more normal in size.

The circumscription of *Calophyllum walkeri* and the other small-leaved montane and submontane taxa in Sri Lanka and southern India has been quite troublesome, partly because some of the important early collections contain two taxa under the same number (see especially *C. trapezifolium* and *C. cuneifolium*). However, the taxa recognized may be distinguished by a number of characters (see TABLE 7). Although it is easy to be misled by lamina shape and size since the length : breadth ratio for all taxa involved decreases rather regularly with altitude, the species themselves having overlapping altitudinal ranges, careful examination of the terminal bud, twig, and midrib usually allow even sterile material to be identified. Differences in hair type within the complex are minor (FIGURES 11, 12), Vesque (1889, 1893) found latex canals in the tissue below the vascular bundle in *C. cuneifolium*, *C. trapezifolium*, *C. thwaitesii*, and *C. walkeri*. This is an uncommon character in the genus.

13. *Calophyllum thwaitesii* Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 260. 1862, *pro parte* (α); Thwaites, Enum. Pl. Zeyl. 407. 1864, *pro parte*; Bedd. Fl. Sylvat. 3: xxii. 1871, *pro parte*; T. Anderson in Hooker f. Fl. Brit. India 1: 275. 1874, *pro parte*; Trimen, Handb. Fl. Ceylon 1: 102. 1893, *pro parte*; Vesque in C. DC. Monogr. Phanerog. 8: 556. 1893, *pro parte*. TYPE: Ceylon [Sri Lanka], Ambagamowa District, CP 3403, *pro parte* (holotype, P; isotypes, BM, BO, GH, K, NY, P, W).

C. decipiens auct., non Wight; Thwaites, Enum. Pl. Zeyl. 51. 1858, *pro parte* (α).

Tree; trunk and bark unknown.

Twigs slightly flattened, 1.7–3.5 mm. across, $\pm$ 4-angled, drying brown, puberulent when young; axillary innovations lacking basal scars; internodes

(0.5-)1-4 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, suberect; terminal bud plump, 3-3.5 mm. long, with brown to grayish, subtomentose indumentum (hairs similar to those in FIGURE 12, e, g), underdeveloped internode not apparent. Petiole 2-6 mm. long, broadly concave above, convex below, puberulent below when young; lamina broadly obovate to elliptic or subtrapeziform, 3.6-8.6 by 3.1-6 cm., bluntly pointed to rounded or slightly retuse at apex, cuneate to rounded or shallowly cordate at base, not undulate but narrowly recurved at margin, coriaceous, drying chestnut to olivaceous above and umber to olivaceous below, often $\pm$ nitid, brown-puberulent on midrib below when young, the midrib above narrowed rather gradually from base, $\pm$ flat to raised, 0.2-0.5 mm. across at midpoint, below slightly raised, $\pm$ striate (angled toward apex), the venation above apparent, raised, below subobscure, $\pm$ flat (latex canals sometimes impressed above, less impressed below), (2 or) 3 to 6 (to 8) veins/5 mm., angle of divergence 50-60°. Inflorescences from foliate axils along stem, with 5 to 7 flowers, unbranched, the axis 3.2-13 cm. long, glabrous, lowest internode (1.2-)2-6 cm. long; bracts ovate to subelliptic, to 5 mm. long, subpersistent; pedicels 1.4-3.5 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8, the outer pair suborbicular, ca. 5 mm. long and across, the inner ones elliptic to obovate, to 7 by 3.5 mm.; stamens ca. 100, the filaments to 3 mm. long, the anthers suboblong, 0.7-1 mm. long, retuse at apex; ovary ca. 1.3 mm. long, the style unknown, the stigma peltate, ca. 1 mm. across. Fruit subspherical, ca. 2 cm. long and across, rounded at apex, drying vinaceous-brown, sharply wrinkled; outer layer detaching cleanly from stone, ca. 2 mm. thick, compact; stone subspherical, ca. 1.4 by 1.6 cm., rounded at apex, the walls ca. 0.25 mm. thick, smooth, unmarked; spongy layer at first thick.

DISTRIBUTION. Sri Lanka (MAP 5).

ADDITIONAL SPECIMENS SEEN. **Sri Lanka:** Horton Plains, 2100 m., *Hladik 1108* (A (frag.), P); Adam's Peak, *Moon s.n.* (FI); sine loco, *CP 1170, pro parte* (W).

ECOLOGY. Montane rain forest.

Calophyllum thwaitesii is a poorly known species that can be recognized by its short, plump, terminal bud; more or less flat veins and slightly raised midrib on the lower surface of the dried lamina; more or less impressed latex canals; and axillary inflorescences with the basal internode 1-6 cm. long. The epithet commemorates G. H. K. Thwaites's work on the plants of Sri Lanka; it was under his auspices that the CP (Ceylon Plants) series was collected.

Calophyllum thwaitesii is probably related to the group of species centered on *C. walkeri*; these species are compared in TABLE 7. *Calophyllum cuneifolium* has plump terminal buds and strongly four-angled twigs like those of *C. thwaitesii*, but its leaf blades are usually narrower and its midrib and venation are more prominent. *Bourdillon 179* (*C. austroindicum*, from India) has leaf blades shaped like those of *C. thwaitesii*, but it, too, differs in venation and midrib prominence. *Calophyllum austroindicum* also has larger, ovoid, beaked fruits.

TABLE 7. Characters distinguishing *Calophyllum walkeri* from related species

	<i>C. austroindicum</i>	<i>C. cuneifolium</i>	<i>C. trapezifolium</i>
TWIG SHAPE	Slightly to strongly flattened, ± strongly 4-angled	Slightly flattened, strongly 4-angled	Strongly flattened, 2- to 6-angled
TERMINAL INTERNODE OF INNOVATION	Often ca. 1/2 length of others	Often ca. 1/2 length of others	Ca. same length as others
TERMINAL BUD			
SHAPE	Plump	Plump	Plump to narrowly conical
LENGTH (mm.)	2.8-3.5	1.5-3.5	(2.5-)4-7(-10)
UPPERMOST PAIR OF AXIL- LARY BUDS	Inconspicuous, ± erect	Inconspicuous, ± spreading	Usually conspicuous, erect
LEAF BLADE			
APEX	Subacuminate to retuse	(Rounded to) retuse	Acute to cuneate (rounded)
LENGTH : WIDTH RATIO	1.5-2.8	1.45-2.3	(1-)1.75-2.6
MIDRIB ON LOWER SURFACE	Raised, rounded	Raised, rounded	Strongly raised, often angled
VENATION			
DENSITY (veins/5 mm.)	5 to 10 (to 15)	3 to 7 (to 9)	10 to 19
PROMINENCE	Apparent	Apparent	At most subapparent

ANGLE OF DIVERGENCE	50–60(–65°)	(25–)35–40°	(45–)55–70°
INFLORESCENCE			
NUMBER OF FLOWERS	7 to 17	9 to 17	(3 to) 5 to 9
LOWEST INTERNODE LENGTH (cm.)	(0.4–)1–3	0.5–2.3	0.8–3.7
PEDICEL			
LENGTH (cm.)	(0.3–)0.6–1.8	0.4–2.3	0.7–2.6(–3)
THICKNESS IN FRUIT (mm.)	Ca. 2	Ca. 2	1.5–2
FLOWER			
TEPAL NUMBER	8 (to 10)	8 to 11	8 to 11
FRUIT			
SHAPE	Ovoid	Subspherical	Ovoid (subspherical)
APEX	Beaked	At most shortly obtuse	Obtuse (rounded)
SIZE (cm.)	3–3.3 × 1.7–2.3	1.8–2.3 × 1.6–2.2	1.8–2 × 1.7–1.9
OUTER LAYER THICKNESS (mm.)	0.8–2	1.5–2.8	0.5–1
STONE THICKNESS (mm.)	0.5–1.2	Ca. 0.4	0.4–0.5

Although *Calophyllum thwaitesii* has been confused with *C. apetalum*, from India, the two species are not at all closely related. In *C. thwaitesii* the lamina is usually broader and with less dense, less apparent venation, the petiole more shallowly channeled, the anthers less than 1 mm. long, and the fruit much bigger and with a much thicker (ca. 2 mm., compared to ca. 0.5 mm.) outer layer. *Calophyllum vergens* (*C. thwaitesii* "β" of Planchon & Triana) differs most obviously from *C. thwaitesii* sensu stricto in its smaller leaf blades that are less coriaceous, cordate at the base, and with somewhat denser, more clearly raised venation, especially on the lower surface. The twigs are also somewhat thinner and are six- or sometimes two-angled.

Of the four collections of this species, *Hladik 1108* (sterile, collected from a small tree) has latex canals that are clearly impressed on the upper surface of the lamina, less so below; *CP 3403* (with flowers) has latex canals that are very slightly impressed on both surfaces; and *Moon s.n.* (sterile) is intermediate in this respect. In *Moon s.n.* the terminal pair of leaves seems to remain erect and enclose the terminal bud. The sheet of *CP 1170* at Vienna (with fruits, clearly belonging) has leaves like those of *CP 3403*, albeit a little smaller.

14. ***Calophyllum trapezifolium*** Thwaites, Enum. Pl. Zeyl. 51. 1858 ("trapezifolium"); Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 282. 1862; Bedd. Fl. Sylvat. 3: xxii. 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 275. 1874; Vesque, Epharmosis 2: t. 15. 1889; Trimen, Handb. Fl. Ceylon 1: 103. 1893; Vesque in C. DC. Monogr. Phanerog. 8: 563. 1893; Alston in Trimen, Handb. Fl. Ceylon (Suppl.) 6: 22. 1931; Worthington, Ceylon Trees, 36. 1959; Maheshwari, Bull. Bot. Survey India 2: 144. 1960, *pro parte*. TYPE: Ceylon [Sri Lanka], Hunasgiri District, 4000–5000 feet [1219–1524 m.], *CP 2446* (isotypes, BM, BO, FI, G, GH, K, NY, P, US, W).

C. zeylanicum Kosterm. Ceylon Jour. Sci. Bio. Sci. 12: 70. 1976. TYPE: Ceylon, Ratnapura Distr., Carney-Adam's Peak road, 200 m., 9 July 1973, *Subramanian s.n.* (holotype, L; isotypes, AAU, K).

C. cuneifolium Thwaites, Enum. Pl. Zeyl. 51. 1858, *pro parte*; Vesque, Epharmosis 2: t. 10. 1889, *pro parte*, in C. DC. Monogr. Phanerog. 8: 557. 1893, *pro parte*.

FIGURE 12. Hairs (from terminal bud, unless otherwise mentioned). a, b, *Calophyllum austroindicum* (DD 20505): a, from peduncle. c, *C. apetalum* (Fernandes 977). d, *C. cuneifolium* (Kostermans 25056), hairs to 360 μm. long, terminal cells with thin walls. e, g, *C. vergens* (Kostermans 24469): e, to 240 μm. long. f, h–q, *C. calaba*. f, var. *bracteatum*, variant (Hasskarl 416). h, i, o, var. *bracteatum* (Kerr 17291). j, var. *bracteatum* variant (Lam 113), many hairs also like g. k, var. *worthingtonii* (Waas 1662). l, var. *bracteatum* (Stone & Kam 11712); m, n, *bracteatum* variant: m, Wirawan 463; n, Kostermans 6307. p, var. *calaba* (Kostermans 24406). q, var. *australianum* (Dallachy s.n), base and apex of hair ca. 360 μm. long. Scale = 60 μm.

Tree 5–20 meters tall, d.b.h. to 80 cm.; trunk without buttresses; outer bark old gold to light brown, deeply to finely fissured (with knobby vertical lines); inner bark deep red to reddish; latex clear yellow to white.

Twigs strongly flattened, (1–)1.5–3 mm. across, 2- to 6-angled, drying dark brown to blackish, puberulent when young; axillary innovations lacking basal scars; internodes 0.5–6(–8) cm. long; uppermost pair of axillary buds $\pm$ pointed, 1–5 mm. long, erect, conspicuous; terminal bud plump to narrowly conical, (2.5–)4–7(–10) mm. long, with grayish brown, puberulo-tomentose indumentum (hairs, FIGURE 11, p, q), underdeveloped internode to 3(–5) mm. long. Petiole 3.5–7 mm. long, $\pm$ concave above, convex below, persistently puberulent below or not; lamina trapeziform or rhombiform to elliptic, ovate, obovate (rarely suborbicular), (1.8–)2.5–7(–10) by 0.9–4.3(–6) cm., acute to cuneate (rarely retuse) at apex, acute to cuneate (rarely rounded) at base, distantly undulate but slightly recurved at margin, coriaceous, drying olivaceous to greenish olivaceous-buff above and sabelline to olivaceous below, $\pm$ persistently and subdensely puberulent on midrib below, the midrib above gradually to abruptly narrowed from base, flat to slightly raised (depressed at first), 0.3–0.6 mm. wide at midpoint, below raised, striate to angled, the venation prominulous to obscure above and below, 10 to 19 veins/5 mm., angle of divergence (45–)55–70°. Inflorescences from foliate axils near ends of twigs (rarely terminal), unbranched, with (3 to) 5 to 9 flowers (flabellately arranged), the axis 1.4–7 cm. long, $\pm$ puberulent toward base, lowest internode 0.8–3.7 cm. long; bracts ovate, 2.5–4 mm. long, deciduous; pedicels 0.7–2.6(–3?) cm. long, glabrous. Flower (?) hermaphroditic; tepals 8 to 11, the outer pair ovate, 5–6 by 3.5–4.5 mm., the inner ones $\pm$ obovate, 7–9.5 by 2.5–5.5 mm.; stamens (90 to) 140 to 325, the filaments to 5 mm. long, the anthers suboblong, 0.7–1(–1.7) mm. long, subrounded to retuse at apex; ovary ca. 2 mm. long, the style ca. 2 mm. long, the stigma peltate, ca. 0.9 mm. across, 3-radiate. Fruit broadly ovoid to subspherical, 1.8–2 by 1.7–1.9 cm., often obtuse (rounded) at apex, drying brown, sharply and closely wrinkled; outer layer detaching cleanly from stone or not, 0.5–1 mm. thick, compact or with small air spaces developing; stone subspherical, 1.3–1.6 by 1.2–1.5 cm., $\pm$ rounded at apex, the walls 0.4–0.5 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Sri Lanka (MAP 6).

SELECTED SPECIMENS SEEN (for explanation of letters, see text). **Sri Lanka:** below Hunasgyriya, direction Mahangane, 800 m., *Kostermans* 24414 (z) (A, K); Newera Ellia, CP 1170, *pro parte* (GH, NY, K, P, US); Madulkele, Knuckles, 900 m., *Kostermans* 25074 (z) (A, AAU, E, K, US), 25083 (A, AAU, E, K, US); Warricyalla, Kandy, Hantam Range, 1067 m., *Worthington* 2505 (A, BM); Kandy Distr., Dotulugala, 1463 m., *Waas* 1041 (NY); E. of Madugoda, 778 m., *Jayasuriya* 2120 (?) (L); Dolosbage, 838 m., *Worthington* 1877 (BM); Jaffra, below 305 m., *de Silva* 59 (NY); Aigburth Estate, Rakwana, 1067 m., *Worthington* 2159 (BM); Rasgalle above Balangoda, 700 m., *Kostermans* 23599 (A, K, L, US); Maskeliya Distr., Moray Estate, Fishing Hut, 1600 m., *Kostermans* 24138 (A, AAU, E, US); Adam's Peak descent, 1524 m., *Balakrishnan* 282 (US); Sinharaja, N. Ensalwatta, Matara Distr., *Sohmer & Waas* 10451 (GH); N. of Pinnawala,

Adam's Peak Sanctuary, 1600 m., *Maxwell & Jayasuriya* 915 (cf. z) (MO, NY, US); Sabaragamuwa Prov., Ratnapura Distr., Manikkawatta Forest, 1300 m., *Waas* 1759 (GH), Hopewell Forest, 900 m., *Waas* 1597 (GH); Double Cutting road, Laxapane to Maskaliya, 900 m., *Kostermans* 24074 (US); near Gartmore Estate, *de Silva* 32 (C, NY); Madamahanevura, 914–1219 m., *CP* 2917, *pro parte* (z) (BO, GH, MEL, P, W); Matale Distr., Matale Road N. of Nuala, Mile 35–36, *Meijer with Balasubramanian* 677 (K); Corbet's Gap, *Meijer with Dassanayake* 656 (US).

ECOLOGY. Locally common, lower montane forests, 600–1600 m. alt., (collected below 305 m.). Flowering February to June; fruiting June and July (fruit dirty green) (FIGURE 5, a, b).

Spherical galls ca. 1.5 cm. across are quite common (e.g., *CP* 242, 2447, *Kostermans* 23599, 24074). They terminate the stem and are bilabiate at the apex.

Calophyllum trapezifolium is a variable species that can nevertheless be fairly readily recognized by its strongly flattened twigs, rather narrow terminal bud usually with an erect and conspicuous pair of buds in the uppermost leaf axils, few-flowered inflorescence with a relatively long basal internode, and often ovoid, pointed fruits with an outer layer not more than 1 mm. thick. The leaves, although very variable in shape and size, are often acute to cuneate at the apex, and the midrib tends to be depressed toward the base on the upper surface and rather prominent and angled on the lower. The epithet *trapezifolium* comes from the trapeziform shape of the leaf blades.

Calophyllum trapezifolium is related to *C. walkeri* and other montane taxa; the characters distinguishing them are given in TABLE 7.

There is a group of specimens ("z" in the list above) that are barely distinguishable from *Calophyllum cuneifolium*; *C. zeylanicum* is based on specimens of this type. The terminal bud is short (2.5–4.5 mm.); the lamina is rather small, elliptic or sometimes obovate in shape, and more or less attenuate at the base; and there are 11 to 14 (rarely 7 to 17) veins/5 mm. diverging from the midrib at 45–55°. The anthers are relatively long for *C. trapezifolium* (1.2–1.7 cm), although the flowers themselves are rather small. *Calophyllum zeylanicum* was compared with *C. cuneifolium* (*Kostermans, loc. cit.*), and the characters by which it was distinguished from that species either tend toward (angle of divergence of venation, lamina shape) or are characteristic of (fruit shape) *C. trapezifolium*. In addition, *C. zeylanicum* has the strongly flattened twigs, the rather well-developed and erect pair of buds in the uppermost leaf axils, the terminal galls, the few-flowered inflorescence with a relatively long basal internode, and the fruits with a thin outer layer characteristic of *C. trapezifolium*. It is possible that further collections will show *C. zeylanicum* to be a taxon discrete enough to be recognized formally (probably subordinate to *C. trapezifolium*), but in view of the variation within the species, such recognition would be premature.

Balakrishnan 282 has the fruits, pedicels, twigs, and terminal buds of *Calophyllum trapezifolium*. Although its suborbicular leaf blades are superficially like those of *C. walkeri*, the midrib is strongly depressed toward the base on the upper surface of the blade and is angled below—characters

of *C. trapezifolium*. *Kostermans 25083* is also superficially like *C. walkeri* in lamina shape, although there is considerable variation in this on a single shoot, but in all other characters (apart, perhaps, from the rounded apex of the fruit) it is like *C. trapezifolium*. *Kostermans 25083* grows in the same area as *Kostermans 25074*, a paratype of *C. zeylanicum*. *Kostermans 24515* and *Jayasuriya 2120* are odd specimens; neither has obvious buds in the uppermost pair of leaf axils. In appearance the former specimen is somewhat similar to *C. calaba*, and the latter to *C. cuneifolium*.

Calophyllum trapezifolium has been distributed with other species under one number several times in the CP series. CP 2917, the type number of *C. cuneifolium* (q. v.), is mixed with *C. trapezifolium* "z"; CP 242, *C. calaba*, is mixed with the typical form of *C. trapezifolium*; and CP 1170, *C. walkeri*, is mixed with a specimen of *C. trapezifolium* that in lamina shape approaches *C. walkeri*.

15. ***Calophyllum cuneifolium*** Thwaites, Enum. Pl. Zeyl. 51. 1858, *pro parte*, *ibid.* 407. 1864; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 289. 1862; Bedd. Fl. Sylvat. 3: 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 275. 1874; Vesque, Epharmosis 2: t. 10. 1889, *pro parte*; Trimen, Handb. Fl. Ceylon 1: 103. 1893; Vesque in C. DC. Monogr. Phanerog. 8: 557. 1893, *pro minore parte*; Alston in Trimen, Handb. Fl. Ceylon (Suppl.) 6: 22. 1931; Worthington, Ceylon Trees, 30. 1959. TYPE: Ceylon [Sri Lanka], Madamahanewera, 3000–4000 feet [914–1219 m.], CP 2917, *pro parte* (isotypes, BM, FI, G, K, P, W).

Tree 18–35 meters tall, d.b.h. to 90 cm.; trunk without buttresses; outer bark yellowish, hard, deeply fissured, peeling in strips 3–5 cm. by ca. 5 mm. thick; inner bark reddish, inside finely ridged longitudinally.

Twigs not flattened, 1.5–2.8 mm. across, strongly 4-angled, drying dark brown, glabrous or sparsely puberulent when young; axillary innovations lacking basal scars; internodes 0.3–2.2 cm. long, terminal internode of innovation frequently $\frac{1}{2}$ (or less) length of others; uppermost pair of axillary buds rounded, less than 1 mm. long, spreading; terminal bud plump, 1.5–3.5 mm. long, with grayish brown, short, tomentose indumentum (hairs, FIGURE 12, d), underdeveloped internode absent. Petiole 0.4–1.2 cm. long, concave to flat above, convex below, glabrous; lamina cuneiform to obovate, (1.75–)2.8–5(–7.5) by (1.2–)1.6–2.5(–3.8) cm., retuse to rounded (rarely obtuse) at apex, narrowly cuneate (slightly rounded) at base, distantly undulate and slightly recurved at margin, coriaceous, drying hazel to greenish olivaceous above and sabelline to hazel below, soon glabrescent or sparsely subpersistently puberulent on midrib below, the midrib above gradually (rarely subabruptly) narrowed from base, level or slightly raised, 0.1–0.25 mm. wide at midpoint, below slightly raised, rounded, the venation $\pm$ apparent above and below, raised, 3 to 7 (to 9) veins/5 mm., angle of divergence (25–)35–40°. Inflorescences from foliate axils along twigs (rarely terminal), with 9 to 17 flowers, unbranched, the axis 3.2–9 cm. long, strongly angled, rather sparsely puberulotomentose toward base, lowest internode 0.5–2.3 cm. long; bracts ovate to

elliptic, 0.2–3 cm. long, subsistent when foliaceous; pedicels 0.4–2.3 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 to 11, sometimes glabrous, the outer pair broadly ovate, ca. 6 by 5 mm., the inner ones elliptic to obovate (rarely outer two ovate to suborbicular), 6–8.5 mm. by 4–5(–6) mm.; stamens 160 to 220, the filaments 2.5–4 mm. long, the anthers suboblong, 0.9–1.6 mm. long, rounded to retuse at apex; ovary 2–2.5 mm. long, the style ca. 2 mm. long, the stigma peltate, 0.8–1 mm. across, 2- to 4-radiate. Fruit subspherical, 1.8–2.3 by 1.6–2.2 cm., bluntly pointed to rounded at apex, drying brownish, rather strongly and closely wrinkled; outer layer adhering to stone, 1.5–2.8 mm. thick, compact; stone subspherical, 1.4–1.6 by 1.35–1.5 cm., rounded at apex, the walls ca. 0.4 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Sri Lanka (MAP 7).

SELECTED SPECIMENS SEEN. **Sri Lanka:** Kandy Distr., Knuckles, Madulkele, 800 m., *Kostermans* 25056 (A, AAU, E, K, L, US); Tonacombe Namanakulla, 1435 m., *Worthington* 5464 (BM); Corbet's Gap, Rangalla, 1158 m., *Worthington* 5047 (BM); Badulla Distr., Madawelagama, at 6th Mile Post, Pine Nursery, 610 m., *Balakrishnan & Jayasuriya* 819 (K, NY, US), Passera-Badulla, Talpitiyakala, 1000 m., *Kostermans* 24437 (A).

ECOLOGY. Locally common, montane forest, sometimes in exposed, wind-swept conditions, 600–1800 m. alt. Flowering June and August; fruiting in June (fruit green).

Calophyllum cuneifolium can be recognized by its short terminal bud; strongly 4-angled twigs; obovate to cuneiform leaf blades with at most slightly raised midribs and clear, distant, steeply ascending venation; many-flowered inflorescences; and spherical fruits with a well-developed outer layer. The specific epithet alludes to the cuneiform shape of the leaf blades characteristic of this species.

Calophyllum cuneifolium is apparently related to *C. walkeri*. For the differences between these and other small-leaved species growing in the mountains of Sri Lanka, see TABLE 7.

Worthington 5413 has a persistently bracteate, terminal inflorescence; *Worthington* 5464, from the same area, has axillary inflorescences with deciduous bracts. The bases of the leaf blades in both specimens are more or less rounded, while those of other specimens, including *Balakrishnan & Jayasuriya* 819 (also with persistent bracts), are narrowly cuneate.

CP 2917, the number of the type collection of *Calophyllum cuneifolium*, seems to be a mixed collection. The original description of *C. cuneifolium* reads "foliis parvis, cuneate spathulatis, obtuse brevi-acuminatis vel retusis, coriaceis." Some shoots of CP 2917 have elliptic leaf blades that are more or less acute at the apex; others have cuneate-spathulate leaf blades that are retuse (cf. description above; the two types of leaves are illustrated in Vesque, 1889, *loc. cit.*). The venation density of the elliptic leaf blades is higher, and specimens with such leaves also have internodes all of similar length, a narrow terminal bud, and erect buds in the uppermost leaf axils.

Duplicates of *CP 2917* that have elliptic leaf blades are referred to *C. trapezifolium*.

16. ***Calophyllum austroindicum*** Kosterm. ex P. F. Stevens, sp. nov.

FIGURE 8, g-i.

C. trapezifolium auct., non Thwaites; Bourdillon, Forest Trees Travancore, 28. 1908; Brandis, Indian Trees, 54. 1907; Rama Rao, Fl. Pl. Travancore, 32. 1914; Gamble, Fl. Pres. Madras 1: 76. 1915; Maheshwari, Bull. Bot. Survey India 2: 144. 1960, *pro parte*; Somasundaran, Handb. Trees Shrubs So. States, 54. 1963.

A speciebus aliis *Calophylli* in gemma terminali parva (2.8–3.5 mm. longa), internodiis innovationis plus minusve eadem longitudine (vel internodio terminali breviori quam aliis), et fructu rostrato parietibus putaminis 0.5–1.2 mm. crassis, differt.

Tree (10–)25–30 meters tall, d.b.h. to 100 cm.; probably lacking buttresses; outer bark pale brown to yellowish; inner bark reddish; latex clear.

Twigs slightly to strongly flattened, 1.3–2(–3) mm. across, $\pm$ 4-angled to subulate, drying dark brown, glabrous (rarely transiently brown-tomentose); axillary innovations lacking basal scars; internodes 0.5–3(–3.5) cm. long (terminal internode notably shorter than others); uppermost pair of axillary buds rounded, ca. 1 mm. long, erect; terminal bud plump, 2.8–3.5 mm. long, with brownish gray, subtomentose to tomentose indumentum (hairs, FIGURE 12, a, b), underdeveloped internode absent. Petiole (3–)5–8 mm. long, shallowly concave above, convex below, almost glabrous; lamina elliptic or trapeziform to obovate, 2.9–7 by 1.2–3.5 cm., subacuminate to rounded (rarely retuse) at apex, narrowly cuneate to acute (rarely rounded) at base, slightly undulate and barely recurved at margin, coriaceous, drying olivaceous, sepia, citrine, or brown-vinaceous above and olivaceous, sepia, or olivaceous-citrine below, more or less glabrous at maturity, the midrib above narrowing gradually from base, flat to slightly elevated, center sulcate at least near base, 0.15–0.35 mm. wide at midpoint, below raised, rounded to striate, the venation subobscure to subapparent on both surfaces, raised (below rarely impressed), 5 to 10 (to 15) veins/5 mm., angle of divergence 40–65°. Inflorescences axillary, with 7 to 17 flowers (3-flowered branches to 1.5 cm. long, or lower flowers flabellately arranged), the axis 1.3–7.7 cm. long, glabrous or sparsely farinose-puberulent toward base, lowest internode (0.4–)1–4 cm. long; bracts unknown; pedicels (0.3–)0.6–1.8 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 to 10, the outer pair suborbicular, 3.7–5 by 3.5–6 mm., the next pair broadly elliptic, ca. 6 by 4 mm., the inner ones elliptic or oblong to obovate, 4.5–8 by 1.7–4 mm.; stamens 100 to 125, the filaments to 2.5 mm. long, the anthers subelliptic to oblong, 0.7–1.3 mm. long, retuse (rarely subacute) at apices; ovary 1.5–1.8 mm. long, the style 1.5–2 mm. long, the stigma peltate, 0.7–1 mm. across, 3-radiate. Fruit ovoid, 3–3.3 by 1.7–2.3 cm., rostrate at apex, drying dark brown-vinaceous, more or less corrugated; outer layer adhering to stone, 0.7–2 mm. thick, compact; stone ellipsoid, 2.4–2.7 by 1.5–1.6 cm., obtuse at apex, the walls 0.5–1.2 mm. thick, smooth, not marked; spongy layer probably becoming thin.

TYPE: India, S. Tamilnadu, Turunneveli Distr., E. slopes Western Ghats, Walaigur cardamon estate, 1100 m., 16 July 1976, *Kostermans* 26264 (holotype, L).

DISTRIBUTION. Southwestern India (MAP 8).

ADDITIONAL SPECIMENS SEEN. **India.** MYSORE: Narimale, Ghat Forests, Coorg, *Tireman s.n.* (Dehra Dun herb. no. 20505) (A). KERALA: Travancore, Udambansholoy, 1524 m., *Meebold* 892/13085 (CAL); Quilon, *Bourdillon* 179 (CAL); road Thakadi to Munar, 1500 m., *Kostermans* 26139 (L). TAMILNADU: Silent Valley, Nilgiris, 610 m., *Beddome* 13 (K), 423 (BM).

ECOLOGY. Large tree, montane ghat forests, 610–1525 m. alt. Flowering March (November and December—*Bourdillon, loc. cit.*); submature fruits June and December (ripe fruit purple—*Bourdillon, loc. cit.*).

LOCAL USE. The tree yields good timber.

Calophyllum austroindicum can be recognized by its small terminal buds; its rather short internodes all approximately the same length (or the terminal one smaller than the others); its fairly small leaves with often rather distant venation; and its beaked fruit with an obtusely pointed, somewhat thick-walled stone. The epithet *austroindicum* was coined because plants referable to this species have been found only in southern India.

Calophyllum austroindicum is perhaps related to the *C. walkeri* complex, from Sri Lanka, but it differs from all members of the complex in its beaked fruits that have a rather thick-walled stone (see also TABLE 7).

Calophyllum austroindicum seems to be a rather variable species. *Bourdillon* 179 has anthers with acute apices and leaves superficially like those of *C. thwaitesii*. *Kostermans* 26139 has leaves that dry olivaceous on the upper surface and young twigs with tomentose indumentum; *Kostermans* 26264 has leaves that dry brown-vinaceous on the upper surface, and even the very young twigs are glabrous or almost so. However, the specimens have similar fruits, which are like those of *Meebold* 892/13085, the only other fruiting specimen seen. *Bourdillon (loc. cit.)* mentioned that the fruits were purple, which is rather unusual; the field notes of the two specimens collected by *Kostermans* mention green fruits, although in neither case is the fruit ripe.

17. *Calophyllum vergens* P. F. Stevens, sp. nov.

FIGURE 8, f.

C. thwaitesii Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 260. 1862, *pro parte* (β); Thwaites, Enum. Pl. Zeyl. 407. 1864, *pro parte*; Bedd. Fl. Sylvat. 3: 1871, *pro parte*; T. Anderson in Hooker f. Fl. Brit. India 1: 275. 1874, *pro parte*; Vesque, Epharmosis 2: t. 8. 1889; Trimen, Handb. Fl. Ceylon 1: 102. 1893, *pro parte*; Vesque in C. DC. Monogr. Phanerog. 8: 556. 1893, *pro parte*; Worthington, Ceylon Trees, 34. 1959.

C. decipiens auct., non Wight; Thwaites, Enum. Pl. Zeyl. 51. 1858, *pro parte* (β).

A speciebus aliis *Calophylli* in gemma terminalis breve 2.5–3.5 mm. longa, lamina parva minore quam 6.5 cm. longa apice rotundata vel leviter retusa

basi vadose cordata, inflorescenti internodio infimo plus quam 1.3 cm. longo, flore cum 8 tepalis, et fructu ovoideo circa 2.4 cm. longo, differt.

Tree ca. 30 meters tall, d.b.h. ca. 40 cm.; outer bark pinkish, pale brown, or yellowish, fissured, loose strips 3–4 cm. wide; inner bark reddish brown, ca. 10 mm. thick.

Twigs slightly flattened, 1.5–3 mm. across, (almost 2-) 4- or 6-angled, sometimes with transverse line at node, drying brown, glabrous or brown farinose-puberulent at first; axillary innovations lacking basal scars; internodes (1–)2–5 cm. long; uppermost pair of axillary buds $\pm$ pointed, to 2.5 mm. long, erect to $\pm$ spreading; terminal bud plump, 2.5–3.5 mm. long, with subadpressed, chestnut brown to gray-brown indumentum (hairs, FIGURE 12, e, g), underdeveloped internode to 1 mm. long. Petiole 2–3.5 mm. long, concave above, convex to angled below, glabrous; lamina broadly ovate or obovate to suborbicular, 1.2–6.3 by 2.1–5.8 cm., rounded (slightly retuse) at apex, shallowly cordate at base, slightly undulate but barely recurved at margin, thinly coriaceous, drying sepia above and cinnamon below, transiently farinose-puberulent on midrib below, the midrib above abruptly narrowed at base, depressed at first, becoming slightly raised, 0.15–0.5 mm. wide at midpoint, below raised, rounded to substrate, the venation above and below $\pm$ apparent, raised, 5 to 9 (to 11) veins/5 mm., angle of divergence 50–60°. Inflorescences from uppermost foliate axils (rarely terminal), with 3 to 5 flowers, unbranched, the axis 1.3–4 cm. long, sparsely farinose-puberulent, lowest internode at least 1.3 cm. long; bracts in terminal inflorescences foliaceous, to 2.7 cm. long, otherwise unknown; pedicels 0.7–2.5 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8, sometimes glabrous, the outer pair elliptic to ovate, 4.5–6 by 2.5–3.8 mm., the inner ones $\pm$ obovate, 5–7.5 by 3–6 mm.; stamens 65 to 75, the filaments to 3 mm. long, slightly connate at base, the anthers oblong, 0.9–1.2 mm. long, rounded at apex; ovary ca. 1.8 mm. long, the style ca. 2.5 mm. long, the stigma peltate, ca. 0.7 mm. across, 3-radiate. Fruit ovoid, ca. 2.4 by 1.8 cm., acute at apex, drying wrinkled; outer layer detaching cleanly from stone, ca. 2 mm. thick, compact; stone subovoid, ca. 1.6 by 1.4 cm., obscurely pointed at apex, the walls ca. 0.25 mm. thick, smooth, unmarked; spongy layer initially thick.

TYPE. Ceylon [Sri Lanka, Hinidoon Corle, 305–610 m.], CP 3403, *pro parte* (holotype, BM; isotypes, BO, FI, G, K, P, W).

DISTRIBUTION. Sri Lanka (MAP 7).

ADDITIONAL SPECIMENS SEEN. **Sri Lanka:** Tumbagoda, road Tamanawette–Masenna, above Balangoda, Adam's Peak jungle, 900 m., *Kostermans* 24469 (A, L), 24474 (L); above road, Rasnagalle–Ratnapura, ca. 700 m., *Kostermans* 24645 (L); Adam's Peak jungle, upper part of Moray Estate near Fishing Hut, 1600 m., *Kostermans* 24469A (L); Panil Kanda Forest, below Hayes Est., 671 m., *Worthington* 6624 (L); Kanneliya F.R., *Meijer* 1037 (US); Kanneliya Forest near Hiniduma, low alt., *Kostermans* 25526 (L); Hiniduma F.R., low alt., *Kostermans* 24723 (L); Hinidumkande (Haycock), near Hiniduma, 500 m., *Kostermans* 25368 (L), 25668 (L).

ECOLOGY. Lowland to colline rainforest, to 900 (rarely to 1600) m. alt.

Calophyllum vergens can be readily recognized by its short terminal bud; small, suborbicular to broadly ovate leaf blades that are little longer than broad and cordate at the base; clear venation; axillary inflorescence with the basal internode at least 1.5 cm. long; and medium-sized, ovoid fruit. The epithet *vergens* (from *vergo*, "to incline," "to tend") was chosen because of the superficial similarities between this taxon and *C. clemensorum*, from Malesia (see below).

Calophyllum vergens is still a rather puzzling taxon. There are considerable, although perhaps not unexpected, differences in shape and size between leaves of adult plants and those of young plants and saplings, those of the latter being elliptic-lingulate, up to 16 by 3.7 cm., and cordate to rounded at the base. There are transverse lines across the nodes of shoots of young plants, as well as most older plants, but these do not seem to occur on the type. Only a single fruit is known (from *Kostermans* 24474); this is detached from the specimen, and the field notes remark "fruit dry."

Planchon and Triana described two morphs of *Calophyllum thwaitesii*, α and β . *Calophyllum thwaitesii* α , *C. thwaitesii* sensu stricto, is clearly a member of the *C. walkeri* complex, while *C. vergens* is a more slender plant, and although probably also a member of this complex, it is perhaps the most easily recognizable species. *Calophyllum vergens* is superficially very similar to *C. clemensorum*, from northeastern Borneo, but the latter has scars at the bases of the axillary inflorescences and fruits about 1 cm. long.

18. ***Calophyllum apetalum*** Willd. Ges. Naturf. Fr. Berlin Mag. 5: 79. 1811, *pro parte*; Sprengel, Syst. Veg. ed. 16. 2: 571. 1825, *pro parte*; Sastri *et al.* Wealth India 2: 17. 1950; Maheshwari, Bull. Bot. Survey India 2: 143. 1960; Somasundaram, Handb. Trees Shrubs So. States, 54. 1963; Troup, Silvic. Indian Trees. ed. 2. 1: 223. 1975; Gandhi in Saldanha & Nicolson, Fl. Hassan Distr. 124. fig. 26C. 1976; *C. spurium* Choisy, Mém. Soc. Phys. Hist. Nat. Paris 1: 229. 1823, in DC. Prodr. 1: 563. 1824; G. Don, Gen. Syst. 1: 623. 1831; Wight & Arnott, Prodr. Fl. Penin. Indiae Orient. 1: 103. 1834, *pro parte*; Graham, Catal. Pl. Bombay, 27. 1839; Walp. Rep. Bot. Syst. 1: 397. 1842, *pro parte*; Dalzell & Gibson, Bombay Fl. 32. 1861 ("*C. speurium*"); Drury, Handb. Indian Fl. 1: 143. 1864, *nomen superfluum*; *C. decipiens* Wight, Ic. Pl. Indiae Orient. 1: pl. 10. 1839, Illus. Indian Bot. 1: 128. 1840; Choisy, Descr. Guttif. Inde, 42. 1849, Mém. Soc. Phys. Hist. Nat. Genève 12: 422. 1851, *pro parte*; Gamble, Fl. Pres. Madras 1: 76. 1915, *nomen superfluum*; *C. wightianum* Wall. ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 256. 1862; Wall. Catal. 4847. 1831, *nomen*; Bedd. Fl. Sylvat. 1: pl. 90. 1871, *ibid.* 3: xxii. 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 274. 1874; Lisboa, Gaz. Bombay Pres. 25: 214. 1886; Vesque, Epharmosis 2: t. 20. 1889, in C. DC. Monogr. Phanerog. 8: 569. 1893; Cameron, Forest Trees Mysore Coorg, 17. 1894; Talbot, Syst. List Trees Bombay Pres. 16. 1894; Woodrow, Jour. Bombay

Nat. Hist. Soc. **11**: 126. 1897; Dalgado, Fl. Goa Savant. 15. 1898; Cooke, Fl. Pres. Bombay **1**: 81. 1901; Talbot, Trees Bombay Pres. ed. 2. 30. 1902; Brandis, Indian Trees, 54. 1907; Bourdillon, Forest Trees Travancore, 28. 1908; Talbot, Forest Fl. Bombay **1**: 101. fig. 63. 1909; Rama Rao, Fl. Pl. Travancore, 32. 1911, *nomen superfluum*. TYPE: India, Quilon, *Wallich dist.* 4847 (neotype, CAL, n.v.; isoneotypes, G, K).

C. calaboides G. Don, Gen. Syst. **1**: 622. 1831. TYPE: described from India.
C. calaba L. Sp. Pl. **2**: 514. 1753, *pro minore parte*; Burman, Fl. Indica, 120. 1768, *pro parte*; Lam. Encycl. Méth. Bot. **1**: 553. 1783.

Tree 8–30 meters tall, d.b.h. to 80 cm.; trunk apparently unbuttressed; outer bark yellowish, strongly fissured; latex white, sticky (*Kostermans* 26073); wood pale reddish white to reddish brown with darker streaks and a characteristic odor (*fide* Maheshwari, *loc. cit.*).

Twigs slightly flattened, 1.8–3(–4) mm. across, strongly 4-angled to subalate, drying yellowish to dark brown, glabrous or sparsely farinose when young; axillary innovations lacking basal scars; internodes 0.5–2 cm. long; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, $\pm$ spreading, inconspicuous, terminal bud plump, 3–6.5 mm. long, with subfurfuraceous to short-tomentose, gray to brown indumentum (hairs, FIGURE 12, c), underdeveloped internode absent (–1 mm. long). Petiole 3–5 mm. long, deeply concave above, convex below, glabrous or almost so; lamina obovate to elliptic, 4–8.5(–10.5) by 2–4.5 cm., rounded to retuse at apex, subtruncate to rounded (rarely acute to cuneate) at base, usually abruptly narrowed at very base, not undulate and only slightly recurved at margin, coriaceous, drying sepia to hazel above and sepia to sabelline below, glabrous or sparsely and transiently farinose on midrib below, the midrib above abruptly narrowed at base, raised, center strongly sulcate near base, 0.3–0.6 mm. wide at midpoint, below raised, striate, the venation $\pm$ apparent above and below, raised, 5 to 9 veins/5 mm., angle of divergence 50–65°. Inflorescences from foliate (rarely defoliate) axils, with 5 to 13 flowers, unbranched, the axis 1.7–7 cm. long, usually sparsely subfarinose, especially toward base (rarely subglabrous), lowest internode (0.5–)1–2.2 cm. long; bracts ovate, ca. 4 mm. long, soon deciduous; pedicels 0.9–1.5(–2.7) cm. long, glabrous. Flower (?)hermaphroditic; tepals usually 4 (rarely 3, 6, 8, or 9), the outer pair broadly ovate to suborbicular, 3.5–6 by 3.3–5.5 mm., the inner ones elliptic to obovate, 6–9 by 3.5–5 mm.; stamens 40 to 85, the filaments to 5 mm. long, free or almost so, the anthers oblong, 1.3–2.5 mm. long, rounded (mucronulate) at apex; ovary ca. 1.5 mm. long, the style ca. 3.5 mm. long, the stigma peltate, 1–1.5 mm. across, ca. 3-radiate. Fruit ovoid to ellipsoid, 0.9–1.5 by 7–9 mm., apiculate or not, drying grayish brown, smooth; outer layer adhering to stone, ca. 1 mm. thick, large air spaces developing; stone ovoid to ellipsoid, 0.75–1.3 by 5–7 mm., rounded to subobtusate at apex, the walls less than 0.1 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. India, Western Ghats (MAP 8).

SELECTED SPECIMENS SEEN. **India.** MAHARASTRA: Concan, *Stocks & Law s.n.* (BM, FI, G, GH, K, P, U, W). MYSORE: N. Kanara, Yellapor, *Talbot 381* (E); Nilkund, *Talbot 245* (E); Shimoga Distr., Hulical, Varshi Stream, *BSI Western Circle 86333* (K); Barakana, Agumbe, *BSI Western Circle 83277* (BM); Castle Rock, Kalmuli Jungle, *Fernandes 470* (A); Hassan Distr., Kempuhole ford, *HFP 927* (K, US); Londa, *Fernandes 977* (A); Dandeli, left bank of Kali R., *Fernandes 1088* (A); Madamhole, Coorg Distr., *BSI Western Circle 86783* (E); Kakethodu, Coorg, *Dehra Dun herb. no. 19148* (A); S. Kanara, *Beddome 421* (BM); monte Dschamalabad prope urbem Mangalore, *Hohenacker 322* (BM, C, G, FI, K, M, P, U, US, W); Bababoodun Hills, Malabar, *Law s.n.* (K). KERALA: S. Kerala, road Poonmudi to Trivandrum, 600 m., *Kostermans 26073* (L); Anamallays, 610 m., *Beddome 420* (BM), *Beddome s.n.* (K, NY); Travancore, Malagatta, *Bourdillon 1566* (K); Quilon, *Wight s.n.* (E). TAMILNADU: Madras State, *Wight s.n.* (K); Kalu Nuddie, *Ritchie 1649* (E, K).

MAP 8. Distribution of *Calophyllum apetalum* (circles), *C. austroindicum* (stars), and *C. cordato-oblongum* (triangles) in India and Sri Lanka.

ECOLOGY. Locally abundant, riverine forests, to 610 m. alt. Flowering October to March, after rains, especially November and December; fruiting March to May (reported December to January—e.g., Bourdillon, *loc. cit.*, as *C. wightianum*) (fruit becoming red with age).

The edges of the leaf blades are sometimes converted into hollow, winged or lipped galls (e.g., *Stocks & Law s.n.*; see also Talbot, 1909, *loc. cit.*, as *C. wightianum*).

LOCAL USES. The wood is strong and is used both in the construction of boats and oil mills and in general building. An oil with a characteristic smell and a bitter taste can be extracted from the seeds; with refinement the bitterness is lost. The oil is composed of the glycerides of stearic, palmitic, oleic, and probably linoleic acids. The fruit is edible (Sastri *et al.*, *loc. cit.*).

Calophyllum apetalum is a distinctive species recognizable by its lamina, which is usually less than 9 cm. long, more or less retuse at the apex, and often rather abruptly narrowed at the very base, and by its strongly four-angled stems. It has small flowers, and the outer layer of the fruit becomes disorganized by the development of large air spaces. There is considerable variation in the shape of the lamina and the fruit, but there are intermediates between the extremes. The epithet *apetalum* refers to the fact that the flower usually has only four tepals; these were called sepals by earlier workers.

Calophyllum spurium, *C. decipiens*, and *C. wightianum* are all illegitimate (superfluous) names, since reference is made to the earlier-published name, *C. apetalum*. Much of the confusion over the correct name for this taxon, which engendered the superfluous names, was due to overestimating the significance of tepal number variation and misinterpreting the nature of the tepals present. Thinking that the sepals were absent, Choisy started the confusion by calling the four tepals "petals"; he renamed *C. apetalum*, *C. spurium*. Further details of the nomenclature and synonymy of *C. apetalum* are given in Stevens (1980b); Maheshwari (*loc. cit.*) neotypified *C. apetalum*.

The meager original description of *Calophyllum calaboides* (Don, *loc. cit.*) suggests that this name is a synonym of *C. apetalum*.

19. ***Calophyllum calaba*** L. Sp. Pl. 732. 1753. SYNTYPES: Ceylon [Sri Lanka], *Hermann* 1: 65, 2: 42, 52, 3: 3 (BM).

Tree (rarely shrub), (0.5–)3–40(–49) meters tall, d.b.h. to 158 cm.; trunk usually without buttresses or spurs (rarely with steep, blunt buttresses to 4.5 meters tall (*SFN* 20865)); outer bark yellowish brown to yellowish, with rather distant, large, shallow, boat-shaped fissures, sometimes pustular, becoming more deeply fissured and scaling with age, inner surface blackish brown to dull yellowish brown; under bark dark red; inner bark thick, (pale) dark red; latex usually yellow, clear, sticky (rarely opaque, white or brownish); sapwood brown to whitish; heartwood reddish to dark brown.

Twigs flattened or strongly flattened, 1–2.5(–3.2) mm. across, 4- (2- or 6-)angled or rounded, drying dark to pale brown or yellowish, $\pm$ persistently farinose to tomentose; axillary innovations lacking basal scars; internodes

0.5–4.5(–8.5) cm. long; uppermost pair of axillary buds $\pm$ rounded, (0.3–)1–5 mm. long, erect, usually conspicuous; terminal bud plump to conical, (1.5–)3–11 mm. long, with grayish subcrustaceous to brown-tomentose indumentum (hairs, FIGURES 12, f, h–q; 13, a–d), underdeveloped internode to 2 mm. long. Petiole (0.2–)0.35–2 cm. long, shallowly to deeply concave above, convex below, soon glabrescent; lamina elliptic to ovate (rarely subobovate to oblong or cuneiform), (1.5–)3–13 by (0.7–)2–4.7(–5.5) cm., subacuminate to retuse at apex, acute to cuneate or cordate at base, slightly undulate and barely recurved at margin, coriaceous, drying brown-vinaceous or olivaceous to sepia above and dark brick or honey-sabelline to sepia below, transiently farinose to subpersistently short-tomentose on or near midrib below (also above), the midrib above usually narrowing gradually (quickly) from base, $\pm$ raised to flat, center sulcate at least at first, (0.1–)0.15–0.4 mm. wide at midpoint, sometimes disappearing ca. 5 mm. short of apex, below raised, striate to angled, the venation $\pm$ apparent above and below, raised (latex canals on upper surface also sometimes raised), (8 to) 10 to 20 (to 28) veins/5 mm., angle of divergence (50–)60–75°. Inflorescences from foliate axils along stem, with (3 to) 5 to 15 flowers, unbranched or with 3-flowered branches to 1.3 cm. long, the axis (0.1–)0.25–3.4 cm. long, puberulent to short-tomentose near base or along entire length, lowest internode 0.5–12 mm. long; bracts broadly elliptic to ovate, 2–5 mm. long, deciduous; pedicels 0.4–2(–2.8) cm. long, glabrous to puberulent, markedly incrassate in fruit or not. Flower (?)hermaphroditic; tepals 4 (rarely 6), rarely glabrous, the outer pair broadly elliptic to ovate, 3–4.5 by 2.5–4.5 mm., sometimes puberulent on back, especially toward base, the inner ones obovate to elliptic or oblong, 3.7–7.5 by 2–5.2 mm., rarely puberulent in strip down back; stamens 20 to 95, the filaments 2–3.5 mm. long, the anthers oblong, 0.4–1.5 mm. long, retuse to mucronulate at apex (rarely hastate, acute at apex); ovary 0.8–1.5 mm. long, the style 1.5–3.5 mm. long, the stigma peltate-infundibular, 0.4–1 mm. across, sometimes 3- or 4-radiate. Fruit spherical to ovoid or ellipsoid, 0.6–1.6 by 0.6–1.1 cm., minutely apiculate or not, drying $\pm$ vinaceous-brown, pruinose or not, broadly wrinkled when young, smooth when ripe; outer layer not detaching cleanly from stone, 0.3–1 mm. thick, air spaces developing, especially under skin; stone spherical to ovoid or ellipsoid, 0.5–1.15 by 0.5–0.8 cm., rounded at apex, the walls 0.15–0.3(–0.5) mm. thick, somewhat thicker at base, smooth, unmarked; spongy layer thin.

Key to the Varieties of *Calophyllum calaba*

1. Lamina usually ovate, retuse to subacute at apex; indumentum usually short-tomentose; inflorescence often branched, indumentum restricted to base of axis; fruit ellipsoid. 19a. var. *calaba*.
1. Lamina variable in shape, usually acute to subacuminate at apex; indumentum rarely short-tomentose; inflorescence very rarely branched, indumentum usually along length of axis; fruit usually spherical.
2. Lamina very coriaceous, usually cuneiform to suborbicular; terminal bud plump. 19d. var. *cuneatum*.

2. Lamina coriaceous, rarely cuneiform or suborbicular; terminal bud conical to plump.
3. Lamina elliptic, usually with fewer than 12 veins/5 mm.
 4. Uppermost pair of axillary buds ca. $\frac{1}{3}$ length of terminal bud; angle of divergence of venation 50–65°; outer layer of fruit less than 0.3 mm. thick; stone with wall less than 0.2 mm. thick. 19b. var. *worthingtonii*.
 4. Uppermost pair of axillary buds ca. $\frac{1}{4}$ length of terminal bud; angle of divergence of venation 60–70°; outer layer of fruit 0.5–1 mm. thick; stone with wall 0.2–0.4 mm. thick. 19f. var. *australianum*.
3. Lamina usually other than elliptic, if elliptic then with more than 12 veins/5 mm.
 5. Lamina strongly cordate at base, with more than 12 veins/5 mm.; terminal bud subtomentose. 19e. var. *E*.
 5. Lamina very rarely cordate at base, if cordate then with fewer than 12 veins/5 mm. and terminal bud other than subtomentose. 19c. var. *bracteatum*.

19a. *Calophyllum calaba* L. var. *calaba*

- C. calaba* L.; Burman f. Fl. Indica, 120. 1768, *pro parte* Zeyl.; Moon, Catal. Pl. Ceylon, 41. 1824; Alston in Trimen, Handb. Fl. Ceylon (Suppl.) 6: 22. 1931; Oostr. Blumea Suppl. 1: 196. 1937.
- C. burmannii* Wight, Ic. Pl. Indiae Orient. 1: pl. 108. 1839, Illus. Indian Bot. 1: 129. 1840; Walp. Rep. Bot. Syst. 1: 397. 1842; Thwaites, Enum. Pl. Zeyl. 52. 1858; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 261. 1862; Bedd. Fl. Sylv. 3: xxii. 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 272. 1874; W. Ferg. Timber Trees Ceylon, 12. 1881; Trimen, Jour. Linn. Soc. London 24: 143. 1888; Vesque, Epharosis 2: tt. 21, 22. 1889; Trimen, Handb. Fl. Ceylon 1: 99. 1893; Vesque in C. DC. Monogr. Phanerog. 8: 571. 1893; Lewis, Descr. Catal. Ceylon, 20. 1902; Worthington, Ceylon Trees, 35. 1959; *C. retusum* Wall. ex Choisy, Descr. Guttif. Inde, 41. 1849, Mém. Soc. Phys. Hist. Nat. Genève 12: 421. 1851. *Nomen superfluum*. TYPE: Ceylon, Col. Walker s.n. (κ, herb. Wight. prop.).
- C. burmannii* Wight β [var.] *parvifolium* Wight, Ic. Pl. Indiae Orient. 1: pl. 107. 1839, Illus. Indian Bot. 1: 129. 1840; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 261. 1862. TYPE: Ceylon, [Macrae] 140 (BM, κ (herb. Wight. prop.)).
- C. inophyllum* auct., non L.; Lam. Encycl. Méth. Bot. 1: 553. 1783, *pro parte*.
- C. apetalum* Willd. Ges. Natürl. Fr. Berlin Mag. 5: 79. 1811, *pro parte*; Sprengel, Syst. Veg. ed. 16. 2: 571. 1825.

FIGURE 13. Hairs (from terminal bud). a–d, *C. calaba*: a, var. *E* (Eyma 3346); b, d, var. *cuneatum* (SFN 32594); c, var. *bracteatum* (SAN 53447). e–g, *C. bracteatum*: e, f, Meijer 878; g, Kostermans 23334. h, *C. pervillei* (Perville 229). i, *C. verticillatum* (7929 SF). j, k, *C. drouhardii* (Forsyth-Major 241). l, *C. chapelieri* (herb. d'Aleizette s.n.). m, *C. milvum* (Baron 4433). n, *C. robustum* (NGF 2077). o, *C. rigidum* (Teysmann, HB 642). Scale = 60 μm.

Tree (1-)6.5-15(-25) meters tall, d.b.h. to 90 cm.; outer bark yellowish to dark gray, rough, deeply fissured; latex sparse, clear or semitransparent, yellow.

Twigs strongly flattened, when older drying dark brown, tomentose to sparsely pubescent; internodes 1-4.5(-7) cm. long; terminal bud conical, 5-7 mm. long, with tomentose to adpressed indumentum, uppermost pair of axillary buds about $\frac{1}{2}$ its length. Lamina ovate (obovate, elliptic, or trapeziform), (3-)3.9-8.4 by (2-)2.5-4.2 cm., retuse to subacute at apex, broadly cuneate to subacute at base, coriaceous, (7 to) 10 to 14 (to 16) veins/5 mm., angle of divergence 60-75°. Inflorescences with 5 to 13 flowers, frequently branched, the axis 0.25-3.4 cm. long, tomentose on lowest internode (immediately above), lowest internode 2-9(-12) mm. long; pedicels 0.7-2(-2.8) cm. long, rarely incrassate in fruit. Outer tepals glabrous dorsally. Fruit ellipsoid (rarely subspherical).

DISTRIBUTION. Sri Lanka (MAP 5).

SELECTED SPECIMENS SEEN. **Sri Lanka:** top Diyaluma Falls, *Waas* 489 (US); S. of Mulliattivu, NE. Coast, *Fosberg with Balakrishnan* 53487 (K, US); Uva Prov., Monaragala Distr., Bibile, Baderenkende, 400 m., *Kostermans* 24406 (A, L, US); Bibile, Alutnawara Road side, 237 m., *Worthington* 2975 (BM); "Talawa," Lunngalla 28/27 Culvert, 620 m., *Worthington* 2964 (A, BM, W); Amparai Distr., Divulana, Nuwaragala F.R., *Jayasuriya* 2084 (K, L); Devulane, Mile 18 Amparai-Kandy Road, *Kostermans* 24843 (A); Labugama reservoir E., 120 m., *Worthington* 3484 (BM), Panadura, 2-4 m., *Comanor* 1002 (A, E, K, MO, US); Ratnapoora, *CP* 242 (BM, BO, FI, G, GH, K, NY, P, W); W. of Kuchchaveli (N. of Trincomalee), "low" alt., *Kostermans* 24818 (G, L); Wilpattu Natl. Park, Kuruttu Pandi Villu, *Mueller-Dombois & Balakrishnan* 68091007 (A, K, NY); Caltura, *Macrae* 140 (BM, K); Kalutura Distr., Welipenna, Hallawakellae, *Balakrishnan* 1168 (K); Batticaloa Distr., 21 km. NE. of Maha Oya, *Stone* 11175 (KLU, US); Batticaloa, "low" alt., *Jayasuriya* 2104 (L); 2 km. W. of Kalkudah, "low" alt., *Jayasuriya et al.* 690 (L, US); NW. Prov. Puttalam Distr., Lihiriyagama, Kalu Mookalana, *Sumithraarachchi* 431 (NY); Kodikamam, *Jayasuriya* 284 (K).

ECOLOGY. Dry or intermediate zone forest, 2-400(-620) m. alt. Often near coast, sometimes on sand dunes; thick bark fire resistant, so plant can grow in grassland; may sprout from cut stumps. *Fosberg with Balakrishnan* 53486 collected in swampy woods. Flowering January to June (flower scented); fruiting January, March, May, June, August, September (fruit green at first, then yellow, finally orange, with pleasant, acid taste).

LOCAL USES. The wood is used for bullock cart poles, spars, and axe handles, and in building. The fruit is sometimes eaten.

19b. *Calophyllum calaba* L. var. *worthingtonii* P. F. Stevens, var. nov.

C. pulcherrimum auct., non Wall. ex Choisy; Trimen, Jour. Bot. London 27: 161. 1889, Handb. Fl. Ceylon 1: 100. 1893; Alston in Trimen, Handb. Fl. Ceylon (Suppl.) 6: 22. 1931; Worthington, Ceylon Trees, 32. 1959.

A varietatibus aliis *Calophylli calaba* in ramulis vetuste in siccitate flavescenti-brunneis, gemmis terminalibus indumento appresso praeditis, lamina elliptica raro obovata nervis lateralibus (8-)9-12(-15) per 5 mm. sub angulo 50-65° e costa abeuntibus, et pedicellis in fructu haud incrassatis, differt.

Tree 10-25 meters tall, d.b.h. to 25 cm.; outer bark yellowish, sometimes pustular or scaly, thin; latex not known.

Twigs strongly flattened, when old drying yellowish brown, at first with adpressed indumentum; internodes (0.5-)1.5-4(-5) cm. long; terminal bud narrowly conical, 3-5.5 mm. long, with adpressed indumentum, uppermost pair of axillary buds about $\frac{1}{3}$ its length. Lamina elliptic (rarely obovate), 3.5-9 by 1.6-3.9 cm., rounded to acute at apex, cuneate at base, coriaceous, the veins (8 or) 9 to 12 (to 15)/5 mm., angle of divergence 50-60°. Inflorescences with 3 to 5 flowers, unbranched, the axis 0.8-1.2 cm. long, puberulent at base, lowest internode 2-3.5 mm. long; pedicels 7-13 mm. long, (?)glabrous, not thickened in fruit. Tepals glabrous dorsally. Fruit subspherical.

TYPE: Ceylon [Sri Lanka], Ratnapura District, Moropitiya, Mahane-Makulana Forest, ca. 600 m., 1 May 1973, *Kostermans 24691* (holotype, A; isotypes, L, US).

DISTRIBUTION. Southwestern Sri Lanka (MAP 6).

ADDITIONAL SPECIMENS SEEN. **Sri Lanka:** Pasdun Korale, Hewesse, *Trimen s.n.*, March 1887 (K), Mandagale Nukelana, Hewesse, *anon.*, March 1887 (L); Kegalla Distr., Dickhena, 400 m., *Waas 1662* (GH); Ratnapura Distr., Mahane-Makulana Forest, 600 m., *Kostermans 24699* (A, G, US); Moropitiya, "low" alt., *Kostermans 24688* (G, L, US), *24689* (L), 100 m., *24659* (L), Kelinkande, near Moropitiya, 200 m., *Balasubramanian s.n.*, 1973 (L); Hinidumakale (Haycock), near Hiniduma, 500 m., *Kostermans 25370* (K, L); Deniyaya, 50 M.P., Diyadawa Forest, 427 m., *Worthington 2915* (BM); Lower Deniyaya, 150 m., *Worthington 2224* (BM); Labugama Reservoir E., 129 m., *Worthington 3482* (BM); Kanneliya Road from Udeyama State Park, 45 m., *Worthington 5267* (?) (BM); Singaradja F.R., *Meijer 525* (US); So. Prov., Naniketa Ela, 45 m., *Worthington 4137* (BM, NSW); Kurunegala Distr., E. slope of Doluwakanda, 525 m., *Jayasuriya & Balasubramanian 538* (K, US); Galle Distr., Kanneliya F.R., *Meijer 971* (US); Weerakande, 800 m., *Kostermans 25604* (A, L); Godekanda (E. of Hiniduma), 150 m., *Jayasuriya et al. 795* (L, US); sine loco, *CP 242, pro parte* (NY).

ECOLOGY. Slender tree of wet or sometimes rather dry rain forest, sometimes streamsides, 40-800 m. alt. Flowering in March; fruiting April, May, July, September (fruit yellow-orange, with sweet-acid taste).

The varietal epithet commemorates T. B. Worthington, who has collected extensively in Sri Lanka.

19c. *Calophyllum calaba* L. var. *bracteatum* (Wight) P. F. Stevens, comb. nov.

C. burmannii Wight var. *bracteatum* Wight, *Illus. Indian Bot.* 1: 129. 1840 ("var. *bractiatum*"); *C. amoenum* Wall. ex Choisy forma γ Planchon

- & Triana, Ann. Sci. Nat. Bot. IV. **15**: 263. 1862, *pro parte*. SYNTYPES: Burma, Tenasserim, *Griffith 439* (κ); Tenasserim or Mergui, *Griffith 595* (κ).
- C. amoenum* Wall. ex Choisy β [var.] *obtusifolium* Choisy, Descr. Guttif. Inde, 42. 1849, Mém. Soc. Phys. Hist. Nat. Genève **12**: 422. 1851, *pro maiore parte*, in Zoll. Syst. Verzeich. **2**: 149. 1854, Pl. Javan. 9. 1858; *C. amoenum* forma β Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 263. 1862. TYPE: Burma, Tavay, 24 Aug. 1827, *Wallich dist. 4849B* coll. Gomez (holotype, g; isotypes, g, κ).
- C. retusum* Wall. ex Choisy β [var.] *parvifolium* Choisy, Descr. Guttif. Inde, 41. 1849, Mém. Soc. Phys. Hist. Nat. Genève **12**: 421. 1851; *C. amoenum* Wall. ex Choisy forma γ Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 263. 1862, *pro parte*. TYPE: Burma, Moalmyre, 3 March 1827, *Wallich dist. 4849A* (holotype, g; isotypes, g, κ).
- C. pulcherrimum* Wall. ex Choisy β [var.] *obtusum* Choisy in Zoll. Syst. Verzeich. **2**: 149. 1854, Pl. Javan. 9. 1858. TYPE: Java, ex montosis Seribu, *Zollinger 1566* (?holotype, p).
- C. saigonense* Pierre, Fl. Forest. Cochinch. **1**: pl. 105. 1885; Vesque in C. DC. Monogr. Phanerog. **8**: 602. 1893; Pitard in Lecomte, Fl. Gén. Indo-Chine **1**(4): 318. 1910; Craib in Schmidt, Bot. Tidsskr. **32**: 328. 1915; Lecomte, Bois Indo-Chine, 124. 1925; Craib, Fl. Siam. Enum. **1**: 121. 1931; Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. **1**: 274. 1943; Phạm & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. *bang 62bis E*. 1960; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. **2**: 303. *fig.* 1970; H. Keng, Gard. Bull. Singapore **28**: 245. 1976. TYPE: Cochinchine, Beucar, ad flumen Saigon, Dec. 1869, *Pierre 3649* (lectotype, p; isolectotypes, κ, p).
- C. curtisii* Ridley, Jour. Asiatic Soc. Bengal, II. **59**: 176. 1890; Curtis, Jour. Straits Branch Roy. Asiatic Soc. **25**: 78. 1894; Ridley, Fl. Malay Penin. **1**: 185. 1922; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 321. 1956; Kochummen, Malayan Forest Rec. ed. 2. **17**: 221. 1965; T. C. Whitmore, Tree Fl. Malaya **2**: 177. 1973; Corner, Gard. Bull. Singapore Suppl. **1**: 104. 1978. TYPE: Malaya, Penang, Government Hill, 500 feet [150 m.], Dec. 1855, *Curtis 523* (isotypes, BM, BO, κ).
- C. harmandii* Pitard in Lecomte, Fl. Gén. Indo-Chine **1**(4): 318. 1910. TYPE: Laos, Bassin de Attopée, *Harmand 1219* (holotype, p).
- C. amoenum* Wall. ex Choisy, Descr. Guttif. Inde, 41. 1849, Mém. Soc. Phys. Hist. Nat. Genève **12**: 421. 1851, *quoad spec. cit.*; Wall. Catal. 4849. 1831, *nomen*; Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 263. 1862; Kurz, Jour. Asiatic Soc. Bengal, II. **43**: 88. 1874, Forest Fl. Brit. Burma **1**: 95. 1877; Theobald, Burma **2**: 636. 1883; King, Jour. Asiatic Soc. Bengal, II. **59**: 176. 1890; Vesque in C. DC. Monogr. Phanerog. **8**: 576. 1893, *pro parte*; Gamble, Pl. Andaman Is. 6. 1903; Brandis, Indian Trees, 55. 1907; Koord.-Schum. Syst. Verzeich. **2**: 39. 1910; Parkinson, Forest Fl. Andaman Is. **1**: 87. 1922; Craib, Fl. Siam. Enum. **1**: 121. 1931; Heyne, Nutt. Pl. Indonesië. ed. 3. **1**: 1081. 1950; Maheshwari, Bull. Bot. Survey India **2**: 142. *pl. 1*. 1960.
- C. hasskarlii* Teijsm. & Binn. ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 273. 1862, *pro parte*.
- C. teysmannii* Zoll. ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 275. 1862, *quoad descr. et spec. cit.*, non Miq.; Vesque, Epharosis

- 2: *tt.* 25, 26. 1889, in C. DC. Monogr. Phanerog. 8: 579. 1893, *pro parte*; Koord. & Valetton, Bijdr. Booms. Java 9: 381. 1903; Koord.-Schum. Syst. Verzeich. 1(Fam. 187): 6. 1912; Koord. Exkursionsfl. Java 2: 617. 1912.
- C. retusum* auct., non Wall. ex Choisy; T. Anderson in Hooker f. Fl. Brit. India 1: 272. 1874, *pro syn.*; Vesque in C. DC. Monogr. Phanerog. 8: 578. 1893, *pro parte*.
- C. wallichianum* auct., non Planchon & Triana; Vesque in C. DC. Monogr. Phanerog. 8: 559. 1893, *quoad Falconer* 761.
- C. kunstleri* auct., non King; Curtis, Jour. Straits Branch Roy. Asiatic Soc. 25: 78. 1894; Ridley, Jour. Straits Branch Roy. Asiatic Soc. 59: 74. 1911; Foxworthy, Malayan Forest Rec. 2: fig. 1928; M. R. Henderson, Gard. Bull. Straits Settl. 4: 224. 1928; Maheshwari, Bull. Bot. Survey India 2: 141. 1960, *pro parte*.
- C. medium* Zoll. ex Vesque in C. DC. Monogr. Phanerog. 8: 579. 1893, *in synonym. Nomen*.

Tree (0.5-)3-40(-49) meters tall, d.b.h. to 158 cm.; outer bark usually yellowish, strongly fissured; latex clear (cloudy) yellow, or almost white.

Twigs flattened, drying brown to yellowish, $\pm$ transiently farinose to subtomentose; internodes 0.5-3(-4) cm. long; terminal bud plump to conical, (2.5-)6-11 mm. long, with subcrustaceous to subtomentose indumentum, uppermost pair of axillary buds $\frac{1}{3}$ - $\frac{1}{2}$ its length. Lamina elliptic to ovate (rarely obovate), (1.5-)4.2-13 by (0.7-)1.9-4.7(-5.5) cm., obtuse to subacuminate (rarely rounded) at apex, acute to rounded at base, coriaceous, with 12 to 20 (to 28) veins/5 mm., angle of divergence (50-)60-70(-75)°. Inflorescences with 5 to 7 (to 12) flowers, unbranched, the axis (0.2-)0.5-1.5(-2) cm. long, puberulent, especially near base, lowest internode 1-3 mm. long; pedicels 4-11 mm. long, puberulent, incrassate in fruit or not. Outer pair of tepals $\pm$ puberulent dorsally. Fruit $\pm$ spherical.

DISTRIBUTION. Vietnam to Borneo, perhaps also the Sunda Islands and Timor (MAP 9).

SELECTED SPECIMENS SEEN (for explanation of letters, see discussion). **Burma:** Tenasserim Div., Tavoy Subdistr., $\frac{4}{5}$ km. S. of Paungdaw, 549 m., Keenan *et al.* 719 (E); Mayin-Uge, Tenasserim R., 0 m., Parkinson 2001 (K); Kalonta, Tavoy Range, 150 m., Sukoe 10806 (NSW); Moulmein, Falconer 761 (E, BO, G, K, M, P); Mergui, Bokpyin, Parker 2764 (A, K), Yanngwa Klong, Parker 2722 (A, K). **Vietnam:** montibus Dinh, ad Baria Gallieae, Pierre 3643 (BM, K, P); Saigon, Botanic Garden, Hliêt 625 (P); Ti Tinh, Tay Ninh, Pierre 86 (K), Cay Cong, Pierre 86 (K), Suôida, Muller 64 (A, BM, P), Beaucoit, Pierre 3649 (K, P), Thu Byh, Muller 964 (P); Chudaumot, Chon Canh F.R., Chevalier 30005 (P); Lagi, SE. reserve de Cay Sangh, Evrard 2278 (P), Bin Thoan, Magnein 13 (P); Bien Hoa, Chevalier 36844 (P). **Cambodia:** Pnomh Penh, Béjaud 459 (A, P); Phu Quoc, sinus Siamica, Pierre 3649 (P); ad montem Pra, prov. Samrong Tong, Pierre 779 (A, BM, K, P); Siém réap, Reorp. Bassac, Pierre 779 (K); entre Samlong et Anlong Veng, pres Massif Dangrek, Poilane 13868 (K, P, US); Benteay Sîei, J. E. Vidal 4838 (P); Kamput, Pierre 3649 (P); montibus Chiang Kinng in prov. Pran, Pierre 3643 (P); Prov. de Kompong Chnang, Kralanh F.R., Chevalier 30037 (P), Pny Ong Ep, Chevalier 36899 (P); entre Aulong Veng et Slek Krei, Poilane 14092 (P, US); Diém Riép, Angkor Thom,

Banteng Drei, *Smitinand & Abbe* 6356 (κ); Kah Kong, près de Thar Bang, 400 m., *Martin* 1505 (p). **Laos:** Savanna Khet, entre Lang à xinh xa ne et L. xoan, *Poilane* 13685 (p); km. 20 route de Savanna Khet à Quang Tri, *Poilane* 11733 (BISH, p, SING); near Kp. Sralas on W. bank of Mekong R. at Isle of Khong (Veal Tg. Tabeng, 40 km. WSW.), *Wharton* 88 (NY); bassin de Sè-Moun, *Harmand* 263 (p); Sedone, environs de Paksé, *J. E. Vidal* 4479 (p). **Thailand:** Ubon Rachatani, Lam Dom Noi, 120 m., *Smitinand & Turbang* 10504 (BKF); Yala, *Put* 3670 (A, BM, C, K, P); Lam Lieng, Ranawng, less than 50 m., *Kerr* 11733 (A, BM, C, K, P); Bang Son, Chumpawn, 20 m., *Kerr* 11318 (A, C, K, P); Kaw Tao, 200 m., *Kerr* 16065 (A, BM, C, K, P); Eastern, Si Sa Ket, *Phengkklai* 900 (C, E, P); Surat, Kaw, Pa-ngan, *Put* 1155 (BM, K), Wang Hin, *Saman* 5 (p); Kao Katakam, 600 m., *Kerr* 18419 (κ); Kapah-Janjaw, *SFN* 2063 (BM, K, SING); Nah Prov., Sriracha Forest, 24 m., *Collins* 804 (BM, K, US); Chaizaburi, Nawng Kai, 200 m., *Kerr* 8526 (E, K); Nong Yai boo, *Collins* 645 (κ); Boi Et, 90 m., *Wanaraly* 62 (κ); Surin, Sangka, 200 m., *Kerr* 8271 (C, K, P); Tola, Salut, 50 m., *Kerr* 13853 (κ, P); Krat, Kao Saming, *Put* 566 (κ); Surat, Chaiya, n.f. Bandon, 10 m., *Seidenfaden* 2576 (C, SING); Koh Chang, Klong Son, 266 m., *Schmidt* 668 (C, K); Phangnga, Ko Kho Khao, *Sangkachand* (1185) (BKF), between Thai Miang and Thung Maphrao, 30 m., *Smitinand* 4157 (BKF); Phatthalung, Pak Phayum, *Siwanna s.n.*, 20 Oct. 1938 (BKF). **Andaman and Nicobar Islands.** ANDAMAN ISLANDS: sine loco, *King's collectors* 378 (A, P). NICOBAR ISLANDS: Nancowry Harbour, *Kamphövener* 2250 (?sapling) (C). **Malaya.** PERLIS: Bukit Bintang F.R., *KEP* 69266 (KEP). KEDAH: Ulu Muda F.R., 305 m., *FRI* 6757 (A, K, KEP, SAR, SING); Enggang F.R., 60 m., *KEP* 73833 (KEP); Kedah Peak, 1036 m., *KEP* 79295 (KEP); Perangin F.R., *KEP* 20687 (KEP); Kubang Pasu, Mile 7³/₄ Jalan Kodiang, *KEP* 73654 (KEP); Kuah, *KEP* 32913 (KEP); Lankawi, Country Club, *van Balgooy* 2316 (L); Bukit Sawak F.R., 15 m. *KEP* 73614 (K, KEP); G. Raya F.R., 90 m., *KEP* 66415 (KEP); Tampoi F.R., *KEP* 71168 (KEP); K. Nerang, Bukit Perah, 150 m., *KEP* 67877 (KEP); Bukit Tangga F.R., *KEP* 79256, *pro parte* (KEP). PINANG: Ayer Hitam Dam Reserve, *Hardial & Samsuri* 202 (A, C, LAE, SAR, SING); Batu Ferengy, *Curtis* 1425 (BM, K, SING); Muku Head, *Curtis* 1425 (K, SING); Pantai Acheh F.R., *KEP* 66354 (KEP, SING). PERAK: near Ulu Kerling, 120–180 m., *King's collector* 8597 (BM, G, K, UC); G. Tempurong, Kampar, 305 m., *FRI* 5851 (KEP); Thaiping, 120–180 m., *King's collector* 8497 (BM, FI, K); Ijok F.R., 45 m., *KEP* 68170 (KEP); Larut, 610–914 m., *King's collector* 5446 (E, FI, K, U, US); Dindings, Bruas F.R., 30 m., *KEP* 69423 (K, KEP); Parit F.R., *KEP* 34263 (KEP); Batang Padang, Behran F.R., 45 m., *KEP* 61807 (KEP); Kerian, Pondok Tanjong F.R., 15 m., *KEP* 68201 (KEP, SING); Kinta, Tualang F.R., 15 m., *KEP* 63271 (KEP); Sungei Palai, Bukit Bujang Malaka, 542 m., *KEP* 54732 (KEP). SELANGOR: F.R.I. Kepong, *KEP* 71971 (A, BO, K, SING, US); Sungei Buloh F.R., *KEP* 13341 (KEP); Ulu Gombak F.R., 762 m., *KEP* 79102 (A, BO, K, NY, SAN, SAR, SING); Weld Hill F.R., *KEP* 1831 (KEP, SING); Ulu Langat F.R., 270 m., *FRI* 15132 (KEP); Rantau Pajang F.R., *KEP* 32324 (KEP); Kajang, Bangi F.R., *KEP* 23666 (KEP); Klang, Bukit Cheraka, *KEP* 38176 (KEP); Kerling, *KEP* 32515 (KEP). NEGRI SEMBILAN: Port Dickson, Sungei Menyala F.R., 0

MAP 9. Distribution of *Calophyllum calaba* var. *bracteatum* (circles), *C. calaba* var. *cuneatum* (solid stars), *C. calaba* var. *E* (open star in circle), *C. calaba* var. *australianum* (open stars), *C. brassii* (squares), and *C. robustum* (half-circles) in Southeast Asia–Australia.

m., *KEP 64582* (KEP, SING); Seremban, Cape Rachado, 45 m., *KEP 71467* (KEP); Kuala Pilah, Seriting F.R., *KEP 62953* (KEP, SING); Senaling Inas F.R., *KEP 42820* (KEP); Senawang F.R., *KEP 1980* (KEP, SING). MALACCA: Ayer Panas F.R., 45 m., *KEP 64163* (KEP); Bukit Shingei, *Alvins s.n.*, 29 March 1866 (SING). KELANTAN: Bukit Tapah Petri, *KEP 32750* (KEP); Ulu Kelantan, Bertam, 45 m., *KEP 65172* (KEP); Temangan, Kota Bahru, *SFN 33506* (KEP); Kemahang F.R., 21 m., *KEP 93587* (KEP); Ulu Sat, 120 m., *KEP 105445* (KEP); Semarak State Land, Pasir Puteh, 6 m., *KEP 68551* (KEP, SING); Sungei Anak Ketil, S. of G. Rabong, 270 m., *FRI 20700* (KEP, SAN). TRENGGANU: Pulau Laut Tengah, *KEP 30691* (KEP); Ulu Dungan near Sg. Behir, 270 m., *FRI 9367* (KEP); Bukit Bauk F.R., *FRI 16877* (KEP); Kemaman, Bukit Kajang, 150 m., *Corner s.n.*, 15 Nov. 1935 (SING); Jemka F.R., 45 m., *KEP 94722* (K, KEP); Bukit Besi, Mile 6 Jalan Talang, 60 m., *KEP 53365* (KEP); Sungei Kerbet, ca. 3 km. below K. Petang, 402 m., *FRI 20346* (KEP); Padang Kandis, road to Kampong Temila, Besut, *SFN 40346* (BO, E, K, SING). PAHANG: Balok F.R., *FRI 3794* (A, K, KEP, SAN, SING); Taman Negara near Kuala Kenyam, Jeram Belau, 305 m., *FRI 20149* (KEP); Pamah, Bukit Sulai, 60 m., *FRI 9159* (KEP); Temerloh, Kemasul F.R., *KEP 10652* (K, KEP); Rompin [Aur F.R.], *KEP 15463* (SING); Klou F.R., *KEP 92314* (KEP); Kuala Lipis distr., 150 m., *KEP 1266* (KEP, SING). JOHORE: Sungei Kayu, *SFN 32324* (A, K, KEP, SING); Kluang F.R., 60 m., *KEP 72702* (KEP); Renggam F.R., 45 m., *KEP 71273* (KEP); Jemaluang F.R., 33 m., *KEP 69967* (KEP); Ma Okil F.R., *KEP 71279* (KEP); Soga F.R., *KEP 79633* (KEP); Banang F.R., *KEP 79533* (KEP); Sungei Kahang, *KEP 5870* (K, KEP); Panchor, Tg. Sarat Range, *KEP 62819* (KEP). **Singapore:** Garden Jungle, *SFN 39444* (KEP, SING). **Sumatra and adjacent islands.** RIAU: Koeantan, Poelau Kedondong, 100 m., *bb 24798* (BO, L); sud de Peranap, chantiers de Semelinang, R. Kuantan Indragiri, *Normand 613* (P); Upper Riau, Pakanbaru, Tenajan R., 30 m., *Soepadmo 137* (A, BO, C, E, LAE, NY, SING). DJAMBI: Djambi, Ma. Pidjoean, 89 m., *bb 12837* (BO). SELATAN: Banjoeasin, Koeboestrecken, 15 m., *Grashoff 805* (BO, L); Rawas, *Dumas 1539* (BO, L); Lematang Ilir, Semangoes, 100 m., *bb 32255* (BO, L); weg van Boea2 naar de zuidkust, 100 m., *Lütjeharms 4707* (A, BISH, BO, G, K, NY, P, SING, US); Lebong, bij ds. Sekandau, Air Lemaœ, 700 m., *bb 2289* (BO, L). BARAT: Sididjoengdjoeng, Poedak, 290 m., *bb 5528* (BO), Moera, 596 m., *bb 6056* (BO), Padang Lawas, *bb 6627* (BO), Taratak Barœ, 600 m., *bb 5801* (BO); Painan, Baroeng Baroeng Belanti, 400 m., *bb 3994* (BO). UTARA: Angkola en Sipirok, Panobasan, 500 m., *bb 26121* (BO, L, SING). BANGKA: Lobok Besar, 30 m., *bb 34058* (A, P, SING); Bukung, 60 m., *bb 34144* (L); Muntok, Majang, *bb 7590* (BO); Kepo, 10 m., *bb 10677* (BO); Rendik, 20 m., *bb 11567* (BO); Perlang, 5 m., *bb 11634* (BO); Toboali, *bb 1940* (BO). BELITUNG: Tandjong Pandan, 100 m., *bb 11836* (BO); Mangar, *Teysmann s.n.* (BO). **Borneo.** SARAWAK. 1st Division: Mt. Santubong, 210 m., *Chew 1345* (A, AAU, L, SAR, SING, UC). SABAH. Keningau: Sook-Tulid forest, 90 m., *SAN 49660* (SAN). LABUK AND SUGUT: Japanese Trail near mile 80, *SAN 53447* (A, SAN). SANDAKAN: Oil Palm Research Station, Mile 32, Sungei Manjang, 30 m., *Stevens et al. 365* (A); Leila F.R., 30 m., *Stevens et al. 347* (A). KALIMANTAN. Timur: Central Kutei, Belajan R. near Long Bleh, *Kostermans 10406* (BO, CANB, K, L, SING). Tengah: Doesson, G. Prarawin, *Korthals s.n.* (young plant) (L). **Java.** BARAT: Bantam, Tjinahoek, G. Karang Poelasari, 1050 m., *Koorders 2829* (BO); Preanger, 200 m., *van Steenis 5076* (a) (BO), *Warburg s.n.*, anno 1886–1887 (a) (E); Garoer, Pangentjongan, *Koorders 26480* (BO); G. Gede, 1300 m., *Kramer 161* (BO); Soekaboemi, Palaboeanratœ, *Koorders 2883* (BO);

Tjiandjoer, Takoka, *Koorders 11966* (BO); G. Mandalagiri, *Lam 113a* (a) (BO, L); Tjampaka near Tjidadap, Tjiharoem, G. Karang, 1000–1300 m., *Buwalda 3620* (a) (BO, L); in montosis Nengotziembangan, *anon.* (a) (L); Passier Toegoe, *Hasskarl 416* (a) (L); Baya, *Hasskarl 499* (a) (L); Pasir Batoe Lawang, 500–600 m., *Backer 9046* (a) (BO); Mt. Seribu, *Zollinger 124* (P). TENGAH: Banjoemas, Tjilatjap, Noesakambangan, *Koorders 34105* (BO); Semarang, Ambarawa, Telomojo, G. Andong, 120 m., *Koorders 27784* (BO, G); Banjarnegara, Pringombo, *Koorders 33931* (BO); G. Muria, Mt. Argodjembangan, 700–1400 m., *Kostermans 6307* (A, BO, SING). TIMUR: Madioen, Ponorogo, G. Wilis Ngebel, 1375 m., *Koorders 2894* (BO); Besoeki, Sitoebondo, Pantjoer-Idzen, 1000 m., *Koorders 14474* (BO). **Lesser Sunda Islands.** BALI: N. of Tabanan, Mt. Batukaru, 1300 m., *Wirawan 463* (A, BO, L). FLORES: Lemo, Golo Ponto, 1500 m., *Schmutz 2977* (L). TIMOR: sine loco, *Teysmann s.n.* (BO).

ECOLOGY. Common in lowland to colline mixed dipterocarp rain forest or evergreen forest, to 1400 m. alt. (in Java 700–1400 m. alt.). In Sabah sometimes on acid, sandy soil. Flowering (Vietnam to Sumatra) October to February (once in July in Cambodia and N. Malaya); flower scented. Fruiting December to May (once in July in Vietnam and Malaya); fruit pale yellowish green (Malaya), pale chestnut (Cambodia: *Martin 1505*), or turning purple-black when ripe (Malaya: *FRI 20700*). In Java and Bali flowering May, June, and November; fruiting July and August.

GERMINATION AND YOUNG PLANT. The radicle probably breaks through the stone near the base. The seedling has one pair of leaves (rarely two?). The first internode is 4–12 mm. long, and subsequent ones become gradually longer. The seedling leaf blades are 1.6–3.4 cm. by (4.5–)5.5–7.5 mm., and the next pair of leaves is similar in size. Subsequently produced leaves are narrower, and the young plant has narrowly ovate to elliptic leaf blades up to 20 by 1.75 cm. The terminal bud is functional, and the young plant is erect. (Data on seedlings from *Stevens et al. 365A* (Sabah); young plants similar throughout Borneo).

LOCAL USES. In Cambodia the wood is used for implement handles; the latex is used for shampoo (*Martin 1505*). The fruit is edible. In Thailand the wood is used for bows, furniture, and houses. In Malesia the wood is used for construction, and the latex is used as a fish poison in fresh water. On Bangka the latex is apparently used to cure(?) ulcers (*bb 33144*).

The epithet *bracteatum* alludes to the prominent bracts on the type specimen.

19d. ***Calophyllum calaba* L. var *cuneatum*** (Symington ex M. R. Henderson & Wyatt-Smith) P. F. Stevens, comb. et stat. nov.

C. cuneatum Symington ex M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 339. pl. 19. 1956; Wyatt-Smith, Malayan Forest Rec. **17**: 113. 1952, *nomen*; Kochummen, Malayan Forest Rec. ed. 2. **17**: 217. 1965; T. C. Whitmore, Tree Fl. Malaya **2**: 177. 1973. TYPE: Malaya, Pahang, Cameron Highlands, 14 May 1936, *SFN 31232* coll. *Holttum* (holotype, SING; isotypes, A, K, LAE, SING).

C. saigonense Pierre var. *nanum* Gagnep. in Humbert, Fl. Gén. Indo-Chine Suppl. 1: 274. 1943, *pro majore parte. Nomen invalidum.*

C. ?pulcherrimum auct., non Wall. ex Choisy; Henderson, Jour. Malay Branch Roy. Asiatic Soc. 5: 243. 1927.

Tree (3–)15–30 meters tall, d.b.h. to 30 cm.; latex brown (*Kostermans* 6285) or white (*SFN* 18002).

Twigs strongly flattened, drying brown to yellowish, subpersistently farinose to puberulent; internodes 0.5–3.5(–4.5) mm. long; terminal bud plump, (1.5–) 2.5–7.5 mm. long, with subcrustaceous to puberulent indumentum, the uppermost pair of axillary buds ca. $\frac{1}{3}$ its length. Lamina elliptic, cuneiform, or suborbicular, 3–8 by (0.7–)1.4–4.5(–5.5) cm., acute to rounded at apex, acute to subcordate at base, very coriaceous, with (9 to) 11 to 17 veins/5 mm., angle of divergence 50–75°. Inflorescences with 3 to 11 flowers; unbranched; the axis 0.5–1.5 cm. long, puberulent, lowest internode 1–3 mm. long; pedicels 0.25–1.5 cm. long, puberulent, incrassate in fruit or not. Outer tepals puberulent dorsally. Fruit spherical.

DISTRIBUTION. Cambodia to Java, scattered (MAP 9).

SELECTED SPECIMENS SEEN. **Cambodia:** Bokor, montagne de l'Éléphant, 900 m., *Poilane* 22977 (P); Mt. Cam Chay, val d'Émeraude, 1000 m., *Tixier* 2812 (KLU); Poporkville and vicinity, 1000 m., *Stone* 9282 (KLU). **Thailand:** Kao Sabap, Chantabun, 500 m., *Kerr* 17793 (A, BM, C, K, P). **Malaya.** PAHANG: Cameron Highlands, 1219 m., *SFN* 32594 (A, K, KEP, SING, US), near Tanah Rata, 1463 m., *SFN* 18002 (KEP, SING); Mentigi F.R., *Kep* 30957 (KEP). **Sumatra.** BARAT: Fort v. d. Kapellen, Soengei Talang, 1000 m., *bb* 6473 (BO). UTARA: Karoland, res. Siboeatan, 1400 m., *bb* 2770 (A, BO, K, SING); Toba, Pokir, *Lörzing* 14422 (BO). **Java.** TENGAH: G. Muria, Tjollo, N. of Kudus, 1500 m., *Kostermans* 6285 (A, BO, K, SING).

ECOLOGY. Colline or lower montane rainforest, sometimes dwarfed and windswept (Cambodia), (500–)900–1500 m. alt. Flowering November (Cambodia) and March (Sumatra). Fruiting December, and March to May; fruit orange (*Martin* 821) or green, turning black (*Stone* 9282), both from Cambodia.

The epithet *cuneatum* alludes to the lamina shape of the type specimen.

19e. *Calophyllum calaba* L. var. E

Shrub ca. 3 meters tall or small tree; latex unknown.

Twigs flattened, 1.5–2.5 mm. across, drying brown, transiently puberulent; internodes 1.5–6.5 cm. long; terminal bud conical, 2–4.5 mm. long, puberulotomentose, uppermost pair of axillary buds about $\frac{1}{2}$ its length. Lamina (broadly) ovate, 2.4–8 by 1.5–4.3 cm., subacute to acuminate at apex, $\pm$ cordate at base, coriaceous, with 12 to 16 veins/5 mm., angle of divergence 60–70°. Inflorescences with 3 to 9 flowers, unbranched, the axis 1–5(–9) mm. long, subtomentose at least at base, lowest internode 0.5–2.5 mm. long; pedicels 6–10 mm. long, glabrous, not incrassate in fruit. Outer tepals sometimes sparsely puberulent toward base. Fruit ovoid.

DISTRIBUTION. Sulawesi (MAP 9).

SPECIMENS SEEN. **Celebes.** SULAWESI: Malili, 0 m., *Kjellberg 2099* (BO); Lake Matano, near Noeha, 383 m., *Eyma 3346* (A, BO, K, L, U).

ECOLOGY. Shrubbery near beach of lake, 383 m. alt., also at sea level. Flowering in August (tepals ("corolla leaves") with red base, pedicels pink); fruiting in August (fruit blue-black).

19f. ***Calophyllum calaba* L. var *australianum*** (F. Mueller ex Vesque) P. F. Stevens, comb. et stat. nov.

C. australianum F. Mueller ex Vesque, *Epharmosis* 2: tt. 22, 23. 1889, in C. DC. Monogr. Phanerog. 8: 574. 1893; F. M. Bailey, Comp. Catal. Queensland Pl. 54. 1913. TYPE: Australia [Queensland], Rockingham's Bay, *Dallachy s.n.* (holotype, P).

C. tomentosum auct., non Wight; F. Mueller, Frag. Phytogr. Austral. 9(80): 174. 1875; F. M. Bailey, Synopsis Queensland Fl. 28. 1883, Queensland Fl. 1: 104. 1899, Queensland Wood, 17. 1899.

Tree to 20 meters tall, d.b.h. to 30 cm.; outer bark yellowish, fissured, somewhat flaky or tessellated; latex clear, sticky (B. P. M. Hyland, pers. comm.).

Twigs strongly flattened, when older drying brown, transiently puberulent; terminal bud rather plump, 3.5–7 mm. long, with subtomentose indumentum, uppermost pair of axillary buds less than $\frac{1}{3}$ its length. Lamina elliptic (rarely suboblong), (3.7–)6–13 by (0.9–)2–3.9 cm., $\pm$ cuneate at apex, acute at base, coriaceous, with (6 to) 8 to 12 veins/5 mm., angle of divergence 60–70°. Infructescences with scars of 5 to 11 flowers, unbranched, the axis 0.4–2.8 cm. long, persistently puberulent near base, lowest internode (0.5–)2–6(–8) mm. long; pedicels 7–12 mm. long, in fruit glabrous, not incrassate. Flower unknown. Fruit ellipsoid.

DISTRIBUTION. Australia, northeastern Queensland (MAP 9).

SELECTED SPECIMENS SEEN. **Australia.** QUEENSLAND: Finch Hatton Gorge, Mackay, *Scanlan s.n.*, 23 Dec. 1964 (BRI); Copperlode Falls dam site, 9.6 km. S. of Cairns, *Gittins 2210* (BRI, NSW); SFR [State Forest Reserve] 143, Little Mossman logging area, 275 m., *Hyland 6757* (LAE); Coast Range, Rockingham's Bay, *Dallachy s.n.*, MEL 44332 (MEL).

ECOLOGY. Rain forest. Fruiting October and February.

The epithet *australianum* was given to this taxon because it was the first species of *Calophyllum* believed to be restricted to Australia.

Calophyllum calaba can be recognized by its usually rather strongly flattened twigs and its medium-sized leaf blades that dry a characteristic olivaceous-sepia color on the upper surface and have fine and usually dense venation. The flowers have four (rarely six) tepals and less than 100 stamens. The spherical-ellipsoid fruits are small and less than 1.6 cm. long; the usually rather thin outer layer of the fruit often becomes disorganized by air spaces, and the

stone has thin walls. The epithet *calaba* is a Carib Indian name for the local form of *C. brasiliense* (see below).

The circumscription and subdivision of *Calophyllum calaba* have given me much trouble. Although *C. calaba* var. *calaba* and var. *bracteatum* differ in numerous, albeit mostly rather minor, characters, they are in part linked by *Calophyllum calaba* var. *worthingtonii* (see 1 below) and the specimens from the Sunda Islands provisionally referred to *C. calaba* var. *bracteatum* (see 3 below); unfortunately the variation of these latter groups is not well understood. The varieties can be recognized by the characters given in the key, but it is clear that the infraspecific classification adopted is liable to be modified.

Sterile specimens of *Calophyllum calaba* var. *bracteatum* from Malaya have been confused with other taxa; see TABLE 6.

There has been considerable nomenclatural and taxonomic confusion over *Calophyllum calaba* and its synonyms, and this is discussed below in some detail.

Circumscription of *Calophyllum calaba*

Planchon and Triana (1862, p. 264) thought that *Calophyllum burmannii* (= *C. calaba* var. *calaba*) was very close to *C. amoenum* (= *C. calaba* var. *bracteatum*), and they distinguished between the two mainly on fruit shape: *C. burmannii* had ovoid fruits, while those of *C. amoenum* were spherical. Vesque (1893, p. 575) thought that *C. australianum* (= *C. calaba* var. *australianum*) was no more than a large-leaved variant of *C. burmannii*, the two agreeing in indumentum and anatomy, but since he did not know the flowers of the latter, he maintained the two. His confusion over *C. amoenum* (see below) probably caused him to overlook the similarity between it and *C. burmannii*.

Calophyllum calaba var. *calaba* has distinctive, moniliform hairs, as noted by Vesque (1893); similar, albeit shorter, hairs occur on *C. calaba* var. *bracteatum*, as in *Hardial & Samsuri 202* (Malaya) and *SAN 53447* (Sabah). However, indumentum variation in *C. calaba* from Sri Lanka is greater than Vesque thought, the hairs of *C. calaba* var. *worthingtonii* having irregular cells in their basal half; there is also considerable variation in specimens from Southeast Asia-Malesia (FIGURES 12, 13). The Javanese specimens provisionally included in *C. calaba* var. *bracteatum* (see 3 below) have hairs with prominent protrusions near the base and thinner cell walls; they are often light colored, rather than brown as in the other specimens. The hairs of *C. calaba* var. *E* consist entirely of large, thin-walled cells (see also below). There are no important anatomical differences in transverse sections of the lamina of specimens from Sri Lanka, from Vietnam to Borneo, and according to Vesque (1893), from Australia. Specimens from the Sunda Islands lack clearly defined latex canals in the lamina (see also Vesque, 1889, 1893, under *C. teysmannii*) but are otherwise similar. There may be considerable variation in fruit color, but few of the observations made so far are reliable. Other variation discussed below is mostly in size and texture of parts and in distribution of indumentum.

Intraspecific Variation in *Calophyllum calaba*

The variation in *Calophyllum calaba* is discussed below under seven headings: 1, specimens from Sri Lanka; 2, the small-leaved Bornean specimens; 3, the specimens collected from the Sunda Islands; 4, Australian specimens; 5, high-altitude specimens with coriaceous leaves; 6, the specimens from the Celebes; and 7, other variation.

1. *Calophyllum calaba* vars. *calaba* and *worthingtonii* are similar in basic leaf type, flower, and fruit, but can be separated by the characters noted above. The differences in bark type, color of the dried twig, and indumentum may be connected with the different habitats of the two taxa. *Calophyllum calaba* var. *calaba*, with fissured bark and often well-developed indumentum, grows in drier places than does *C. calaba* var. *worthingtonii*, which has smooth bark and indumentum that is less well developed. At Labugama Reservoir the two taxa may grow fairly near one another (*Worthington* 3484, var. *calaba*, collected "from a stump"; *Worthington* 3482, var. *worthingtonii*, collected "in a cleared space originally forest"). The indumentum of *Worthington* 3484 perhaps approaches that of var. *worthingtonii*. Kostermans (1976) thought that plants here placed in *C. calaba* var. *worthingtonii* were the young stage of var. *calaba*, but the situation is not that simple.

It should be noted that in leaf shape, unbranched inflorescence, and indumentum, *Calophyllum calaba* var. *worthingtonii* approaches var. *bracteatum*.

On a sheet of CP 242 (*Calophyllum calaba* var. *calaba*) at Paris there are single flowers in the axils of foliage leaves; these flowers are twice the size of flowers on a normal inflorescence and are borne on pedicels ca. 2 cm. long. The pedicels of *Kostermans* 24406 (also var. *calaba*) have become notably incrassate in fruit (cf. var. *bracteatum*), but this specimen is otherwise unremarkable.

2. The specimens from Borneo cited above all have strongly flattened twigs that dry a yellowish color, well-developed, short-tomentose indumentum, and small leaves with petioles 2–5 mm. long and blades (1.5–)2.1–6(–8.2) by 1.1–2.2(–2.7) cm. that are often retuse at the apex; there are 17 to 24 (to 28) veins/5 mm. *Chew* 1345 has rather old flowers; *Kostermans* 10406 is just past flowering; the other specimens are sterile. Bark characters of trees seen in Sarawak and Sabah are similar to those of Malayan trees and also agree with the description given by Henderson and Wyatt-Smith (*loc. cit.*) for *Calophyllum curtisii*. Specimens with flowers and ripe fruits are needed; however, rotting fruits found under the tree from which *Stevens et al.* 365 was taken were apparently similar to fruits of the Malayan specimens, the stone measuring ca. 5 mm. long and across with walls less than 0.2 mm. thick.

3. Although about 50 numbers of the *Calophyllum calaba* complex have been collected from Java to Timor, most are sterile; I do not understand the variation in the area. There is a small group of specimens (denoted by "a" under *C. calaba* var. *bracteatum*, not incorporated into the description) from West Java in which the twigs are only slightly flattened and are sharply

four-angled, the lamina is strongly undulate at the margin, and the veins are relatively distant (only 5 to 9 (to 10)/5 mm.). The base of the lamina is variable in shape and is sometimes subcordate (see 6 below); hence some specimens have been identified as *C. venulosum*! In inflorescence, flower, and fruit there is good agreement with *C. calaba* var. *bracteatum*, and Hasskarl 499 has hairs similar to those typical of *C. calaba*, although with somewhat thinner cell walls.

Of the other specimens from the area, *Teysmann s.n.* (Timor) has branched inflorescences, as have some cultivated specimens from Java in Beccari's herbarium (at FI); the inflorescence axis is often glabrous toward the apex, the pedicels are long (0.7–1.6 cm., to 2 cm. in fruit), often glabrous, and not strongly angled, and the stone wall is 0.15–0.5 mm. thick. The lamina has nine to fifteen veins/5 mm.

Where these specimens differ from *Calophyllum calaba* var. *bracteatum* in inflorescence and flower they approach var. *calaba*. The venation density and fruit with a rather thick outer layer are similar to those of var. *australianum*. Specimens with a more coriaceous lamina approach the Javanese specimens of *C. calaba* var. *cuneatum*.

4. *Calophyllum australium* is a poorly known taxon from Queensland; I have not seen flowers from this area. However, specimens of *C. australium* are similar to those of *C. calaba* var. *bracteatum* in facies and fruit, so *C. australium* is reduced to varietal rank under *C. calaba*, albeit with some hesitation. *Calophyllum calaba* var. *australianum* has fewer than ten veins/5 mm., more or less elliptic leaf blades, and ellipsoid fruits with an outer layer that is relatively thick at maturity and with relatively thick-walled stones. In venation density, leaves of Javanese specimens of *C. calaba* are more or less intermediate between those of vars. *australianum* and *bracteatum*.

5. *Calophyllum calaba* var. *cuneatum* is basically a high-altitude form of the species, and as might be expected, it has more coriaceous leaf blades. The leaf blades of the specimens cited from Cambodia are often rounded at both the apex and the base, while the specimens from Java and Sumatra have rather plump terminal buds and subdepressed midribs. The latex of *C. calaba* var. *cuneatum* is reported as being white or brown; that of *C. calaba* var. *bracteatum* is nearly always clear yellow.

Further collections may show that *Calophyllum calaba* var. *cuneatum* cannot be maintained. If it is assumed that specimens of *C. cuneatum* from Malaya come from under 3000 feet in altitude, they key out as *C. curtisii* (= *C. calaba* var. *bracteatum*) in Henderson and Wyatt-Smith (*op. cit.*). These authors thought that *C. cuneatum* was close to *C. fraseri*; the type specimen of the latter species also has flowers with four tepals. However, whatever the status of that specimen, most of the material placed in *C. fraseri* belongs to a taxon quite unrelated to *C. calaba* (see also the discussion after *C. fraseri*).

The manuscript name "*Calophyllum karoense* Beum." has been used for this taxon (*bb 2770*, see Henderson & Wyatt-Smith, *loc. cit.*).

6. *Calophyllum calaba* var. *E* at first sight looks very different from the other material placed in the species. It has a cordate lamina that is rather undulate at the margin, long internodes, congested inflorescences, and hairs with unthickened cell walls (FIGURE 13, a). However, it seems to approach *C. calaba* from the Sunda Islands, and until more collections are made from this area, it seems premature to describe it formally. Its fruits are reported to be blue-black when ripe, an unusual color for this species.

7. *Helper 881* (Burma) has strange, almost hastate anthers, but it is otherwise unremarkable.

Nomenclature and Synonymy

Three species were mentioned in the protologue of *Calophyllum calaba*: one from the West Indies (*C. brasiliense* sensu lato, *C. antillanum* sensu stricto); one from Sri Lanka (*C. calaba* sensu stricto); and one from India (*C. apetalum*). A detailed discussion of the nomenclature of these three names has been given elsewhere (Stevens, 1980b); *C. calaba* is to be typified on the element from Sri Lanka.

Identity of *Calophyllum amoenum*

The name *Calophyllum amoenum* has been used sporadically for plants here included in *Calophyllum calaba* var. *bracteatum*, but this is incorrect even if this taxon is maintained at the specific level. Choisy's description of *C. amoenum*, given below, is very muddled, and although Planchon and Triana (1862a) satisfactorily disentangled the taxa involved, their nomenclature unfortunately cannot be followed.

"*C. amoenum* (Wall! cat.) foliis elliptico-lanceolatis acutis, floribus racemosis racemis luxuriantibus divaricatis, petalis 4 post inflorescentiam reflexis minimis. (Wall. cat! no 4849. A. Moalmyre. C. Amherst. 1731. Amherst.) V. quoque ex Griffith in H. Boiss. Folia saepè acutissima et aliquandò semipedalia."

Planchon and Triana (*loc. cit.*, p. 279) noted that there was a specimen of *Calophyllum polyanthum* collected by Griffith, but without number or locality, in Boissier's herbarium at Geneva; Choisy had labeled this specimen *C. amoenum*. Choisy's description of the inflorescence and of the probably eight-tepaled flowers (the 4 "petals" plus, presumably, 4 sepals) of *C. amoenum* agree with Griffith's specimen rather than with the Wallich specimens cited by Choisy. The reference to the petals being small and reflexed might better fit specimens of *C. amoenum* as it has often been interpreted, since the four small tepals become reflexed. However, *Wallich dist.* 4949C (G), the specimen on which part of Choisy's description of *C. amoenum* may be based, lacks flowers. Choisy's citation of *Wallich dist.* 4849A and 4849C under *C. amoenum* is probably due to confusion between these specimens at Geneva. A label of *Wallich dist.* 4849A is attached to an original label of 4849C, through which the stem of a specimen of the latter number is inserted. Choisy's description of the leaves fits both Wallich's and Griffith's

specimens. *Calophyllum amoenum* is typified by the only unambiguous part of the description (that of the inflorescence), and hence on the unlocalized specimen collected by Griffith; *C. amoenum* so typified is reduced to synonymy under *C. polyanthum*.

If the taxon previously called *Calophyllum amoenum* is recognized as a distinct species, it must be called *C. saigonense* Pierre.

Additional nomenclature and synonymy

The specimen of *Calophyllum burmannii* var. *parvifolium* from Wight's herbarium now at Kew bears the number "140." (At the British Museum there is a probable duplicate of this specimen. It was collected by Macrae and is also numbered 140.) [Macrae] 140 has more oval blades, tomentose twigs, and more richly flowered inflorescences than is usual in *C. calaba* var. *calaba*. The venation is dense (14 to 19 veins/5 mm.), and the specimen is superficially rather different from others. Wight (1840, *loc. cit.*) noted that *C. burmannii* var. *parvifolium* had an inflorescence with more numerous flowers and shorter pedicels than *C. burmannii* sensu stricto, and that the leaves were smaller and more decidedly oval; the twigs were described as being tomentose. However, the variety is not worth maintaining.

Calophyllum burmannii var. *bracteatum* was based on Griffith 439 and 595, purportedly from Malacca (Malaya). Although Wight designated his varieties of *C. burmannii* merely by Greek letters, from his discussion it is clear that he considered them to be varieties. Wight spelled the varietal epithet "bractiatum," which was changed by Planchon and Triana (1862a) to "brachiatum." However, since Wight specifically referred to the bracts of his variety and made no mention of any branching, the epithet should be spelled "bracteatum." The specimen of Griffith 439 at Kew has prominent bracts; the locality of the specimen is given as Tenasserim (in Burma). The specimen of Griffith 595 is in fruit; the locality of one of the two sheets is given as "Mt. Merpu," and that of the other as "Tenasserim."

The type specimens of *Calophyllum amoenum* var. *obtusifolium*, *C. retusum* var. *parvifolium*, and *C. saigonense* are all clearly referable to *C. calaba* var. *bracteatum*. Choisy (1851, *op. cit.*) apparently did not give any rank to the taxa that he designated by Greek letters. However, in a numerical list of Wallich's specimens at the end of his paper (p. 437), he noted under Wallich 4849 "les échantillons marqués de la lettre β [*Calophyllum amoenum* β *obtusifolium*] constituent une variété assez distincte." It seems reasonable to consider the taxa that Choisy designated by Greek letters to be varieties. This argument can be applied to the infraspecific epithet of *C. pulcherrimum* Wall. ex Choisy β *obtusum* Choisy since Choisy recognized varieties elsewhere in the same publication (see also Article 35.3 of the Leningrad Code).

The type of *Calophyllum retusum* var. *parvifolium* is Wallich dist. 4849A. Choisy (*loc. cit.*) cited the type as Wallich 1731, from Moalmyre; this is Wallich's original number—and the epithet *parvifolium* Wallich's original name—for the plant.

Choisy cited Wallich dist. 4849B, the type of *Calophyllum amoenum* var. *obtusifolium*, as "Wall. cat! no. 4849. B [Wallich's final catalogue number]

Tavay. (W. Gomez). Id. pl. Birm. no. 1731 [an earlier number for the same specimen; W. Gomez was the collector of the plant] et 153. Tavay [the field number of the specimen]."

At the British Museum and Paris there are possible isotypes of *Calophyllum australianum* collected by Dallachy from Rockingham's Bay. Dallachy collected these specimens on September 13, 1867, October 3 and 4 [1867], and February 22, 1868. Since it is unclear from which collections the Paris and London duplicates came, isotypes of *C. australianum* cannot be designated.

A specimen of *Pierre 3649* at Paris, collected at "Beucar, ad Saigon," is designated the lectotype of *Calophyllum saigonense*. This is the only collection that Pierre made near Saigon, and it agrees well with the protologue. Pierre's handwritten notes are attached to a sheet of *Pierre 779* at Paris.

Calophyllum harmandii was separated from *C. saigonense* in a key by Pitard (*loc. cit.*) on inflorescence size: *C. harmandii* was supposed to have an inflorescence with fewer than five flowers, while that of *C. saigonense* had five or more. Gagnepain (1943) considered *C. harmandii* to be an insufficiently known species and did not include it in his key. However, the type specimen of *C. harmandii* has infructescences with seven or more scars and is indistinguishable from *C. saigonense*.

Henderson and Wyatt-Smith, in their description of *Calophyllum curtisii* (*loc. cit.*), noted that *Wallich 4849A* belonged to the same taxon as their species, and so it is not surprising that *C. curtisii* is here reduced to synonymy under *C. calaba* var. *bracteatum*. They ascribed an "umbelliform" inflorescence to *C. curtisii*, but as is characteristic of *C. calaba* var. *bracteatum*, each pair of flowers is separated by an internode, the internodes separating the pairs of the flowers on the end of the inflorescence tending to be longer than the lower ones.

Planchon and Triana (1862a) appear to have been somewhat confused over the taxon that they called *Calophyllum teysmannii*. The description that they gave and the specimens that they cited are referable to *C. calaba* var. *bracteatum*, but *C. teysmannii* is a superfluous name for *C. dasypodum*. This is discussed further under *C. dasypodum*.

20. ***Calophyllum bracteatum*** Thwaites, Enum. Pl. Zeyl. 51. 1858; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 280. 1862; Bedd. Fl. Sylv. 3: xxii. 1871; T. Anderson in Hooker f. Fl. Brit. India 1: 274. 1874; Vesque, Epharmosis 2: tt. 5, 6. 1889; Trimen, Handb. Fl. Ceylon 1: 102. 1893; Vesque in C. DC. Monogr. Phanerog. 8: 554. 1893; Lewis, Descr. Catal. Ceylon, 22. 1902; Alston in Trimen, Handb. Fl. Ceylon (Suppl.) 6: 21. 1931; Worthington, Ceylon Trees, 28. 1959. TYPE: Ceylon [Sri Lanka], Saffragam district, Carailla Corle, March 1863, CP 2674 (isotypes, BM, BO, G, GH, FI, K, P, W).

C. acuminatum auct., non Lam.; Moon, Catal. Pl. Ceylon, 41. 1824.

Tree 20–30 meters tall, d.b.h. to 113 cm.; trunk without buttresses; outer bark pinkish red-brown to yellowish, smooth, or very thin and with deep fissures, panels white and wide, with close-set lenticels (Worthington, *loc.*

cit.); inner bark deep red; latex white, resinlike, sparse. Branches pendulous.

Twigs slightly flattened, 1.5–2 mm. across, strongly 4-angled, drying dark brown, subpersistently brown-tomentose; axillary innovations lacking basal scars; internodes to 4 cm. long at beginning of innovation, as short as 3 mm. at end; uppermost pair of axillary buds rounded, to 1 mm. long, erect; terminal bud plump, 6–8(–9.5) mm. long, brown-tomentose (hairs, FIGURE 13, e–g), underdeveloped internode not apparent. Leaves at beginning of innovation: petiole 4.5–9 mm. long, concave above, convex below, soon glabrescent; lamina ovate to elliptic, 6.5–19 by 2.4–6(–8) cm., acuminate at apex, acute to broadly cuneate or subtruncate at base, undulate and slightly recurved at margin, thinly coriaceous, drying umber to dull olivaceous above and olivaceous to sabelline below, often shiny, $\pm$ persistently subtomentose on midrib (sometimes on surface as well), the midrib above rather quickly narrowed at base, slightly depressed at first, becoming $\pm$ raised, 0.2–0.7 mm. wide at midpoint, below raised, slightly striate, the venation above and below subapparent, raised, 8 to 13 veins/5 mm., angle of divergence 60–70°. Leaves at end of innovation: petiole as short as 1.5 mm.; lamina linear to narrowly obovate, 2–5.5 by 0.2–1 cm., often subpersistently short brown-tomentose above and below. Inflorescences from foliate axils toward ends of twigs, with 1 to 7 flowers, unbranched, the axis 0.3–3.6 cm. long, puberulo-tomentose, lowest internode 0.3–0.9(–2) cm. long; bracts elliptic to ovate, 2–5 by 1–2.5 mm., subpersistent; pedicels 3–8 mm. long, to 1.7 cm. long in fruit, pubescent, slender. Flower (?)hermaphroditic; tepals 4 or 8, the outer pair ovate to obovate, 5–6 by 3–3.5 mm., cucullate or not, thin, short-tomentose on back, the inner ones obovate to narrowly elliptic, 4–6 by 1.7–3.5 mm.; stamens 80 to 90, the filaments to 2.7 mm. long, the anthers elliptic, 0.4–0.7 mm. long, rounded to retuse at apex; ovary 1–1.2 mm. long, the style 1.8–2.7 mm. long, the stigma subpeltate, ca. 0.5 mm. across, slightly radiate. Fruit ellipsoid, 1.5–1.8 by ca. 1 cm., minutely apiculate or not, drying brown, smooth; outer layer not detaching cleanly from stone, ca. 0.4 mm. thick, with large air spaces developing; stone ellipsoid to obovoid, 1–1.65 by 0.65–0.9 cm., rounded to obtuse at apex, the walls ca. 0.2 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southwestern Sri Lanka (MAP 5).

SELECTED SPECIMENS SEEN. **Sri Lanka:** Southern Prov., Nelliwa, Galle Distr., Kalubowitiyan Kanda, *Tirvengadum & Cramer* 258 (P, US); Ratnapura Distr., Sinharaja Forest, SE. of Weddagala, *Meijer* 878 (A, US); Kurulugala Kanda base, *Waas* 405 (K, NY, US); Kuruwita, N. of Ratnapura, 500 m., *Kostermans* 23334 (A, AAU, G); Madampe, 180 m., *Worthington* 2133B (BM); Springwood Estate, Rakwana 88/6, *Worthington* 2649 (A, BM); Knehija Forest, Udiyama S.P., 60 m., *Worthington* 5261 (BM); Nakiyodeniya, 75 m., *Worthington* 5254 (BM); Tumbagoda, upper road Balangoda, Rassagala, 800 m., *Kostermans* 24464 (E, K, L), above Balangoda, 600 m., *Kostermans* 24461A (L); Moropitya F.R., near base camp 10 km. S. of main road, *Meijer* 459 (US).

ECOLOGY. Rainforest, often in river valleys, 50–915 m. alt. Flowering January to March and July; fruiting February and April to July (fruit white (*Kostermans* 23334)).

LOCAL NAME AND USES. "Walu-keena" (Sinhalese). The wood is used for buildings, masts, and plywood.

Calophyllum bracteatum is a very distinctive species easily recognized by the conspicuous alternation in leaf size and shape along the stem. Leaves produced early in the flush are large and are separated by well-developed internodes, while those produced toward the end are much smaller and narrower and are separated by short internodes. The slender inflorescence axis with its subsistent bracts is also a distinctive feature (the name *bracteatum* refers to these rather persistent bracts).

Calophyllum bracteatum is perhaps related to *C. calaba*, which dries a similar color and has rather similar fruits; its hairs strikingly resemble those of *C. cordato-oblongum*, an otherwise very different species.

21. *Calophyllum soulattri* Burman f. Fl. Indica, 121. 1768; F. Mueller, Jour. Roy. Soc. New S. Wales **24**: 174. 1890, Bot. Centralbl. **44**(1): 29. 1891; Merr. Interp. Rumph. Herb. Amboin. 371. 1917, Philip. Jour. Sci. **19**: 366. 1921, Enum. Philip. Fl. Pl. **3**: 81. 1923; Holthuis, Blumea **5**: 214. 1942; Heyne, Nutt. Pl. Indonesië. ed. 3. **1**: 1085. 1950; Sastri *et al.* Wealth India **2**: 20. 1950, *pro parte*; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 319. 1956; Maheshwari, Bull. Bot. Survey India **2**: 142. 1960; Backer & Bakh. f. Fl. Java **1**: 386. 1963; T. C. Whitmore, Guide Forests Brit. Solomon Is. 77. 1966; I. H. Burkill, Dict. Econ. Prod. Malay Penin. ed. 2. **1**: 416. 1966; T. C. Whitmore, Gard. Bull. Singapore **22**: 15. 1967; Meijer, Bot. Bull. Herb. Forest Dept. Sabah **7**: 16. 1967; Phạm, Cây-Cỏ Miền Nam Việt-Nam. ed. 2. **2**: 300. fig. 1970; Foreman, Check List Vasc. Pl. Bougainville, 42. 1971; T. C. Whitmore, Tree Fl. Malaya **2**: 192. 1973; Hartley *et al.* Lloydia **36**: 276. 1973; P. F. Stevens, Austral. Jour. Bot. **22**: 399. 1974, Jour. Arnold Arb. **57**: 175. 1976; H. Keng, Gard. Bull. Singapore **28**: 245. 1976; Corner, Gard. Bull. Singapore Suppl. **1**: 105. 1978; Perry, Med. Pl. E. SE. Asia, 174. 1980; *C. suriga* Buch.-Ham. ex Carey in Roxb. Fl. Indica. ed. 2. **2**: 608. 1832; Roxb. Hortus Bengal. 93. 1814; G. Don, Gen. Syst. **1**: 623. 1831, *nomen*; Wight, Illus. Indian Bot. **1**: 129. 1840; Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 292. 1862[?]; T. Anderson in Hooker f. Fl. Brit. India **1**: 276. 1874; Vesque in C. DC. Monogr. Phanerog. **8**: 609. 1893, *nomen superfluum*. TYPE: Java, *Burman s.n.* (G).

Apoterium sulatri Blume, Bijd. Fl. Nederl. Indië **5**: 218. 1825. TYPE: Java, *Blume s.n.* (lectotype, L, herb. Lugd. Bat. 903, 343-183).

C. tetrapetalum Roxb. ex G. Don, Gen. Syst. **1**: 622. 1831, Hortus Bengal. 93. 1814, *nomen*; Carey in Roxb. Fl. Indica. ed. 2. **2**: 608. 1832; Wight, Illus. Indian Bot. 129. 1840. TYPE: "stove plant, native of the East Indies" (n.v.).

C. hirtellum Miq. Pl. Jungh. 201. 1854, Fl. Indiae Batavae **1**(2): 511. 1859. TYPE: Java, Tjanjor, *Junghuhn s.n.* (holotype, L; isotypes, P, U).

C. cymosum Miq. Fl. Indiae Batavae, Suppl. **1**(3): 497. 1861; F. Mueller in Walp. Ann. Syst. Bot. **7**: 357. 1868. TYPE: Sumatra occidentalis,

- Paja-Kombo, *Teysmann*, *HB* 653 (lectotype, U; isolectotypes, BO, K, L, MEL).
- C. diepenhorstii* Miq. *Fl. Indiae Batavae*, Suppl. 1(3): 497. 1861; F. Mueller in Walp. *Ann. Syst. Bot.* 7: 357. 1868; Vesque in C. DC. *Monogr. Phanerog.* 8: 605. 1893; *C. spectabile* Willd. var. *diepenhorstii* (Miq.) Boerl. *Catal. Pl. Phanerog. Horto Bot. Bogor.* 2: 81. 1901. TYPE: Sumatra, in prov. Priaman, *Diepenhorst*, *HB* 2236 (holotype, U; isotypes, BO, L, MEL).
- C. lanceolatum* Warb. *Bot. Jahrb.* 13: 381. 1891, non Blume, 1825, nec Teijsm. & Binn. 1853; *C. warburgii* Engler in Engler & Prantl, *Nat. Pflanzenfam.* 3(6): 222. 1893, *nomen novum*; Lauterb. *Nova Guinea Bot.* 8: 843. 1912, *Bot. Jahrb.* 58: 13. 1922; A. C. Smith, *Jour. Arnold Arb.* 22: 345. 1941, *pro majore parte*. TYPE: Kei Inseln, anno 1889, *Warburg* 20048 (isotypes, A, LAE (frag.), US).
- C. spectabile* Willd. var. *ceramicum* Boerl. *Catal. Pl. Phanerog. Horto Bot. Bogor.* 2: 80. 1901. TYPE: Cult. hort. Bogor. (semina ex Ceram) sub numero *VI C 46* (holotype, BO; isotypes, BO, US).
- C. spectabile* Willd. var. *miquelii* Boerl. *ibid.* 81. TYPE: Cult. hort. Bogor. sub numero *VI C 137* (holotype, BO; isotypes, BO).
- C. kiong* Lauterb. & K. Schum. in K. Schum. & Lauterb. *Fl. Deutschen Schutzgeb. Südsee*, 450. 1901; Lauterb. *Bot. Jahrb.* 58: 11. 1922; O. Schwarz, *Repert. Sp. Nov.* 24: 89. 1927. SYNTYPES: Deutsch Neu Guinea [Papua New Guinea, Morobe Province], Sattelberg, Nuselang, 850 m., 8 Dec. 1893; *Kärnbach* 74 (frag., WRS�); bei Laleca, 300 m., 12 April 1889, *Hellwig* 657 (WRS�); Sattelberg, 2 Dec. 1898 & 10 Jan. 1899, *Bammler* 6 (WRS�).
- C. hibbardii* Elmer, *Leafl. Philip. Bot.* 2: 503. 1908. TYPE: Philippine Islands, Negros Island, prov. Negros Oriental, Cuernos Mountains, Dumaguete, 3500 feet [1067 m.], April 1908, *Elmer* 9837 (isotypes, A, BM, BO, E, F, FI, G, K, L, LY, MO, NY, US, W).
- C. lancifolium* Elmer, *Leafl. Philip. Bot.* 7: 2683. 1915 ("C. lancifolia"); Merr. *Enum. Philip. Fl. Pl.* 3: 80. 1923. TYPE: Philippine Islands, Mindanao, Agusan Province, Cabadbaran (Mt. Urdaneta), 1000 feet [305 m.], July 1912, *Elmer* 13266 (lectotype, A; isolectotypes, BM, BO, E, F, FI, G, GH, K, L, MO, NY, U, UC, US, W).
- C. zschokkei* Elmer, *Leafl. Philip. Bot.* 7: 2686. 1915; Merr. *Enum. Philip. Fl. Pl.* 3: 81. 1923. TYPE: Philippine Islands, Sibuyan Island, Magallanes (Mt. Giting-Giting), Paula River, 750 feet [225 m.], March 1910, *Elmer* 12129 (lectotype, GH; isolectotypes, A, BM, BO, E, F, FI, G, K, LY, MO, NY, P, W).
- C. versteegii* Lauterb. *Bot. Jahrb.* 58: 12. 1922. TYPE: Süd Neu Guinea, Noord Fluss, Nepenthes-Hügel, 25 Sept. 1907, *Versteeg* 1748 (isotypes, BO, K, L, U).
- C. cholobtaches* Lauterb. *ibid.* 59: 20. 1924, *pro majore parte*. TYPE: Palau Inseln, Korrör, 10–100 m., 13 Feb. 1914, *Ledermann* 14251 (lectotype, WRS�).
- C. solomonense* A. C. Smith, *Jour. Arnold Arb.* 22: 346. 1941, *paratypo excepto*; Whitmore, *Guide Forests Brit. Solomon Is.* 78. 1966, *pro parte*, *Gard. Bull. Singapore* 22: 9. 1967, *pro parte*; P. F. Stevens, *Austral. Jour. Bot.* 22: 398. 1974, *pro parte*. TYPE: Solomon Islands, Guadalcanal, Ma-Massa, Konga, 500 m., 8 Feb. 1931, *Kajewski* 2469 (holotype, A; isotypes, BM, BO, BRI, G, L, P, SING).

- C. paludosum* C. T. White, Jour. Arnold Arb. **31**: 98. 1950; T. C. Whitmore, Guide Forests Brit. Solomon Is. **77**. 1966, Gard. Bull. Singapore **22**: 14. 1967. TYPE: Solomon Islands, New Georgia, Bupara River, 16 Oct. 1945, *BSIP* 192 coll. Walker & White (holotype, BRI; isotypes, A, CANB, K, LAE, MEL).
- C. spectabile* auct., non Willd.; Choisy in DC. Prodr. **1**: 562. 1824; G. Don, Gen. Syst. **1**: 622. 1831, *pro parte*; Moritz, Syst. Verzeich. Zoll. Java, **25**. 1845-46; Choisy, Descr. Guttif. Inde, **43**. 1849, Mém. Soc. Phys. Hist. Nat. Genève **12**: 423. 1851, *pro parte*, in Zoll. Syst. Verzeich. **2**: 149. 1854, Pl. Javan. **10**. 1858; Miq. Fl. Indiae Batavae **1**(2): 511. 1859; Planchon & Triana, Ann. Sci. Nat. Bot. IV. **15**: 266. 1862, *pro parte*; T. Anderson in Hooker f. Fl. Brit. India **1**: 271. 1874, *pro parte*; Kurz, Jour. Asiatic Soc. Bengal, II. **43**: 88. 1874, *ibid.* **45**: 119. 1876, Forest Fl. Burma **1**: 94. 1877; Naves in Blanco, Fl. Filip. ed. 3. *t.* 241. 1879; Fernand.-Vill. Novis. App. **17**. 1880; Theobald, Burma **2**: 636. 1883; Pierre, Fl. Forest. Cochinch. **1**: *pl.* 107. 1885; Vidal, Rev. Vasc. Pl. Filip. **54**. 1886; Vesque, Epharmosis **2**: *tt.* 26, 27. 1889; King, Jour. Asiatic Soc. Bengal, II. **59**: 175. 1890; Vesque in C. DC. Monogr. Phanerog. **8**: 583. 1893; Drake in Grandid. Hist. Nat. Polit. Madagascar **35**: *pl.* 356. 1896; Gamble, Pl. Andaman Is. **6**. 1903; Koord. & Valetton, Meded. s'Lands Plant. **61**(Bijd. Booms. Java 9): 386. 1903; Merr. Philip Is. Bur. Gov. Lab. Publ. **27**: 20. 1905; Brandis, Indian Trees, **55**. 1907; Pitard in Lecomte, Fl. Gén. Indo-Chine **1**(4): 323. 1910; Koord.-Schum. Syst. Verzeich. **1**(Fam. 187): 5. 1912; Koord. Exkursionsfl. Java **2**: 617. 1912; Koord.-Schum. Syst. Verzeich. **3**(1): 87. 1914; Ridley, Fl. Malay Penin. **1**: 185. 1922, *pro parte*; C. E. Parkinson, Forest Fl. Andaman Is. **1**: 87. 1922; Gagnep. in Humbert, Fl. Gén. Indo-Chine, Suppl. **1**: 274. 1943; H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s. **24**: 77. 1948, in Humbert, Fl. Madagascar Comores, Fam. **136**: 5. 1951, *pro parte*; Phạm & Nguyễn, Cây-Cỏ Miền Nam Việt-Nam, 179. 1960.
- C. apetalum* auct., non Willd.; Blanco, Fl. Filip. ed. 2. 429. 1845, *ibid.* ed. 3. **2**: 415. 1879, *excl. descr. fr.*
- C. acuminatum* auct., non Lam.; Hassk. Abh. Naturf. Ges. Halle **9**: 184. 1866.
- C. wallichianum* auct., non Planchon & Triana; Kurz, Jour. Asiatic Soc. Bengal, II. **45**: 119. 1876; Theobald, Burma **2**: 637. 1883; Maheshwari, Bull. Bot. Survey India **2**: 146. 1960, *pro parte*.
- C. pulcherrimum* auct., non Wall. ex Choisy; Fernand.-Vill. Nov. App. **17**. 1880.
- C. burmannii* auct., non Wight; Lauterb. Nova Guinea Bot. **8**: 309. 1910.
- C. kunstleri* auct., non King; Merr. Philip. Jour. Sci. C. **7**: 307. 1912, Sp. Blanc. 267. 1918, Bibl. Enum. Bornean Pl. 393. 1921, Enum. Philip. Fl. Pl. **3**: 79. 1923.
- ?*C. odoratissimum* Norona, Verh. Batav. Genootsch. **5**(4): 12. 1790. *Nomen.*
- C. oblongum* Koord. ex Koord.-Schum. Syst. Verzeich. (Fl. N. O. Celebes) **3**: 87. 1914, Fl. N. O. Celebes, Suppl. **2**: *pl.* 89. 1922. *Nomen.*
- C. treubii* Koord. ex Koord.-Schum. Syst. Verzeich. (Fl. N. O. Celebes) **3**: 87. 1914, Fl. N. O. Celebes, Suppl. **2**: *pl.* 88. 1922. *Nomen.*
- C. celebicum* Koord. (*pro maiore parte*), *C. minahassae* Koord., et *C. wigmannii* Koord. ex. Koord.-Schum. Syst. Verzeich. (Fl. N. O. Celebes) **3**: 87, 88. 1914. *Nomina.*

C. sorsogonense Elmer ex Merr. Enum. Philip. Fl. Pl. 3: 81. 1923, in synonym. sub *C. zschokkei*, nomen; Elmer, Leaflet. Philip. Bot. 10: 3744. 1939. *Nomen invalidum*.

C. inophyllum auct., non L.; Holthuis, Blumea 5: 214. 1942.

Calophyllum sp. Walker, Forests Brit. Solomon Is. Prot. 124. 1948.

C. canum auct., non Hooker f.; Keith, N. Borneo Forest Rec. ed. 2. 2: 313. 1952, *pro parte*.

C. lowii auct., non Hooker f.; J. Anderson, Trees Peat Swamp Sarawak, pl. 26b. 1973.

Tree 4.5–26 meters tall (rarely shrub), d.b.h. to 70 cm.; trunk very rarely buttressed, spurred, or with small knee roots to 7 cm. tall; outer bark usually yellowish to pale brown, with distant, shallow, boat-shaped fissures, often slightly flaky and scaly, not hoop marked, inner surface straw colored to sulfur or bright yellow; under bark reddish; inner bark dark to pale red; latex usually white and fluid (yellowish brown to yellow, especially in Solomon Islands).

Twigs rather strongly flattened, (1–)1.5–4.5(–5.5) mm. across, 4-angled (rounded, or 2- or 6-angled), with obscure horizontal line at node, drying brown (yellowish), subglabrous to persistently tomentose; axillary innovations lacking basal scars; internodes (0.5–)1.5–10 cm. long; uppermost pair of axillary buds pointed, (0.5–)2–5 mm. long, erect (rarely $\pm$ spreading, or inconspicuous); terminal bud conical, 0.4–2 cm. long, with short, grayish- to brown-adpressed to brown-tomentose indumentum (hairs, FIGURE 14, a–m), underdeveloped internode lacking (–2 mm. long). Petiole (0.15–)0.6–2.7 cm. long, broadly (rarely deeply) concave above, convex below, glabrous to subpersistently tomentose; lamina ovate to elliptic or suboblong (rarely subobovate), (3.5–)6.5–29(–36) by (1.5–)2.4–10.2 cm., acute to acuminate (rarely rounded or truncate and apiculate) at apex, acute to cuneate (rarely rounded to shallowly cordate) at base, usually closely undulate and slightly recurved at margin, coriaceous, drying umber to olivaceous-buff above and sepia to sabelline-olivaceous below, glabrous to subpersistently tomentose on midrib above and below (rarely entire lower surface initially tomentose), the midrib above usually narrowing rather quickly (gradually) near base, $\pm$ broadly depressed at base or not, raised (very rarely surrounding leaf also raised), 0.15–0.4(–0.6) mm. wide at midpoint, below raised, striate to subangled or rounded, the venation on both surfaces subobscure to apparent, finely raised, (6 to) 12 to 18 (to 21) veins/5 mm., angle of divergence (60–)65–80°. Inflorescences from foliate axils, with (3 to) 7 to 21 flowers, usually flabellate, branched,

FIGURE 14. Hairs (from terminal bud, unless otherwise indicated). a–m, *Calophyllum soulattri*: a, LAE 52389; b, Sinclair 10866; c, BS 38937; d, BS 38967; e, Kuswata & Soepadmo 232; f, Brass 2469; g, h, NGF 15542; i–l, *Cel./V-318* (hairs to 840 μ m. long, individual cells to 230 μ m. long), j–l, from stem; m, *Kostermans & Soegeng* 237, much variation on this specimen. n–s, *C. rigidum*: n, SFN 30873; o, S 13704; p, *Teymann*, HB 642; q, *Teymann*, HB 11379; r, FRI 8109; s, Hallier 2138. t, *C. moonii* (*Kostermans* 24670), apical cells sometimes thin walled. Scale = 120 μ m.

branches with up to 5 flowers and to 2.7 cm. long, the axis to 0.3–3.5 cm. long, puberulent to tomentose at base, often glabrous toward top, lowest internode to 0.5(–1.7) cm. long; bracts ovate, to 6 mm. long, tomentose on lower surface, deciduous; pedicels 0.6–2.8(–3.2 in fruit) cm. long, glabrous (rarely tomentose), usually slender. Flower (?)hermaphroditic; tepals 4, the outer pair ovate, 4.5–6 by 3–5 mm., rarely tomentose on back, the inner pair $\pm$ obovate, 5–9 by 3.2–5 mm.; stamens 40 to 140, the filaments to 4 mm. long, the anthers oblong, 0.7–2.5(–3) mm. long, rounded to retuse at apex; ovary 1–2 mm. long, the style 1.5–2.5 mm. long, the stigma peltate, 0.4–0.7 mm. across, 3- (rarely 4-)radiate. Fruit $\pm$ spherical, 0.9–1.6(–2.2) by 0.9–1.5(–1.8) cm., often apiculate, drying blackish, pruinose, smooth (rarely wrinkled); outer layer detaching cleanly from stone, (1–)1.5–3.5 mm. thick, compact, air spaces sometimes developing under skin; stone subspherical, 0.7–1.1(–1.5) by 0.65–1(–1.3) mm., rounded at apex, the walls 0.2–0.4(–0.8) mm. thick, smooth, unmarked, basal plug sometimes present; spongy layer thin.

DISTRIBUTION. Vietnam to Australia (Northern Territory), the Solomon Islands, and Palau Island; more or less naturalized on the Mascarenes (MAP 10).

SELECTED SPECIMENS SEEN (for explanation of letters, see discussion). **Vietnam:** Haut Donai, stat. agric. de Blao, 800 m., *Poilane* 22402 (BO, K, P); Baochang ad Bienhoa, *Pierre* 1797 (K, P); montibus Dinh ad Baria Gallia, *Pierre* 1797 (K, P); ad Caybé in Galliae Austria, *Pierre* 435 (A, BM, BO, MO, NY, P, SING, US); Bienhoa, Trang Bom, *Poilane* 23613 (B, K, P). **Cambodia:** Phu Quoc, *Pierre* 3646 (P); Phom Kohay, Pursat, *Muller* 635 (P); Koh Kong, Kirirom, *Dy Phon* 2012 (P). **Thailand:** Tripagodas, ca. 40 km. N. of Wangka, 280 m., *Bloembergen* 536 (A, BO, BRI, K, P, SING); Bangsak, Trang, under 50 m., *Kerr* 19035 (A, BM, C, K); Bang Son, *Put* 1562 (BM, K); Suradhanee, Prasong, Hue Din Sua, *Boonchu* s.n., 18 Oct. 1933 (BKF). **Andaman and Nicobar Islands.** **MIDDLE ANDAMAN:** Amit-la-ted [Claudius Range], *Parkinson* 1173 (A); Middle Strait, *Kurz* s.n., *pro parte* (K); Dhany Khari, *King's collector* s.n., 31 Oct. 1894 (A); Port Mount, *King's collector* s.n., 19 Oct. 1894 (A, P); Ani Khet, *King's collector* s.n., 13 June 1891 (E). **SOUTH ANDAMAN:** Port Blair, *Parkinson* 696 (A). **CAMORTA:** sine loco, *Kurz* s.n., Feb. 1875 (K). **Malaya.** **PERLIS:** State Land Bukit Keterin, 15 m., *KEP* 73912 (KEP). **KEDAH:** Bukit Tunga F.R., *KEP* 79256, *pro parte* (KEP). **PINANG:** sine loco, *Wallich dist.* 4841D (BM, G, K). **NEGRI SEMBILAN:** Pasoh F.R., *anon.* s.n., 9 July 1974 (KEP). **MALACCA:** in a garden, *Maingay* 1063 (*Kew dist.* 167) (K). **KELANTAN:** Kemalrang F.R., T. Meserh, *KEP* 84795 (KEP). **PAHANG:** Kuantan, *KEP* 15748 (SING); Endau, *KEP* 29640 (SING). **JOHORE:** Sungei Gembut, *SFN* 36806 (A, K, KEP, LAE, SING); Sungei Tuenseh, *Corner* s.n., 10 June 1934 (KEP, SING); Jason Bay, *Sinclair* 10866 (A, B, E, FI, G, K, NY, P, SING); Kuala Sedili, *Kadim & Noor* 247 (A, BO, K, LAE, SING); Pulau Pisang, *Wyatt-Smith* s.n., 18 Nov. 1954 (KEP); Pulau Yu, 40 m., *Allen* s.n., 30 July 1955 (SING). **MALACCA STRAITS:** Pulau Jarak, *KEP* 71009 (KEP, SING). **Sumatra and adjacent islands.** **RIAUI:** Lingga, Semarang, 20 m., *Bünnemeijer* 7540 (BO, L); Asahan, Boerach Batoe, 30 m., *Yates* 2106 (BO, K, L, MICH, NY); T[ebing] Tinggi, 5 m., *Bruinier* 160 (BO). **SELATAN:** Benkoelen Is., Malakoni, 20 m., *bb* 19720 (A, BO); Enggano, Boea-Boea, 100 m., *Lütjeharms* 3882 (A, BISH, BO, K, NY, P, SING, US). **BARAT:** near Pajakumbuh, Haran Canyon, 150 m., *Meijer*

MAP 10. Distribution of *Calophyllum soulattri* (stars, collections with stones that
in Southeast Asia-Australia.

5394 (L, SING), Tjiakar, 500 m., *Meijer* 4765 (CANB, K, L, SING), base of Mt. Sago, Kampong Padang Panjang, 600 m., *Meijer* 5648 (L); Priaman, *Diepenhorst*, *HB* 2359 (BO, L, U). UTARA: Padang Si Dimpoean, Padang Lawas, Sosopan, Aek Si Olip, *Toroës* 5447 (A, G, K, NY); Is. Morsala, Silabua, 5 m., *Kostermans' collector* 16, anno 1951 (A, BO, K, L, SING); Sibolga, Baroes, Koboën (M. Tapoes), 0 m., *bb* 31028 (A, BO, L, NY, SING); Zuid Nias, Hili Batoe, 10 m., *bb* 5754 (BO). ATJEH: Karolanden, Lao Pengoeloe, *bb* 12514 (BO), Lao Soeloe, 200–300 m., *bb* 9287 (BO); Labeohan Batoe, Bila, Goenoeng Panjaboengan, *Toroës* 4357 (A, NY, US), Pasar Baroe, *bb* 8890 (BO), Goenting Sago, *bb* 7725 (BO); Simaloer Is., Tapah (Defajan), *Achmad* 1691 (BO, L). BANGKA: Lobok Besar, Perlang near Kabu, 50 m., *bb* 34191 (A, K, SING); Rias, 10 m., *bb* 15396 (BO, L); Gadoeng, 20 m., *bb* 10567 (BO). BELITUNG: Tandjong Pandan, Air Malih, 30 m., *bb* 9185 (BO); Mangar, *Teysmann s.n.* (BO). **Borneo and adjacent islands.** SARAWAK. 1st Division: Kuching, *S* 21597 (K, L, SAR, SING); Lundu, *S* 9558 (K, L, SAR, SING); Semengoh F.R., 30 m., *Stevens et al.* 285 (A); Mattang, *Beccari P. B.* 1299 (FI); Telok Paku, Bako N[at.] P[ark], *S* 14751 (A, K, SAN, SAR, SING). 3rd Division: Batang Lassa, *S* 33634 (f) (KEP, SAN, SAR). 4th Division: Batang Bintulu, 0 m., *S* 12098 (K, L, SAN, SAR, SING). BRUNEI. Andalau F.R., 60 m., *Ashton s.n.*, July 1959 (SAR); Sungei Samit (Belait), *KEP* 30429 (K, KEP). SABAH. Ranau: Mile 9, Telupid–Ranau road, *SAN* 73828 (K, L, SAN). Sandakan: Ulu Dusun F.R., 5 m., *Stevens et al.* 350 (f) (A). Kinabatangan (Lamag): Bintang Mas Karamuak, 21 m., *SAN* 81641 (A). Lahad Datu: Matrid, *A* 2493 (K, KEP, L, SING); Silam, 90 m., *SAN* 47680 (K, L, SAN, SAR, SING); Pulau Sakar, 12 m., *SAN* 25363 (K, KEP, L, SAN, SAR, SING); Kelumpang F.R., Mostyn Lor Malang, 30 m., *SAN* 40883 (K, L, SAN, SING); Tembaran Is., 30 m., *KEP* 80511 (KEP); Kunak, 15 m., *SAN* 68098 (K, L, SAN); Madai F.R., 90 m., *SAN* 46117 (K, L, SAN). Semporna: Semporna, near Agr. Station, *SAN* 26321 (?f) (BO, K, KEP, L, SAN, SAR, SING). KALIMANTAN. Timur: Salimbatoe, Sungei Roemah, 25 m., *bb* 11237 (f) (BO); Mara, 150 m., *bb* 10833 (f) (BO); Mt. Ilas Bungaan, 400 m., *Kostermans* 13937 (f) (BO, K, KEP, L, LAE, NY, SING); Tandjong Redeb, Kelai R. near Long Lanuk, 10 m., *Kostermans* 21129 (f) (BO, CANB, G, K, L); Tundjung Plateau, near Djohan Asa, 100 m., *Kostermans* 12623A (BO, CANB, K, KEP, L, SING); Tidoengsche Landen, Malinau (Kabiran), 10 m., *bb* 17855 (A, BO); Bloe-oe, *Jaheri* 1489 (BO); W. Koetei, Mendom (Sei Atan, Klindjan), 100 m., *bb* 29268 (f) (BO, L, MO); Boven Makaham, Laham, 40 m., *bb* 20607 (A, BO); E. Koetei, G. Tepian Lobang, on Menubar, NE. of Sangkulirang, 200 m., *Kostermans* 6034 (f) (A, BO, K, SING). Selatan: G. Pamatton, *Korthals s.n.* (L); Doesson, *Korthals s.n.* (L); Martapoera, Manoekapan, *Labohm* 2071 (BO), Djoengoer, 350 m., *bb* 10413 (BO); Afd. Pleihari, Kampong Kintap, *bb* 2154 (BO, L), Bentok Darat, 300 m., *bb* 10723 (BO); Sungei Alang, 200 m., *bb* 14199 (BO). Tengah: Sampit, Samrang, 30 m., *bb* 10540 (BO), Koeling, 10 m., *bb* 9858 (f) (BO); Afd. Beneden Dyak., Sei Kladan (Kahajan), *bb* 2097 (BO, L). Barat: Moera Kojong, 10 m., *bb* 7479 (BO); Palo, 5 m., *Becking* 35 (BO); Mempewa, Toho, 25 m., *bb* 6326 ($\pm$ f) (BO). **Philippine Islands.** PALAWAN: Binohan Mt., near Puerto Princessa, *Ebalo* 395 (A, NY, UC). CALAMIAN: Busuango Is., Malbato, *Marche* B305 (P). MINDORO: Mt. Yagaw, 500 m., *PNH* 19091 (L, PNH). LUZON. Mountain: Bontoc subprov., *Vanoverbergh* 1888 (?h) (P), 3280 (?h) (F). Cagayan: sine loco, *FB* 22061 (US). Nueva Vizcaya: Caraballo Mt., *Loher* 13636 (M, US). Pangasinan: sine loco, *FB* 8298 (NY). Nueva Ecija: sine loco, *FB* 22182 (BM, BO, P, US). Aurora: Baler, Principe, *Merrill* 1049 (K, NY, US). Bulacan: Angat, *Species Blancoanae* 336 (A, BM, BO,

F, GH, K, MO, NY, P, US, W). Zambales: sine loco, *FB 5841* (?c) (LY). Rizal: Montalban, *Loher 12299* (h) (A, M, UC); Manila, San Mateo, *Vidal 976* (FI, K). Bataan: Lamao R., Mt. Mariveles, *FB 1812* (K, NY, US). Laguna: Famy, Minayotan, 500 m., *PNH 39376* (= *Lagrimas s.n.*, 23 March 1959) (c) (A, L, PNH, SAN, SING); San Antonio, *FB 13197* (BM, BO, K, LY, P, US). Quezon: Mt. Binuang, *BS 28632* (h) (A, BO, K, P, US); Lucban, 1000 m., *Elmer 7525* (s) (A, BO, E, F, FI, G, K, L, LY). Camarines Norte: sine loco, *FB 30616* (NY). Camarines Sur: Sipaco, *FB 30331* (SING). Albay: Monito, *FB 27383* (c) (A); Bataan Is., *BS 80689* (K, MICH, NY). Sorsogon: Cumadcad R., 150 m., *PNH 9776* (c) (A, PNH); Irosin (Mt. Bulusan), *Elmer 17385* (s) (A, BISH, BM, BO, C, F, FI, G, GH, K, MO, NY, P, U, UC, US). CATANDUANES: sine loco, *BS 30293* (A, US). SIBUYAN ISLAND: Capiz, Magallanes (Mt. Giting Giting), 310 m., *Elmer 12293* (BISH, BM, BO, E, F, FI, G, K, MO, NY, W). TICAPO ISLAND: sine loco, *FB 1085* (K, NY, US). SAMAR: sine loco, *BS 17493* (BM, K, US). LEYTE: sine loco, *Wenzel 1613* (A, BM, F, G, MO, NY). NEGROS: Negros Oriental, Dumaguete, Cuernos Mts., 1067 m., *Elmer 9837* (h) (A, BM, E, FI, G, K, LY, MO, US, W). PANAY: Guimaras Is., *FB 317* (NY, US). MINDANAO. Surigao: sine loco, *FB 25074* (A, K, US). Agusan: Cabadbaran (Mt. Urdaneta), 610 m., *Elmer 13989* (A, BISH, BM, C, E, F, FI, G, GH, K, LY, M, NY, P, U, W). Lanao: Lake Lanao, Camp Keithley, *Clemens s.n.*, Feb. 1907 (G), June, 1907 (K). Bukidnon: Mt. Candoon, *BS 38937* (h) (A, K, P, US); Mt. Dumalucpihan, *BS 38967* (A, P, US); Kimantri Plain, Malaybalay, *FB 30279* (B, BO, P, US). Davao del Sur: Santa Cruz, *Williams 2770* (A, NY, US). **Java and adjacent islands.** BARAT: Buitenzorg, Tjikeumeuh, 250 m., *Bakhuisenf. 3563* (BO, L, U); Pakantjilan, *Bakhuisenf. 276* (U); SE. van Depok, Tjilong, *Backer 31212* (BO); Bodjong Eyot., 200 m., *Bakhuisenf. 6351* (BO, L); Tjitjadas, SE. of Batavia, 15 m., *Lanjouw 8* (A, BO, K); Kampong Baru, 200 m., *Schiffner 2245* (A, BO, K); Kampong Nangrang, 250 m., *Schiffner 2244* (BO, L); Tjamplong, *Kuhl & van Hasselt s.n.* (L); Udjong Kulon Nature Reserve, Mt. Pajung, 300 m., *Kostermans s.n.*, 17 Dec. 1960 (A, BO, L, SING), Tjiuluran-Sangiang Sirah, 100–300 m., *Wirawan 344* (f) (BO, K, L, SING). TENGAH: Djokjakarta, Sleman, Kalioerang, 1000 m., *Ja 2569* (BO, L); Karel bij Karangmodjo, *Boerrigter 85S* (BO); Semarang, *Koorders 2873* (BO, G); Kedoengdjati (Djamboessen), *Koorders 25403* (BO); Djapara, Soemanding, *Ja 1837* (BO); Kedoe, Weetoetoe, W. van Kedjadar, 500 m., *Plokheim s.n.*, 9 Nov. 1921 (BO). TIMUR: montis Ngebell, prope Pondrongo, *Waitz s.n.* (L); Kediri, G. Pandan, *Thorenaar 204* (BO). KARIMOENDJAWA: Tandjong Gelam, *Karta 305* (BO). BAWEAN ISLAND: G. Besar, 400 m., *Buwalda 3192* (= *Ja 4234*) (f) (A, BO, L). **Lesser Sunda Islands.** BALI: Mt. Sangiang, 500 m., *Kostermans s.n.*, 7 July 1958 (f) (L). LOMBOK: Mambalan, 600 m., *bb 21396* (A, BO). SUMBA: Loka-Winggor, *Teymann, HB 8826* (BO); Djagamango, 975 m., *bb 5400* (BO). SUMBAWA: Mt. Batulanteh, 500–600 m., *Kostermans 18611* (f) (BO, G, L, P), 19076 (A, BO, C, CANB, G, LAE, NY, P, SING); Matemaga, 650 m., *bb 14050* (BO); Kawowo, 700 m., *bb 12024* (BO). FLORES: Ngada, Keo, 1400 m., *bb 21428* (BO, L); S. part Mt. Ndebi, 400 m., *Kostermans s.n.*, April 1965 (f) (L); Werang (Kempo), 350 m., bis Berg Beliling, 1600 m., *Schmutz 2018* (?f) (L); Denge to Wai Rebo, 900 m., *Schmutz 3537* (f) (L); Nunang, 900 m., *Schmutz 663* (?f) (L); Ngada, Nderoe, 800 m., *bb 11399* (BO); Maoemere, G. Egon, 1703 m., *bb 6897* (BO). SOLOR: Belodoea, 750 m., *bb 15975* (BO). WETAR: Kali, N. v. Ilwaki, 700 m., *bb 27200* (?f) (BO, K, L, SING). **Celebes.** TALAUD: Karakelang, G. Duata, 200 m., *Lam 2925* (A, BO, K), G. Piapi, 400 m., *Lam 3263* (BO, K). SULAWESI: Manado, Amoerang, Loban Kolai, 250 m., *bb 17133* (A, BO); Paloe, Ngilalaki,

1250 m., *bb* 28259 (BO), Banggai, Pongian, 100 m., *bb* 31876 (r) (BO); Minahassa, Kajoewatoe, 200 m., *Koorders* 17292 (BO, P), bij Tondano, 900 m., *Koorders* 17302 (BO, P), Pinamorongangebergte, 500 m., *Koorders* 17301 (BO, P); Boleang Mongondow, Rangagon, 250 m., *bb* 32482 (BO); B. Boalemo, Popaja, 250 m., *bb* 15698 (BO); Mamasa, Pena, 1500 m., *bb* 33066 (?) (BO, L); Enrekeng, Rantalemo, 1100 m., *bb* 29191 (BO, SING); Todjamboe, 700 m., *Kjellberg* 2946 (BO); Liasa, 300 m., *Kjellberg* 2263 (BO); Kosali-Porema, 500 m., *Kjellberg* 2615 (BO); Djeneponto, Lembaja, 1650 m., *bb* 8576 (BO); Malili, *Kjellberg* 2033 (r) (BO), nabij La Rona, *bb* 2370 (BO), Boschafd. Bataemati, 600 m., *bb* 23570 (BO), B. Takale Kadjoe, 1500 m., *bb* 24074 (?) (BO, L), Oesoe, *Cel.* III/63 (r) (BO), Kawata, 200 m., *Cel.* V/318 (r) (A, BO); Sungei Tolewonu, *Musser et al.* 528 (A); Sungei Sadaunta, *Musser et al.* S-19a (A); Wavotobi, 100 m., *Kjellberg* 864 (BO); Lepo-Lepo, presso Kandari, *Beccari s.n.* (FI, herb. Becc. 1138); Mengkoka, Kolaka, 0-100 m., *Elbert* 3229 (r) (A, BISH, BO, CANB, FI, G, SING, US). KABAENA: Balo, Eempuhu, *Elbert* 3305 (r) (BO). MUNA: Onsoeme, 100 m., *bb* 21773 (r) (A, BO). BUTUNG: Bone, Bonteriloe, 1100 m., *bb* 29018 (BO). **Moluccas.** SANANA: Molboefa, 200 m., *bb* 29819 (BO, L, SING); Soelabesi, *Hulstijn & Atje* 410 (BO, L). HALMAHERA: Tasoia, G. Sembilan, 300 m., *Pleyte* 266 (A, BO, K, SING). MOROTAI: G. Sabatas, 180 m., *Lam* 3567 (A, K). BATJAN: sine loco, *de Vries* (?95) (L). BURU: Kak Toea, 800 m., *bb* 22831 (L, MO); Wai Geren Olon, 800 m., *bb* 21506 (BO, L). AMBON: Waai, Mt. Salahatu, 200 m., *Kuswata & Soepadmo* 255 (A, BO, K, LAE, P, SING); Benteng, *Rant* 533 (BO); Amboina, *Pl. Rumph. Amboin.* 482 (BO, F, K, L, MO, P, SING, US); Hitoe Messen, 150 m., *Pl. Rumph. Amboin.* 481 (BM, BO, GH, K, NY, P, US); Latoera, *Boerlage* 415 (BO). SERAM: Kairatu, Gemba, 0-5 m., *Kuswata & Soepadmo* 110 (A, BO, L, NY, P, SING), Waiselang, 150 m., *Kuswata & Soepadmo* 232 (A, BO, CANB, K, P, SING); Roembatoe, 800 m., *bb* 23035 (BO); W. of Piroe, 1-100 m., *Rutten* 1645 (BO, K, L); Porong Mountains, Makina, 1000-1200 m., *Rutten* 2246 (A, BO); Wae Kali, 100-200 m., *Kornassi* 1017 (BO, K, L); Kiandarat, 60 m., *bb* 25839 (BO). **Papuasias**—see Stevens (1974). Also, KAI ISLANDS: Keteil a Tual, *Beccari s.n.* (FI, herb. Becc. 1139-1141). TANIMBAR ISLANDS: Makatian, 30 m., *bb* 24403 (A, BO); P. Jamdena, Weri Ranarmoje, *Buwalda* 4676 (A, BO, K, SING); near resthouse between Kp. Ingei and Otember, *Buwalda* 4216 (A, BO, K). ARU ISLANDS: P. Kobroor, Dosinamalaoe, *Buwalda* 5093 (A, BO, K). IRIAN BARAT. Geelvink Bay: Japen, Seroei, *bb* 30629 (A, SING). PAPUA NEW GUINEA. Manus: Derimbat, 50 m., *LAE* 52459 (A, LAE); Kaguli Ridge, 30 m., *LAE* 52940 (LAE); Mt. Dremsel, 600 m., *LAE* 59153 (LAE). **Australia.** NORTHERN TERRITORY: Melville Island, *Dunlop* 3435 (DNA, CANB); Port Darwin, *anon.*, anno 1890 (BRI). **Caroline Islands.** PALAU: Urukthapel, *Dutton* 80 (US).

ECOLOGY. Small tree of lowland or colline rainforest, rarely dominant in canopy (Great Nicobar Island); to 1700 m. alt. Prefers well-drained habitats but sometimes in swamp forest, where it develops small knee roots (Malaya—Corner, *loc. cit.*; Sabah—pers. obs.). In Sabah, Papua New Guinea, and the Solomon Islands (Santa Isabel), also over ultramafic rock. Also in secondary forest. Flowering throughout year, but in Java mostly September to December. (In Cambodia flowering in October, fruiting December to March—*Dy Phon* 2012). Entire inflorescence white (except yellow anthers and reddish stigma); flower scented. Ripe fruit purplish black.

Galls—conical protuberances ca. 1 mm. tall—occur just in from the edge

of the lamina on *Pleyte 266* (from the Moluccas). Similar galls on a specimen from Sumba Island were caused by gall midges (Docters van Leeuwen-Reijnvaan & Docters van Leeuwen, 1941).

GERMINATION. The radicle breaks the stone to one side of the base, and the seedling has two pairs of leaves usually separated by a very short internode, although in *Stevens et al. 285A* the internode is up to 1 cm. long. Subsequent internodes are ca. 1 cm. long; their length is not affected by the light or nutrient status of the plant. The terminal bud is functional, and growth is erect. Eventually internodes more than 5 cm. long are produced (Stevens, 1974, *loc. cit.*; *Stevens et al. 285A*, 358, 916). Burger's account (1970) of the germination does not agree with this.

On Manus Island, and probably also on Bougainville and the Solomon Islands (Papuasias), the radicle pushes out a well-developed basal plug 5–7 mm. across during germination. The seedling has two pairs of leaves separated by a very short internode; the first internode is up to 5 cm. long (*LAE 52458*, *52459*; *NGBF 1219*).

LOCAL USES. Although the wood of *Calophyllum soulattri* is not very durable, it is used for masts and spars and in house construction throughout its range. In Bangka "getah malang-malang" is used to poison dogs. The bast, "babakan slatri," is given to horses in Djakarta once a month to keep them in good condition. An infusion of the root is rubbed on to alleviate rheumatic pain. Oil from the seeds is used like that of *C. inophyllum* (q. v.); the sourish fruits can be eaten, but if eaten in excess they cause severe stomachache and diarrhea (Heyne, *loc. cit.*). In the Caroline Islands fresh bark from the shoot is used as medicine for women who have just given birth (Lauterbach, as *C. cholobtaches*). On the Huon Peninsula (Papua New Guinea) the leaves are reported to make a durable thatch (*Clemens 184*).

Although a variable species, *Calophyllum soulattri* is usually readily recognizable by the well-developed uppermost pair of axillary buds that are nearly always tightly adpressed to the terminal bud, and by the somewhat thinly coriaceous lamina that is rather closely undulate at the margin and that often dries a characteristic olivaceous-buff on the upper surface, the venation being fine. The inflorescence, which nearly always has lateral branches half the length of the main axis or longer, is also distinctive. The fruits are usually subspherical and dry blackish and smooth; the outer layer is well developed and compact, and the stone wall is thin. The hairs show little variation; they typically have a single basal branch. The epithet *soulattri* is derived from a Javanese local name for the plant.

Calophyllum soulattri has been confused with *C. kunstleri* (= *C. rigidum*). However, the venation on the dry lamina of *C. kunstleri* is apparently twice as dense on the upper surface as on the lower, the inflorescence is unbranched (the flowers tend to be arranged in pseudowhorls), and the fruit usually dries brown and wrinkled. In Malaya, sterile material of *C. soulattri* and *C. symingtonianum* has been confused; for differences between these species, see TABLE 6.

Variation within *Calophyllum soulattri*

The greatest variation within *Calophyllum soulattri* is in the Philippines-Celebes-Moluccas area. Although some of this variation is rather trivial (in such characters as indumentum, leaf texture, and midrib type—this perhaps rather surprisingly) and is neither correlated with other characters nor always constant within a collection, field work in this area may lead to some modification of the limits of *C. soulattri*. More important variation occurs in the fruit (e.g., the larger-fruited specimens from the Tanimbar Islands). The rather remarkable variation in germination, seedlings, and fruits in *C. soulattri* from the easternmost part of Papuasias (see below) may eventually lead to the plants there being given formal recognition.

In the area from Java and eastern Borneo to the Moluccas and the Aru Islands, there are a number of specimens with strongly flattened twigs that are rounded at the edges (specimens "f" in the list above). Such specimens also tend to have a thicker lamina that dries a browner color than is usual; the indumentum is often, but not always, poorly developed; and the pedicels are strongly incrassate in fruit. In specimens of this type from the Lesser Sunda Islands, the submature fruits are about 1.5 cm. long and dry brown and wrinkled; in Borneo (e.g., *Kostermans* 6034, Kalimantan) the fruits dry brown and smooth, with the stone walls about 0.7 mm. thick—thicker than is usual in *C. soulattri*. *Kuswata & Soepadmo* 253 (Ambon), which also has flattened twigs, has a chartaceous lamina and stones with walls only about 0.4 mm. thick.

In a number of specimens from Sulawesi ("r" in the list), the midrib on the upper surface of the lamina is surrounded by raised blade. However, such specimens are not otherwise unusual.

Fruiting specimens from the Tanimbar Islands (e.g., *Kuswata & Soepadmo* 110) have fruits up to 2.3 by 1.8 cm. that dry blackish and wrinkled; the stone walls are about 1 mm. thick. Such specimens have not been incorporated in the description and are included here *faute de mieux*; they possibly approach *Calophyllum leleanii*. Two specimens from Sulawesi (bb 24074, 33066) have large, ellipsoid fruits 2–3.3 cm. long with ellipsoid stones that are pointed at the apex and have walls ca. 1.5 mm. thick. Specimens collected by Kurz from the Nicobar Islands also have rather large fruits; in this case the wall of the stone is ca. 0.8 mm. thick, and the specimens are more typical.

Specimens similar to those from Papuasias that have well-developed tomentose indumentum on the vegetative parts and on at least the lower part of the inflorescence axis (see Stevens, 1974a, *loc. cit.*) occur elsewhere in the range of the species. However, there are intermediates between such specimens and those with inconspicuous indumentum, and it is unwise to recognize taxa based on indumentum characteristics.

Calophyllum spectabile var. *ceramicum* was described from a robust specimen with leaf blades up to 27 by 10.2 cm.; such specimens (e.g., *Pleyte* 266) are quite common in the Moluccas. Similar specimens have also been collected in central Sulawesi, where the local people consider that the plants belong to a species distinct from the small-leaved form (compare *Musser*

et al. 528, the large-leaved form, with *Musser et al.* 507, the smaller-leaved form). However, it seems premature to recognize a taxon based on these large-leaved specimens.

Elmer based his invalidly published name, *Calophyllum sorsogonense*, on a plant that has the inflorescence, flower, and fruit characters of *C. soulattri*, but has a lamina that is shallowly cordate at the base and dries a rather dark, dull brownish gray, and a petiole that is short (specimens "s" in the list, from the Philippine Islands); at first sight this is a very distinctive form. However, the leaves of some specimens from Sulawesi have well-developed petioles and blades that are more or less acute at the base and more or less truncate at the apex, being finally mucronate; in characters like indumentum and color of the dried leaf, they are similar to *C. sorsogonense*. Such specimens (e.g., *Koorders* 17300, to which the name *C. oblongum* *Koorders* has been given) also approach some from Java (e.g., *Koorders* 28105). Sterile specimens recently collected in Sulawesi (e.g., *Musser et al.* 1044) also have cordate leaf bases, but are otherwise quite different.

The type specimen of *Calophyllum hibbardii* (*Elmer* 9837) has leaf blades that dry a rather dark brown color; although the lateral branches of the inflorescence are long, the inflorescence is not flabellate, and its lowest internode is up to 1.7 cm. long. (The isotype of *C. hibbardii* at Lyons has a terminal inflorescence.) The pedicels in young fruit are up to 3.2 cm. long, and the fruits are immature—when mature, they might be rather large for *C. soulattri*. *Calophyllum hibbardii* is a fairly distinct variant of *C. soulattri*, but it cannot be recognized formally (specimens matching the type of *C. hibbardii* are denoted by "h" in the above list; they are known only from the Philippine Islands).

Other specimens from the Philippine Islands ("c" in the list) have coriaceous leaf blades with relatively distant venation, but they are otherwise like *Calophyllum soulattri*.

Stevens (1974a, *loc. cit.*) cited *NGBF* 1089A (from Manus Island, Papua New Guinea; consisting only of fruits) as *Calophyllum pseudovitiense* (= *C. neo-ebudicum*), albeit with some hesitation: the stones have basal plugs (as in *C. pseudovitiense*) but were picked up underneath a tree of *C. soulattri*. Further collections from Manus Island by D. B. Foreman clearly show that such fruits come from a tree that in vegetative and floral characters agrees with *C. soulattri*. However, the relatively thick-walled stones have basal plugs that are pushed out during germination, and the young plant has long internodes from the very beginning; in all young plants seen of *C. soulattri* *sensu stricto* (in Sarawak, Sabah, various places on the Papua New Guinea mainland, and New Britain), the internodes are initially short. Similar fruits occur probably on Bougainville (*NGBF* 1219) and certainly on the Solomon Islands (New Georgia group: *BSIP* 192, 1249, 2812, 5953, 6144, 11597, 15808); they may be up to 2.5 cm. long. The only other specimen of *C. soulattri* *sensu lato* with mature fruit seen from the Solomon Islands (Choiseul: *BSIP* 17507) had stones with a discolored area ca. 2.5 mm. across at the base, as in "normal" *C. soulattri*, but no plug. Latex of specimens from the Solomon Islands is frequently reported as being yellow(ish) in color, sometimes clear

(e.g., *BSIP* 192), but not always (*BSIP* 3833 and 2388 apparently had white latex). *NGBF* 1219, taken from the tree under which the stones with basal plugs were collected on Manus, had white latex. *Calophyllum soulattri* on the mainland of Papua New Guinea sometimes has yellow latex (e.g., *Hartley* 11906), although it is usually white. Fruits of both types turn blackish purple when ripe. Clearly much careful field work is needed to understand this variation; it should be remembered that *C. paludosum* C. T. White was described from a specimen (*BSIP* 192) that has stones with a basal plug.

Synonymy and Nomenclature

In the following discussion, reasons are given for the reduction of several species to synonymy under *Calophyllum soulattri*, and a number of names are lectotypified. Further details of the synonymy of *C. lanceolatum* and names based on specimens collected in Papuasias are given in Stevens (1974a).

Calophyllum soulattri was described from material originating from Java. At Geneva there are three specimens of this species originally in Burman's herbarium and subsequently in that of Delessert; two are annotated "*soulattri*" (by different hands, one apparently by Burman).

Merrill (1917, *loc. cit.*) was correct in his equation of *Bintangor montana* Rumphius (Herb. Amboin. 2: 216. t. 72. 1741) and *B. montana secunda* Rumphius (*ibid.*, p. 217) with *Calophyllum soulattri*: Rumphius mentioned the characteristically drying leaves. *Bintangor montana secunda* was described as having leaf blades "bifid" at the apex; specimens of *C. soulattri* with retuse apices are uncommon, even in Sulawesi.

Apoterium sulatri is lectotypified on a specimen apparently annotated by Blume held at Leiden (herb. Lugd. Bat. 903, 343-183).

The original publication of *Calophyllum tetrapetalum* must be ascribed to G. Don, not Roxburgh. Don described *C. tetrapetalum* from a stove plant, and the description fits *C. soulattri*: "leaves ovate or oblong lanceolate, obtusely acuminate. Racemes axillary, short, corymbose, 2-3 together. . . . Native of the East Indies." I have not seen authentic material of *C. tetrapetalum* Roxb. ex G. Don. Roxburgh's description (1832, *loc. cit.*) of a plant with very finely serrulate leaves is at first glance that of a different species (or genus!). However, a Roxburgh specimen from the East Indies at the British Museum, although annotated *C. tetrapetalum*, is clearly *C. soulattri*; because of the way that the specimen was pressed, the rather closely undulate leaf margin appears to be serrulate.

The name *Calophyllum suriga* is a superfluous name for *C. soulattri*, since the latter is cited as a synonym in the protologue. Whether or not the species described by Carey (in Roxburgh, 1832, *loc. cit.*) is to be assigned to *C. soulattri* is another matter (see also Planchon & Triana, *loc. cit.*). The description reads rather like that of *Mammea longifolia* (Wight) Planchon & Triana;¹³ for instance, the flowers are said to be borne below the leaves.

¹³ Kostermans (1961) used the name *Mammea suriga* (Buch.-Ham. ex Roxburgh) Kosterm. for this species.

I have not seen material which could be assigned to the original *C. suriga*.

Calophyllum hirtellum, *C. cymosum*, and *C. diepenhorstii* have all previously been reduced to synonymy under *C. soulattri* or *C. spectabile*; they are based on specimens representing a common form of the species. *Calophyllum cymosum* was based on two specimens, one collected by Junghuhn from northern Sumatra, the other collected by Teysmann from western Sumatra; a sheet of the latter at Utrecht is designated the lectotype. Boerlage (*loc. cit.*) described two varieties of *Calophyllum spectabile* (= *C. soulattri* as now interpreted) and reduced *C. diepenhorstii* to a variety of that species, but none of these varieties can be maintained. The type specimen of *C. spectabile* var. *miquelii* is unremarkable.

A few more details of the synonymy of some Papuasian names can now be given. I have seen syntypes (or fragments of them) of *Calophyllum kiong*, and it is clear that Whitmore was correct in reducing this to synonymy under *C. soulattri* (Whitmore, 1967, *loc. cit.*). The name "kiong," used 75 years ago in the Finschhafen area and taken by Lauterbach and Schumann for the epithet of their *C. kiong*, is still used there for this plant. The reduction of *C. versteegii* to *C. soulattri* is not yet definite. The inflorescences of the isotypes may have a short axis to 2 mm. long, but the inflorescence is neither flabellate nor branched. The leaf blades dry a dark, rich, shining brown above. These are rather unusual characters for *C. soulattri*. Details of the typification of *C. solomonense* are discussed under *C. leleanii*.

Calophyllum lancifolium was described from Philippine material with very narrow leaf blades. However, there are intermediates between it and broader-leaved specimens (e.g., *Williams* 2770 and *FB* 24736). The specimen of *Elmer* 13266 at the Arnold Arboretum is designated the lectotype of *C. lancifolium*. *Calophyllum zschokkei*, also from the Philippines, was described from specimens having rather small leaves and lacking well-developed indumentum; they link the larger-leaved specimens from the Philippine Islands with two particularly small-leaved specimens, *BS* 38967 (Mindanao) and *BS* 30293 (Luzon). The sheet of *Elmer* 12129 at the Gray Herbarium is made the lectotype of *C. zschokkei*.

Vanoverbergh 1888, determined by Merrill as *Calophyllum vanoverberghii* and collected from the type locality of that species, matches the type of *C. hibbardii* (see above) fairly well. *Calophyllum vanoverberghii* was described as having an oblong, very coriaceous leaf blade that dried the same color on both surfaces, while the duplicates seen of *Vanoverbergh* 1888 have an ovate, subchartaceous leaf blade that has not dried concolorous. Although the description of the inflorescence of *C. vanoverberghii* suggests that it is similar to that of *C. soulattri*, I hesitate to reduce *C. vanoverberghii* to synonymy under *C. soulattri* without seeing type material.

Of the five specimens cited in the original description of *Calophyllum cholobtaches*, fragments of three (*Ledermann* 14251, *Raymondus* 128 and 334) have been seen; *Raymondus* 29 and 293A have not. *Ledermann* 14251 was the only fertile specimen (Lauterbach, *loc. cit.*), and the fragment of this number at Wrocklaw (designated the lectotype) has the branched inflorescence and almost chartaceous, rather greenish-drying lamina characteristic

of *C. soulattri*. Lauterbach compared *C. cholobtaches* to *C. kiong* (also = *C. soulattri*) but noted that the former had less dense and more steeply ascending venation. These differences are of no significance. The leaves seen of *Raymondus* 128 and 334 both have only 6 to 8 veins/5 mm.—very distant for *C. soulattri*. However, only the former specimen is probably to be referred to *C. soulattri*, while the latter is *C. pelewense* (q. v.).

Early authors almost without exception used the name *Calophyllum spectabile* Willd. for *C. soulattri*. *Calophyllum spectabile* was described from Mascarene material and is a synonym of *C. tacamahaca* (for more details see Stevens, 1976, *loc. cit.*).

22. ***Calophyllum brassii*** A. C. Smith, Jour. Arnold Arb. **22**: 352. 1941; P. F. Stevens, Austral. Jour. Bot. **22**: 359. 1974. TYPE: Netherlands New Guinea [Irian Jaya], Idenburg River, 4 km. SW. of Bernhard Camp, 850 m., 7 March 1939, *Brass & Versteegh 13122* (holotype, A; isotypes, BO, BRI, L).

Tree 20–30 meters tall, d.b.h. to 68 cm.; trunk without spurs or buttresses; outer bark yellowish brown to dark brown, with few to many shallow fissures, inner surface brown-orange and orange mottled; under bark brown-red and dark red mottled; inner bark reddish; latex white, rather curdy, slightly sticky (also reported to be light yellow or brownish).

Twigs (strongly) flattened, 2.5–6 mm. across, $\pm$ 2-, 4-, or 6-angled, with obscure raised horizontal lines at node, drying brown (yellowish), $\pm$ persistently subfarinose to short-tomentose; axillary innovations lacking basal scars; internodes 0.5–6(–8) cm. long; uppermost pair of axillary buds $\pm$ pointed, 2.5–7 mm. long, erect; terminal bud subconical, 0.5–1.4 cm. long, with brownish gray, short-tomentose to (?) subcrustaceous indumentum, the hairs unthickened except at base, often with short, basal branches, the underdeveloped internode to 1.5 mm. long. Petiole 1–6(–8) mm. long, broadly concave above, convex to angled below, subpersistently tomentose or subglabrous; lamina elliptic to oblong, (3–)6–17 by (1.9–)4–6 cm., rounded to shallowly retuse or apiculate at apex, (narrowly to) broadly rounded or cordate at base, usually only slightly undulate and strongly recurved at margin, (thickly) coriaceous, drying brick or cinnamon to greenish olivaceous above and near sabelline below, subpersistently puberulent to short-tomentose on midrib below (also above), the midrib above usually narrowing fairly quickly near base, raised, 0.25–0.6 mm. wide at midpoint, below strongly raised, usually angled, the venation subobscure (rarely subapparent) above and below, depressed to raised above, raised below, 10 to 16 veins/5 mm., angle of divergence 65–80°. Inflorescences from foliate axils, with numerous flowers, flabellate, branched, branches to 1.3 cm. long and with 5 flowers, the axis 1.2–5 cm. long, $\pm$ tomentose, especially at nodes and toward base, lowest internode 1.5–4.5 mm. long, upper internodes to 1.7 cm. long; bracts suboblong to semiorbicular, to 3 mm. long, deciduous; pedicels (0.5–)0.7–2 cm. long, glabrous. Flower (?) hermaphroditic; tepals 4 (rarely 5), the outer pair lingulate, 3.8–4.5 by 1.7–2 mm., the inner pair elliptic to obovate, 4–4.7 by 2.1–2.7 mm.; stamens 65

to 105, the filaments to 2.3 mm. long, the anthers subelliptic, 0.4–0.7 mm. long, retuse at apex; ovary 0.6–0.9 mm. long, the style 1.2–1.7 mm. long, the stigma peltate-infundibular, 0.3–0.5 mm. across, not radiate. Submature fruit broadly ovoid, ca. 1.4 by 1.3 cm., apiculate, drying brown, deeply wrinkled; outer layer not detaching cleanly from stone, 0.7–1.5 mm. thick, compact; stone ovoid, 1–1.1 by 0.8–1 cm., apiculate, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer initially thick.

DISTRIBUTION. Western portion of the New Guinea mainland (MAP 9).

ADDITIONAL SPECIMENS SEEN. **Papuasias**. IRIAN JAYA. Vogelkop: N. slopes of upper Aifat Valley, between Senopi and Aifatfeka, W. of Kebar Valley, 920 m., *BW 12843* (L, LAE), 870 m., *BW 12848* (L, LAE). Fakfak: Tavoei [Onin Peninsula], *bb 22317* (probable) (A, BO, L, LAE, SING). Digul: 5 km. NE. from junction Iwoer R. and E. Digul, Sub. Div. Moejoe, 400 m., *BW 8530* (L). PAPUA NEW GUINEA. Western: Kiunga, 20 m., *Stevens et al. 838* (A).

ECOLOGY. Primary colline (often with *Agathis* Salisb.) or sometimes lowland rainforest, (20–)400–920 m. alt. Flowering and fruiting in March; ripe fruit blackish.

Stevens et al. 838 has subspherical, eventually crateriform galls in rows along the midrib of the lower surface of the lamina, or sometimes just in from the margin.

GERMINATION AND YOUNG PLANT. The radicle breaks the stone wall to one side of the base. The seedling has two pairs of leaves separated by an internode less than 5 mm. long. Subsequent internodes are less than 1.5 cm. long. The terminal bud is functional, and the plant is erect. Only after the plant is some 30 cm. tall are internodes of ca. 3 cm. long or more produced (pers. obs.).

Calophyllum brassii can be recognized by its strongly flattened twigs and its very coriaceous leaves, which are usually broadly rounded to cordate at the base, strongly recurved at the margin, and with rather dense venation. The branched inflorescence has a short basal internode and numerous flowers with four tepals. The epithet commemorates L. J. Brass, one of the greatest botanical collectors in New Guinea.

A few fruits occur on *Stevens et al. 838*; all lack an embryo. They are spherical, about 7.5 mm. long and across, with the outer layer about 1.8 mm. thick, and the obovoid stone about 5.5 by 3.2 mm. across and strongly apiculate (all measurements from fluid-preserved material). The wrinkled fruits of *Brass & Versteegh 13122* are still immature, but it is interesting to see that there, too, the stone is apiculate; it is probable that mature fruits, when dried, will be almost smooth.

Calophyllum brassii is close to *C. soulattri* (Smith, *loc. cit.*; Stevens, *loc. cit.*). However, the leaf blades of *C. soulattri* are rarely so coriaceous or cordate at the base, the inflorescences have fewer flowers, and the stone is not apiculate.

BW 12843 and *12848* (from the Vogelkop) differ from the other specimens

of this species in their yellowish-drying twigs and their relatively thinner leaves. *Stevens et al.* 838 tends to have short internodes, and like the specimens from the Vogelkop, its indumentum is subtomentose. Although this specimen was found at much lower altitudes than the others, it should be noted that at Kiunga genera and species commonly found at higher elevations grow at less than 30 meters altitude. In addition to *Calophyllum brassii*, *Dimorphanthera* F. Mueller (two species), *Vaccinium* L., *Lithocarpus* Bl., and *Podocarpus* L'Hér. ex Pers. all grow in the same area.

BW 8530 is superficially similar to the form of *Calophyllum goniocarpum* that grows at Kiunga, since it has the most narrowly rounded leaf bases of the specimens included in *C. brassii* (cf. also *bb 22317*). *Calophyllum brassii* and *C. goniocarpum* are not at all closely related and differ in inflorescence (much longer axis with short branches (if any) in *C. goniocarpum*) and fruit (angled, much larger, thicker-walled stone in *C. goniocarpum*). The uppermost pair of axillary buds is erect and usually well developed in *C. brassii*, and suberect and inconspicuous in *C. goniocarpum*; this difference helps to distinguish sterile material of the two taxa.

23. ***Calophyllum rigidum*** Miq. Fl. Indiae Batavae, Suppl. 1(3): 497. 1861; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868; Vesque in C. DC. Monogr. Phanerog. 8: 606. 1893; H. Keng, Gard. Bull. Singapore 28: 255. 1976. TYPE: Sumatra, ad littoram Siboga, *Teysmann*, HB 642 (holotype, U; isotypes, BO, K, L, MEL, P, W).

Calophyllum kunstleri King, Jour. Asiatic Soc. Bengal, II. 59: 174. 1890; Ridley, Fl. Malay Penin. 1: 182. 1922, *pro parte*; I. H. Burkill & M. R. Henderson, Gard. Bull. Straits Settl. 3: 347. 1925; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 320. 1956; Maheshwari, Bull. Bot. Survey India 2: 141. 1960, *pro parte*; I. H. Burkill, Dict. Econ. Prod. Malay Penin. ed. 2. 1: 416. 1966, *pro parte*; T. C. Whitmore, Tree Fl. Malaya 2: 187. 1973; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978. SYNTYPES: Malaya, Perak, Larut, 300 feet [90 m.], Dec. 1883, *King's collector* [*Kunstler*] 5328 (A, BO, FI, G, K, SING, US), 100 feet [30 m.], Dec. 1883, 5374 (G, K, SING, UC, US), 100 feet [30 m.], Jan. 1884, 5459 (FI, P).

Tree 6–24(–36) meters tall, d.b.h. to 45 cm.; trunk without buttresses, “loop roots” sometimes present in plants from swamps; outer bark gray-brown to dark brown, shallowly fissured or with vertical lines of lenticels, often hoopmarked, inner surface blackish; under bark dark red; inner bark red; latex clear yellow and fluid or sticky, opaque yellow and not very sticky, or yellowish brown. Branches often pendulous, at least in Malaya.

Twigs slightly to strongly flattened, (0.9–)1.2–3.5 mm. across, $\pm$ 4-angled, soon becoming rounded, usually drying blackish (mid-brown), subpersistently puberulous to short-tomentose; axillary innovations lacking basal scars; internodes (1.3–)2–4(–6.5) cm. long; uppermost pair of axillary buds subacute, to 4 mm. long, suberect, plump and very conspicuous just before flowering; terminal bud plump to narrowly conical, (3–)4.5–10(–13) mm. long, with usually castaneous, short, tomentose indumentum (hairs, FIGURES 13, o; 14, n–s),

underdeveloped internode to 2.5(-6) mm. long. Petiole 0.6-1.5(-2.3) cm. long, concave to $\pm$ flat above and convex (rarely subangled) below, subpersistently puberulo-tomentose; lamina ovate (subelliptic to suboblong), (4-)6.7-17.5 by (1-)2.2-5.6 cm., gradually (short-)acuminate at apex with acumen to 1.7 cm. long, (rarely retuse (Sarawak)), cuneate or attenuate (rarely rounded) at base, not undulate or barely so and not recurved at margin, coriaceous, drying bay to umber and usually shiny above, umber and $\pm$ shiny below, $\pm$ persistently puberulent to subtomentose on midrib below (also above), the midrib above gradually narrowed from base, level or slightly raised, $\pm$ strongly sulcate, 0.2-0.4(-0.7) mm. wide at midpoint, below usually strongly raised, rounded or slightly striate, the venation subobscure to apparent above, latex canals and veins often equally clear especially in older leaves, apparent below, latex canals less prominent than veins, raised, (7 to) 10 to 17 veins/5 mm., angle of divergence 40-70(-80)°. Inflorescences from foliate axils along twig, with 3 to 11 flowers, usually unbranched (rarely with 3-flowered branches to 3 mm. long), the axis 0.2-2.5 cm. long, short-tomentose toward base, lowest internode 1-5 mm. long, flowers often congested (with 2 pseudo-whorls of 4 and 5, or 4 and 3, flowers); bracts ovate, 2-6.5 by 1-2.5 mm., short-tomentose below, subpersistent; pedicels 0.5-2.7 cm. long, slender, glabrous, to 1.2 mm. thick in fruit. Flower (?)hermaphroditic; tepals 4, the outer two ovate, 4-5.5 by 3-4 mm., the inner two elliptic to obovate, 5-9 by 2.3-3.5 mm.; stamens ca. 75, the filaments to ca. 4.5 mm. long, the anthers elliptic-oblong, 0.5-0.8 mm. long, retuse at apex; ovary 1.5-2.5 mm. long, the style 2.8-4.3 mm. long, the stigma peltate, ca. 0.5 mm. across. Fruit spherical, 1.2-1.6 cm. long and across, minutely apiculate, when young usually ovoid and sharply pointed at apex, drying brown, broadly wrinkled; outer layer eventually detaching cleanly from stone, 1-2.5 mm. thick, compact; stone ellipsoid to subspherical, 1.1-1.4 by 1-1.25 cm., rounded at apex, the walls 0.15-0.5 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southern Malay Peninsula to western Borneo, scattered; excluding Java (MAP 11).

SELECTED SPECIMENS SEEN. **Malaya.** PERAK: Larut, 90 m., *King's collector* 5328 (A, BO, FI, G, K, SING). MALACCA: Bukit Sedanan, *Derry* 119 (BM, SING); Ayer Panas, *Derry* 151 (SING). NEGRI SEMBILAN: Seremban, Cape Rachado F.R., 45 m., *KEP* 71466 (KEP); Port Dickson, P[asir] Panjang F.R., *KEP* 66506 (KEP); Senaling Inas F.R., *SFN* 1753 [= *KEP* 628 *fide* Henderson & Wyatt-Smith, *loc. cit.*] (SING); Tampin F.R., S. slope of G. Tampin, 540 m., *FRI* 14233 (K, KEP, SAN, SING); G. Angsi, Pemas, 457 m., *FRI* 14586 (K, KEP, SAR, SING); Kuala Pilah, Serting, *KEP* 62876 (KEP). PAHANG: Ulu Sungai Anak Endau, 180 m., *FRI* 8109 (atypical) (A, KEP, SAR, SING); Tasek Bera State Land, *KEP* 35850 (KEP); Rompin, *KEP* 6538 (SING). JOHORE: Mawai, Sungei Tementang, *SFN* 34719 (A, B, K, KEP, LAE, P, SING); G. Panti E., *Jumali & Kuswata* 218 (BO); Kota Tinggi, *Ridley* 4185 (K, SING); Kluang F.R., 225 m., *KEP* 76289 (KEP); Renggam F.R., 90 m., *KEP* 71264 (KEP); Ulu Sedili, G. Sumalayang, 610 m., *FRI* 14104 (atypical) (A, K, KEP, SAN, SING). **Singapore:** Jurong Road, 17th mile, *Baker* 5732 (G, NSW); Bukit Mandai, *Ridley* 1955 (SING). **Sumatra.** RIAU: Upper Riau, Pakanbaru, Tenajan R., *Soepadmo* 40 (B, BO, C, E, L, SING). SELATAN: Banjoeasin en Koeboestreken, Bajoeng Lintjir, 15 m., 148

MAP 11. Distribution of *Calophyllum rigidum* in Malasia.

T I P 15 (BO, L). UTARA: Siboga, *Teysmann*, *HB 642* (BO, K, L, MEL, P, U, W). BANGKA: Djebus, *Teysmann s.n.* (BO). BELITUNG: Tandjong Pandan, 30 m., *bb 10244* (BO); Mangar, *Teysmann s.n.* (BO). **Borneo and adjacent islands.** SARAWAK. 1st Division: Bako Natl. Park, 75 m., *S 16203* (?) (A, K, SAN, SAR); Lundu, G. Pueh, 457 m., *S 13704* (A, BO, K, SAN, SAR, SING); G. Matang, 305 m., *Stevens et al. 250* (?) (A); Semengoh Arboretum, 30 m., *Stevens et al. 139* (A); Semengoh F.R., *Stevens et al. 288* (?) (A). KALIMANTAN. Tengah: Beneden Dajak, Kapoeas, Moeroei, Danau Rawah, 1 m., *bb 2602* (L). Barat: Karimata Archipelago, *Teysmann*, *HB 11379* (BO, FI, K, L); Soengai Kenepai, *Hallier 2138* (A, BO, K, P); Smitau, P. Madjang, 30 m., *bb 7677* (BO).

ECOLOGY. Well-drained mixed dipterocarp forest (throughout its range), swamps (Malaya, Sumatra), and sub-kerangas vegetation (Sarawak); 0–610 m. alt. Flowering December and February (Malaya), June (Sumatra); fruiting March to May, August (fruit whitish (*KEP 35850*)).

GERMINATION AND YOUNG PLANT. The radicle probably breaks through the stone to one side of the base. The seedling appears to have two pairs of leaves separated by an internode 0.5–2.7 cm. long (*148 T I P 15*). Each later-produced internode is successively longer. The terminal bud is functional, but the young plant is arched, with the leaves being held in one plane; the stem only later straightens. (Young plants seen in both Malaya and Sarawak: *Stevens et al. 53, 247.*)

LOCAL USES. *Calophyllum rigidum* is used in ship building and for general construction (Malacca).

Calophyllum rigidum can be readily distinguished from other species of the genus by its rather coriaceous lamina, which is usually gradually acuminate at the apex and which often dries a dark, bay brown. The venation density on the upper surface of the lamina is often apparently twice that on the lower (due to the latex canals as well as the veins being raised on the former),

and the midrib on the lower surface is very prominent, yellowish, and rounded. As King noted in his description of *C. kunstleri*, "the nervation is closer than in any other species that I have seen, and the surfaces of the leaves have a peculiarly lustrous sheen." The terminal buds usually have a very dark brown tomentum, and the axillary buds are often plump, conspicuous, and clearly supra-axillary. The inflorescence is congested (see below), the flowers have four tepals, and the wrinkled fruits have a compact, relatively thick outer layer. The epithet *rigidum* refers to the leaf blades, which are usually thick and rigid when dry.

The inflorescence of *Calophyllum rigidum* is commonly described as being subumbellate, but it is unlike the subumbellate inflorescence of *C. soulattri*. The inflorescences of *C. soulattri* are usually flabellate and branched; those of *C. rigidum* are never flabellate and are only rarely branched. In some specimens up to seven flowers from three nodes may arise together on a condensed axis (e.g., *King's collector 5328*, Malaya), while in others four flowers from two nodes may arise together and be separated from the terminal triad, or triad plus one or two pairs, by an internode ca. 1 cm. long (e.g., *SFN 30877* and *Ridley 4185*, Malaya; *Soepadmo 40*, Sumatra). In specimens such as *Teysmann, HB 642* (Sumatra) and *Hallier 2138* (Kalimantan), the inflorescences commonly have a subbasal group of four flowers and a terminal group of five flowers.

The variation in leaf—especially in *Calophyllum rigidum*—is rather great. The type specimen has leaf blades somewhat more coriaceous than those of other specimens, although with similar details of midrib and venation. Its twigs dry brown, while those of the other specimens usually dry blackish. Most of the specimens collected from Malacca and Negri Sembilan (Malaya) are at first sight very different from the others, having slender twigs (less than 1.3 mm. across), small leaves (less than 8 by 2.2 cm.), and flowers usually in pairs on the inflorescences and separated by well-developed internodes. In *Derry 151* the lowest internode is almost absent. However, in other details these specimens are not unusual.

FRI 8109 and *12304* (Malaya) have more or less elliptic leaf blades with rather obscure venation, but in details of infructescence and fruit they agree well with the other specimens. Some specimens from around Kuching, Sarawak (e.g., *Stevens et al. 240, S 13704*), have leaf blades that are retuse at the apex. In other vegetative characters they agree fairly well with the other specimens, although the terminal bud is not such a dark brown. Their fruits and arched seedlings are also typical of the species; their flowers are unknown. *Stevens et al. 288* (Sarawak, sterile) is a perplexing specimen; it is rather robust and has something of the facies of *Calophyllum castaneum*, but its indumentum is quite different, since the hairs do not have the enlarged, birefringent apical cells characteristic of that species.

The hairs of *Calophyllum rigidum* are rather variable, although the variation is less than might be expected (FIGURES 13, o; 14, n-s). There is frequently a basal branch, often made up of only a single cell. The cells, at least at the base, have notably thick and rather rough walls, and the hairs are often entirely composed of such cells. If the apical cells are thin walled, they

lack the brown contents found in the thick-walled ones. The hairs are erect or curved; if curved, the curvature is either notably abrupt and at the middle or near the apex of the hair, or more gradual and from near the base.

24. **Calophyllum robustum** P. F. Stevens, Austral. Jour. Bot. **22**: 392. 1974.

TYPE: Papua, Northern District, Dobodura Plain, Samboga River area, 100 feet [30 m.], 13 March 1945, *NGF 2077* coll. *Cavanaugh & Fryar* (holotype, LAE; isotypes, A, BRI, CANB, E, K, L).

Tree 18–30 meters tall, d.b.h. to 65 cm.; trunk (?) without buttresses; outer bark yellowish at first, becoming gray to brown, deeply fissured; under bark pink; inner bark brown; latex milky or clear yellow; sapwood yellowish red, extremely hard, merging to red heartwood. Crown spreading, smaller branches and leaves $\pm$ pendulous.

Twigs flattened, 3.5–5 mm. across, 4-angled and with a $\pm$ prominent raised line decurrent from middle of petiole, sometimes with obscure horizontal raised lines at nodes, drying dark brown to blackish, subpersistently farinose-puberulent; axillary innovations lacking basal scars; internodes 1.5–6 cm. long; uppermost pair of axillary buds $\pm$ pointed, 1–4(–12) mm. long, spreading; terminal bud narrowly conical, 1.6–3.3 cm. long, with brown, subcrustose to puberulent indumentum (hairs, FIGURE 13, n, also moruloid), underdeveloped internode 4–7 mm. long. Petiole 1.3–2.3 cm. long, deeply concave above, convex to angled below, drying blackish, glabrous to persistently puberulent; lamina oblong to elliptic, 13–31 by 5–8.5 cm., abruptly acuminate at apex, rounded to shortly acute at base, rather closely undulate and narrowly recurved at margin, coriaceous, drying gray-olivaceous above and sabelline below, subpersistently farinose-puberulent on midrib below, the midrib above narrowing gradually from base, raised, center sulcate, 0.4–0.6 mm. wide at midpoint, below strongly raised, angled, the venation subapparent above, apparent below, raised, 13 to 16 veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils, with scars of 5 to 7 flowers, unbranched, the axis 0.4–1.1 cm. long, with farinose to puberulent indumentum at least near base, lowest internode 4–8 mm. long; bracts unknown; pedicels 1.2–1.5 cm. by 2.5–3 mm., glabrous. Flower unknown. Fruit spherical to ovoid-ellipsoid, 2.5–3 by 1.8–2.3 cm., acute to subrounded at apex, drying brown, densely and shallowly wrinkled; outer layer not detaching cleanly from stone, 1.2–2.6 mm. across, compact, strong; stone ca. 2.5 by 1.7 cm., obtusely pointed at apex, the walls less than 0.1 mm. thick, smooth, (?) unmarked; spongy layer thin.

DISTRIBUTION. Eastern New Guinea (MAP 9).

SPECIMENS SEEN. **Papuasias**: see Stevens, *loc. cit.*

ECOLOGY. Well or poorly drained lowland rainforest, 30–180 m. alt. Fruiting March and November.

GERMINATION. The radicle probably breaks through the stone to one side of the base. The seedling has two pairs of pseudovercillate leaves. Subse-

quently produced internodes are long, but the stem is arched at first, becoming erect only some 30 cm. or more behind the apex. The terminal bud is functional. (Based on two seedlings only; see also Stevens, *loc. cit.*)

Calophyllum robustum can be recognized by its long, narrowly conical terminal bud, and by its densely veined, more or less oblong leaf blades 13–31 cm. long that have a strongly angled midrib on the lower surface and that dry an olivaceous color on the upper surface. The wrinkled fruits have a tough outer layer and appear to have a very thin-walled stone. (The 1.5 mm. thick stone mentioned earlier (Stevens, *op. cit.*, p. 394) may refer to this tough outer layer, but more collections are needed to confirm fruit structure.) The epithet *robustum* refers to the large leaves and terminal buds and the thick stems of this species.

25. *Calophyllum moonii* Wight, Ic. Pl. Indiae Orient. 1: pl. 111. 1839, Illus. Indian Bot. 1: 129. 1840; Walp. Rep. Bot. Syst. 1: 397. 1842; Thwaites, Enum. Pl. Zeyl. 52. 1858; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 269. 1862; Bedd. Fl. Sylv. 3: xxii. 1871. TYPE: Ceylon [Sri Lanka], eastern Korle, *Moon s.n.* (n.v.). FIGURE 15, i.

C. spectabile auct., non Willd.; T. Anderson in Hooker f. Fl. Brit. India 1: 271. 1874, *pro parte*; Trimen, Handb. Fl. Ceylon 1: 99. 1893; Vesque in C. DC. Monogr. Phanerog. 8: 583. 1893, *pro parte*; Lewis, Descr. Catal. Ceylon, 20. 1902.

C. soulattri auct., non Burman f.; Alston in Trimen, Handb. Fl. Ceylon Suppl. 6: 22. 1931; Sastri *et al.* Wealth India 2: 20. 1950, *pro parte*; Worthington, Ceylon Trees, 32. 1959.

Tree 20–30 meters tall, d.b.h. to 35 cm.; no buttresses; outer bark yellowish, thin and smooth, or very dark brown and smooth, or dark yellow-gray, thick, and with wide panels (Worthington, *loc. cit.*), sometimes deeply fissured; inner bark dark red; latex clear (*Kostermans 24658*).

Twigs flattened, 3–5 mm. across, $\pm$ 4-angled, drying blackish, with brown, puberulent to tomentose indumentum, soon glabrescent or not; axillary innovations lacking basal scars; internodes (1–)3–12 cm. long; uppermost pair of axillary buds $\pm$ pointed, 2–12 mm. long, spreading to suberect, very obvious; terminal bud plump, 1.2–2 cm. long, with brown, tomentose indumentum (hairs, FIGURE 14, t), underdeveloped internode to 2 mm. long. Petiole 1–1.8 cm. long, concave above, convex below, sometimes persistently puberulent below; lamina ovate to suboblong or elliptic, (7–)9–16(–20.5) by (3.7–)5–6.5 cm., rounded to retuse (acute) at apex, broadly rounded to acute at base, distantly undulate and slightly or not recurved at margin, coriaceous, drying hazel above and sabelline below, soon glabrescent or persistently puberulo-tomentose on midrib below, the midrib above narrowing quickly near base, raised, 0.3–0.5 mm. wide at midpoint, below strongly raised, angled toward apex and striate toward base, the venation subapparent above and apparent below, raised, 8 to 13 (to 16) veins/5 mm., angle of divergence 70–85°. Inflorescences from foliate axils toward ends of twigs, with 5 to 11 flowers, flabellate, unbranched, the axis 1–3.5 cm. long, $\pm$ tomentose at base, lowest

FIGURE 15. a-c, *Calophyllum milvum* (28423 SF). a, bud, $\times 3$. b, c, fruit, $\times 0.75$: b, transverse section; c, from outside. d, e, *C. humbertii* (23728 SF): d, terminal bud, $\times 6$; e, fruit, $\times 1$. f-h, *C. lingulatum* (4800 RN). f, g, fruit, $\times 1$: f, from outside; g, longitudinal section. h, terminal bud, $\times 3$. i, *C. moonii* (Kostermans 24670), $\times 1$, arrow at indented stone apex. j-l, *C. verticillatum* (7929 SF). j, terminal bud, $\times 3$. k, l, fruit, $\times 1$: k, from outside; l, longitudinal section. m-o, *C. paniculatum*. m, terminal bud (1297 RN), $\times 1$. n, o, fruit (11078 SF), $\times 1$: n, from outside; o, longitudinal section. p, q, *C. aff. paniculatum* 1 (23120 SF), fruit, $\times 1$: p, longitudinal section; q, from outside. r, s, *C. aff. paniculatum* 2 (22855 SF), fruit, $\times 1$: r, longitudinal section; s, from outside. t, *C. vernicosum* (de Cary 14522), terminal bud, $\times 6$.

internode 0.3–2 cm. long; bracts ovate, ca. 3 mm. long, deciduous; pedicels (0.3–)0.6–1.8 cm. long, glabrous, in fruit to 3 mm. thick. Flower known only in late bud, (?)hermaphroditic; tepals (?)4 or 6 to 8, the outer pair ca. 6 by 5.5 mm., the inner ones 6–7.5 by 2.5–4.5 mm.; stamens 75 to 110, the filaments to 3 mm. long, the anthers oblong, 1–1.5 mm. long, retuse at apex; ovary ca. 2 mm. long, the style ca. 2.5 mm. long, the stigma peltate, ca. 1.2 mm. across, 2-radiate. Fruit ovoid to ellipsoid, 1.8–2.5 by 1.6–1.9 cm., apiculate or not, sometimes with fibrous stipe to 3.5 mm. long, drying cinnamon, smooth or shallowly and broadly wrinkled; outer layer not detaching cleanly from stone, ca. 1 mm. thick, notably fibrous, air spaces developing; stone subellipsoid, 1.1–1.4 by 0.9–1.2 cm., shallowly retuse at apex, the walls ca. 0.2 mm. across, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southwestern Sri Lanka (MAP 7).

SELECTED SPECIMENS SEEN. **Sri Lanka:** Kalutura Distr., Hallawakellae forest, Welipenna, *Balakrishnan* 1178 (K, US); Kuttapitiya Jungle, Pelmadulle, 4 m., *Worthington* 6437 (?) (L); Ratnapura Distr., Moropitiya logging area, *Kostermans* 24670 (A, E, K, L, US); Athweltota near Moropitiya, *Jayasuriya* 904 (AAU, K); Mahane-Makalane hill forest, near Moropitiya, 400 m., *Kostermans* 24701 (L); Kalawana–Moropitiya road, close to culvert 29/3, 100 m., *Cramer* 4159 (US); Hiniduma F.R., *Kostermans* 24704 (?) (L, US), Hinidumkande (Heycock), near Hiniduma, 500 m., *Kostermans* 25502 (K, L); Heycock Forest, sea level, *Cramer* 3084 (?) (US); Kunneliya Forest S. P., 60 m., *Worthington* 5262 (BM, F); Naunkilla ela, Kaneliya F.R., 30 m., *Worthington* 3678 (BM); sine loco, *CP* 3402, *pro parte* (K, US).

ECOLOGY. Lowland rainforest, to 500 m. alt. Fruiting April to June; fruit green, acid.

GERMINATION AND YOUNG PLANT. The radicle probably breaks the stone near the base. The seedling has a single pair of leaves. Subsequent pairs of leaves (which are produced singly) are separated by internodes of 0.7–1.3 cm. The terminal bud is functional, and the plant is probably erect. (*Kostermans* 25560, four plants.)

Calophyllum moonii is a distinctive species recognizable by its long terminal bud and conspicuous, often spreading, uppermost pair of axillary buds; its large, coriaceous leaf blades that are often rounded to retuse (at most acute) at the apex; and its few-flowered, flabellate but unbranched inflorescences. The fruits have a fibrous outer layer and a thin-walled stone that is shallowly retuse at the apex. The epithet commemorates F. Moon.

There is some variation in the apex of the lamina in *Calophyllum moonii*. Wight (1839, *loc. cit.*) illustrated a specimen with rather narrowly elliptic leaf blades that are acute at the apex and base, but many specimens have broader, subovate leaf blades that are more or less retuse at the apex and rounded at the base. I thought at first that there were two species involved, but there is no difference in characters such as terminal bud, indumentum, and fruit in specimens differing in leaf apex. Wight's illustration shows the flower as having four tepals; in the flowers dissected I have found six to eight.

The specimens from Hiniduma and Kuttapitiya Jungle are sterile; they are included here with some hesitation.

The retuse apex of the stone of *Calophyllum moonii* is rather remarkable. It was noticed in all fruiting specimens examined.

There is little similarity between *Calophyllum moonii* and *C. soulattri* (or *C. spectabile* auct., non Willd.), with which it has been confused; Kostermans (1976) noted that the two were distinct. Although the inflorescences of *C. moonii* are flabellate, they are unbranched (vs. practically always branched in *C. soulattri*). In *C. soulattri* the uppermost pair of axillary buds is characteristically closely adpressed to the terminal bud, the lamina is thinner and dries closely undulate, the fruit dries blackish and has a compact outer layer that practically lacks fibers, and the stone is rounded at the apex. The relationships of *C. moonii* are obscure, but the hairs are similar to those of *C. tomentosum* (cf. FIGURES 14, t, and 11, l).

26. *Calophyllum milvum* P. F. Stevens, sp. nov.

FIGURE 15, a-c.

C. parviflorum auct., non Baker f.; Drake in Grandid. Hist. Phys. Nat. Polit. Madagascar 35: pl. 357. 1894; Lecomte, Madagascar Bois Forêt d'Analamazaotra, 102. pl. 39. 1922; H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s. 24: 78. 1948, in Humbert, Fl. Madagascar Comores, Fam. 136: 8. 1951.

A speciebus aliis Calophylli in internodio infimo innovationis circa duplo longiore quam aliis, foliis parvis coriaceis basibus cuneatis vel in petiolis decurrentibus et nervis lateralibus subobscuris, floribus cum 8 tepalis (duobus exterioribus interdum subpersistentibus), et parietibus fructus 1.2-2 mm. crassis, differt.

Tree 12-20 meters tall, d.b.h. to 60 cm.; trunk without buttresses; outer bark gray, brown, or whitish, fissured; inner bark yellowish or red; latex yellow or blackish (Lecomte, *loc. cit.*).

Twigs somewhat flattened, 1.8-3(-3.5) mm. across, 4-angled or rounded, drying dark brown to blackish, puberulent when young; axillary innovations lacking basal scars; lowest internode of an axillary innovation (1.8-)2.8-5.5 cm. long, others 0.5-3 cm. long; uppermost pair of axillary buds rounded, to 1.2 mm. long, suberect; terminal bud plump, (3.5-)5-8.5 mm. long, with compact, grayish to brown indumentum (hairs, FIGURE 13, m), underdeveloped internode to 2(-6) mm. long. Petiole 0.3-1.1 cm. long, shallowly concave above and convex below, glabrescent; lamina elliptic to obovate (rarely subcuneiform), (1.8-)2.3-7 by (1.1-)2-4.2 cm., rounded to retuse at apex, cuneate to decurrent at base, slightly undulate and narrowly recurved at margin, very coriaceous, drying umber to sabelline on both surfaces, $\pm$ transiently puberulent on midrib below, the midrib above gradually narrowed from base, at least margins raised, 0.2-0.6 mm. wide at midpoint, below raised, striate, the venation obscure on both surfaces, slightly raised to flat, 9 to 15 veins/5 mm., angle of divergence 55-65°. Inflorescences from foliate axils, with 7 to 11 flowers, unbranched, the axis 3-6 cm. long, puberulent, especially toward base, lowest internode 1-4 cm. long; bracts ovate, ca.

3 mm. long, deciduous; pedicels 0.5–1.3 cm. long, $\pm$ glabrous. Flower (?)hermaphroditic; tepals 8 (rarely 7), the outer pair broadly ovate, 6–7.5 by 6–6.5 mm., sometimes persisting in fruit, the inner ones $\pm$ obovate, 7.5–12 by 3–8 mm.; stamens 115 to 180 (to 255), the filaments to 4.5 mm. long, the anthers oblong, 1–2.1 mm. long, $\pm$ retuse at apex; ovary 2–2.5 mm. long, the style 3–3.5 mm. long, the stigma peltate, 1–1.4 mm. across, 3- or 4-radiate. Fruit spherical to ovoid, 1.8–2.7 by 1.5–2.1 cm., rounded to acute at apex, drying brown, broadly and shallowly wrinkled, perhaps smooth when young; outer layer probably not detaching cleanly from stone, 1.5–3.5 mm. thick, compact; stone subspherical to ovoid, 1.4–1.8 by 1.2–1.65 cm., obtuse (rounded) at apex, the walls 1.3–2 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Madagascar [Moramanga], forêt d'Analamazaotra, 800 m., *Perrier de la Bâthie* 5328 (holotype, P; isotypes, G, K).

DISTRIBUTION. Central Madagascar (MAP 12).

SELECTED SPECIMENS SEEN. **Madagascar:** Ambatondrazaka, Manakambahiny-est, Nonokambo, 26556 *SF* (P), Manaka, 6901 *RN* (P); Ambodipaiso, Toby-Ambodipaiso, 900 m., 26663 *SF* (P); massif de l'Andringitra, forêt d'Ambodipaiso, Manakanbahiny, 1200 m., *Cours* 2333 (P); Perinet, Analamazaotra, 25673–25677 *SF* (all P); Bevetraka, 21266 *SF* (P), 21267 *SF* (P); Sahahamy, 2530 *SF* (P), Ambotrafanga, 27-B-R-172 *SF* (P); Manjakandriana, Antiahambavy, 15879 *SF* (P); Ambatondrazaka, Manaka[na] Est, 6901 *RN* (P); Fianarantsoa, Fandranda, Sambalahy, 13531 *SF* (P); Ajozorobé, Tsaralahy, *Fénéol* 15 (P); Anosibe, ouest du village d'Antandava (P.K. 45 de la route Moromanga–Anosibe), 28423 *SF* (P), Ankazomanitra, 26809 *SF* (P); sine loco [?E. Imerina], *Baron* 2235 (E, K *pro parte*, P), 2244 (E, K, P), 2662 (K), 4433 (BM, K, MO, P), 7045 (K).

ECOLOGY. Locally common in colline/lower montane, mossy, and dry forest, sometimes on summits, 800–1200(–1500) m. alt. Flowering December and January. Fruiting November to January; fleshy fruit eaten by lemurs and potomacheres, the former rejecting and the latter ingesting the seeds (?stones: *Perrier de la Bâthie*, 1948, *loc. cit.*). (*Perrier de la Bâthie* (1951, *loc. cit.*) recorded flowering in January and February, fruiting from February to June.)

GERMINATION. The seeds apparently do not germinate unless they are surrounded by the pericarp (*Perrier de la Bâthie*, 1948, *loc. cit.*).

LOCAL USES. The wood is used in carpentry and construction.

Calophyllum milvum is a typical montane species of the genus, having small, rather thickly coriaceous leaf blades with obscure venation, shoots with short internodes, and inflorescences with relatively long axes and large flowers. However, the lowest internode of the innovation, which is clearly about twice as long as the upper internodes, and the thick-walled stone immediately distinguish it from other species, including *C. parviflorum*, with which it has been confused. The epithet *milvum* alludes to the characteristic, almost kitelike lateral shoots.

The specimen 29179 *SF* (Massif d'Anorimbato, à l'ouest d'Ambaravarana (Tsiroanomandidy)) is from a locality to the west of the others cited, and it may be related to *Calophyllum milvum*. However, the lamina has much clearer venation and is broadly revolute at the margin. The specimen was in flower when collected in May; flowering in *C. milvum* seems to be restricted to December and January. Other specimens with lateral shoots like those of *C. milvum* but with clear venation are discussed under *C. pervillei*.

27. *Calophyllum lingulatum* P. F. Stevens, sp. nov.

FIGURE 15, f-h.

A speciebus aliis *Calophylli* quibus laminis cordatis habent in inflorescentiis axillaribus haud ramosis, floribus cum 8 tepalis, et fructibus apicibus acutis putaminibus parietibus crassis haud signatis vel angulatis, differt.

Tree; trunk and bark not known.

Twigs slightly flattened, 1.7–2 mm. across, strongly 4-angled when young, drying dark brown, $\pm$ glabrous; axillary innovations lacking basal scars; lowest internode of axillary innovation 2.2–3.5 cm. long, others 1–2 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, suberect; terminal bud plump, 3–4.5 mm. long, with brown, subcrustaceous-puberulous indumentum, underdeveloped internode absent. Petiole 1–1.5 mm. long, obscure; lamina ovate or lingulate to oblong, 4.7–8.2(–12.5) by 2.2–4.5 cm., rounded to obtuse at apex, cordate at base, strongly undulate and slightly recurved at margin, coriaceous, drying shiny and umber on both surfaces, subfarinose on midrib below, the midrib above abruptly narrowed near base, soon becoming raised, 0.2–0.4 mm. wide at midpoint, below raised, angled toward apex and striate toward base, the venation subapparent on both surfaces, slightly raised, 7 to 10 veins/5 mm., angle of divergence 60–70°. Inflorescences from foliate axils on ends of twigs, with 5 to 9 flowers, unbranched, the axes 1.9–5 cm. long, farinose-puberulent toward base, lowest internode 1.3–2.5 cm. long; bracts elliptic, ca. 3 mm. long, deciduous; pedicels 0.35–1.4 cm. long, sparsely farinose. Flower (?) hermaphroditic; tepals 8, the outer pair ovate, 5.5–7.5 by 4.5–6 mm., the inner ones elliptic to obovate, 8.5–11 by 2.4–5 mm.; stamens 85 to 100, the filaments to 4.5 mm. long, the anthers oblong, 1.2–1.6 mm. long, slightly retuse at apex; ovary 1.5–2.5 mm. long, the style ca. 3 mm. long, the stigma peltate, ca. 1 mm. across, 3-radiate. Fruit ovoid, ca. 2.4 by 1.9 cm., acute at apex, drying brown, densely and shallowly wrinkled; outer layer not detaching cleanly from stone, 2.5–3 mm. thick, compact; stone ellipsoid, ca. 1.65 by 1.4 mm., rounded at apex, the walls 1–1.7 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Madagascar, Ambanja, Marovato, 18 Nov. 1952, 4500 RN coll. *Sajy* (holotype, P; isotype, P).

DISTRIBUTION. Northern Madagascar (MAP 12).

ADDITIONAL SPECIMEN SEEN. **Madagascar:** Mandritsara, Antsirabe, Antsiatriaba, 3-R-388 *SF* (P).

ECOLOGY. Flowering and fruiting in November.

MAPS 12, 13. 12, distribution of *Calophyllum milvum* (solid circles), *C. milvum* var. (long, erect triangle), *C. lingulatum* (empty stars), *C. vernicosum* (half-circles), *C. fibrosum* (erect triangles), *C. humbertii* (inverted triangles), *C. verticillatum* (solid stars), and *C. chapelieri* (empty circles; overlapping distribution with *C. verticillatum*, stars in circles) in Madagascar. Inset: *C. comorense* (Comores Islands). 13, distribution of *C. recedens* (solid circles), *C. paniculatum* (erect triangles), *C. aff. paniculatum* 1 (solid stars), *C. aff. paniculatum* 2 (empty stars), *C. aff. paniculatum* 3 (inverted triangles), and *C. drouhardii* (empty circles) in Madagascar. Inset: *C. tacamahaca* (Mascarenes).

LOCAL USES. The wood is used in construction and for joinery.

Calophyllum lingulatum can be recognized by its cordate-based lamina, axillary inflorescences, flowers with eight tepals, and fruits with rather thick-walled stones that are neither marked nor angled. The epithet refers to the rather tongue-like shape of the leaves.

Calophyllum lingulatum is perhaps related to *C. milvum*, which has similar inflorescences, flowers, and fruits. Both species apparently also have axillary innovations with the basal internode much longer than the others, although this must be confirmed for *C. lingulatum*. There are, however, numerous

vegetative differences between the two. The terminal bud of *C. lingulatum* is shorter, and the lamina is thinner and cordate at the base. The midrib on the upper surface of the lamina is sharply raised; the venation is more distant and is easily visible, rather than subobscure.

Although 3-R-388 SF is sterile, it is almost certainly *Calophyllum lingulatum*. The measurement of lamina length in parentheses in the description is taken from this specimen.

28. *Calophyllum humbertii* P. F. Stevens, sp. nov.

FIGURE 15, d, e.

A *Calophyllo milvo*, quo aliter similis est, in gemma terminali 2–3 mm. longa (in *C. milvo* (3.5–)5–8.5 mm. longa), folia basi obtusa vel rotundata (cuneata vel decurrenti), inflorescentia bracteis foliaceis subpersistentibus praedita (parvioribus, haud persistentibus), et putamine parietibus circa 0.2 mm. crasso (1.3–2 mm. crasso), differt.

Small tree; trunk and bark not known.

Twigs slightly flattened, 1.7–2 mm. across, slightly 4-angled, drying blackish, glabrous; axillary innovations lacking basal scars; first internode of an axillary innovation 2–4.5 cm. long, others 1–3 cm. long; uppermost pair of axillary buds rounded, ca. 0.7 mm. long, erect; terminal bud plump, 2–3 mm. long, brown-puberulent, underdeveloped internode to 0.8 mm. long. Petiole 2–3 mm. long, broadly concave above and convex below, glabrous; lamina obovate to suborbicular, 1.9–3.9 by 1.2–2.9 cm., rounded or slightly retuse at apex, obtuse to rounded at base, not undulate but slightly recurved at margin, coriaceous, drying umber to fulvous on both surfaces, glabrous at maturity or persistently subpuberulent on midrib below, the midrib above gradually narrowed from base, slightly depressed to flat, 0.3–0.5 mm. wide at midpoint, often disappearing ca. 3 mm. below apex, below raised, $\pm$ rounded, the venation obscure on both surfaces, $\pm$ flat, 8 to 11 veins/5 mm., angle of divergence 45–60°. Inflorescences from foliate axils, with 7 to 9 flowers, unbranched, the axis 3.2–4.5 cm. long, glabrous or sparsely subfarinose toward base, lowest internode 1–2.5 cm. long; bracts leafy, cuneiform, to 2.7 by 2.9 cm., subpersistent; pedicels 0.6–1.1 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 (rarely 9), the outer pair ovate, 4.5–5.5 by ca. 3.5 mm., the inner ones obovate to elliptic, 7–8 by 3–6.5 mm.; stamens 100 to 115, the filaments to 3 mm. long, the anthers oblong, 1–1.4 mm. long, retuse at apex; ovary ca. 1.5 mm. long, the style ca. 2 mm. long, the stigma peltate, 1.3–1.5 mm. across, $\pm$ 3-radiate. Fruit broadly ovoid, ca. 2.3 by 1.8 cm., obtuse at apex, drying brown, sublongitudinally wrinkled; outer layer detaching cleanly from stone, ca. 2 mm. thick, compact; stone broadly ovoid, ca. 1.7 by 1.4 cm., rounded at apex, the walls ca. 0.2 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Madagascar, sommêt oriental du massif de Marojejy (nord-est), à l'ouest de la haute Manantenina, affluent de la Lokoho, 1850–2137 m., anno 1949, *Humbert & Cours 23728* (holotype, P; isotypes, P).

DISTRIBUTION. Northern Madagascar (MAP 12).

ADDITIONAL SPECIMENS SEEN. **Madagascar:** massif de Marojejy, à l'ouest de la haute Manantenina, 1500–1700 m., *Humbert 22592* (P); vallée de la Lokoho (nord-est), mont Beondroka, au nord de Maroambihy, 1000–1450 m., *Humbert 23516* (P).

ECOLOGY. Small tree, montane (sometimes ericoid) forest, 1000–2137 m. alt. Flowering and fruiting in March.

Calophyllum humbertii can be recognized by its short terminal bud; axillary innovations in which the first-produced internode is much longer than subsequent ones; small, broad leaf blades; and fruits, which have a relatively thick, compact outer layer and a thin-walled stone. The epithet commemorates the noted French botanist, H. Humbert.

The facies of *Calophyllum humbertii* is somewhat similar to that of *C. milvum*; in both the axillary shoots have basal internodes that are much longer than the others. However, the shorter terminal bud, broadly obovate to suborbicular lamina, subpersistent and foliaceous bracts, and thin-walled stone of *C. humbertii* immediately distinguish it from *C. milvum*.

Two specimens of *Calophyllum humbertii* (*Humbert & Cours 23728* and *Humbert 22592*) have fruits. Those of the former are more or less mature, while those of the latter are clearly immature; in neither is the stone wall well developed.

29. *Calophyllum laxiflorum* Drake, Bull. Soc. Linn. Paris **2**: 1220. 1896; H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s. **24**: 79. 1948, *pro parte*, in Humbert, Fl. Madagascar Comores, Fam. **136**: 12. fig. 2, 6–8. 1951, *pro parte*. TYPE: Madagascar, sine loco, *Chapelier s.n.* (holotype, P; isotype, P).

C. sorapa Drake in Grandid. Hist. Phys. Nat. Polit. Madagascar **35**: pl. 358, 2. 1896.

(?)Tree; trunk and bark not known.

Twigs rather strongly flattened, 1.7–2.4 mm. across, strongly 4-angled, drying blackish, glabrous when mature, axillary innovations lacking basal scars; internodes (0.2–)0.5–5 cm. long; uppermost pair of axillary buds rounded, less than 0.5 mm. long, inconspicuous; terminal bud plump, 1.7–2.4 mm. long, with short, grayish indumentum. Petiole 2–3.5 mm. long, broadly and shallowly concave above, convex below, glabrous; lamina obovate, 2.7–4.8 by 1.4–2.4 cm., acute at apex, cuneate or $\pm$ rounded at base, slightly recurved but barely undulate at margin, coriaceous, drying dark brown and nitid above, dark brown below, glabrous when mature, the midrib above rather abruptly narrowing at or near base, slightly raised, 0.15–0.25 mm. wide at midpoint, below raised, not very conspicuous, obscurely angled, the venation above $\pm$ apparent, slightly raised, below subobscure, not raised, 4 to 7 veins/5 mm., angle of divergence 20–40°. Inflorescences from foliate axils, with 5 to 9 flowers, unbranched, the axis 4.5–6 cm. long, glabrous, lowest internode ca. 2.5 cm. long; bracts unknown; pedicels 1.1–1.9 cm. long, glabrous. Flower and fruit unknown (ovary ca. 2 mm. long).

DISTRIBUTION. Known only from the type collection, made in (?eastern) Madagascar.

Calophyllum laxiflorum is a poorly known species that can be recognized by its short terminal bud, its obovate leaf blades that dry dark, shiny brown and have steeply ascending venation, and its long, few-flowered inflorescence axis with a long basal internode. The epithet *laxiflorum* alludes to the inflorescence, in which the flowers are separated by relatively long internodes.

Perrier de la Bâthie (1951, *loc. cit.*) included three species in *Calophyllum laxiflorum*: *C. laxiflorum* sensu stricto, *C. pervillei*, and *C. verticillatum* (the last described here as new). 28357 SF has leaves similar to those of the preceding species, but its fruits are quite different; there are yet other small-leaved specimens with more widely ascending venation. Since the taxonomic situation is so unclear, the two early names have been narrowly circumscribed. *Calophyllum verticillatum*, described below, is very different from the other small-leaved taxa with which it has been confused. Other small-leaved specimens are discussed after the treatment of *C. pervillei*.

Calophyllum laxiflorum is known only from the type specimen, which is just past flowering. The leaves differ from those of *C. pervillei* and 28357 SF in their steeply ascending venation (angle of divergence 20–40°, vs. at least 50° for the other species) and in the dark, shining, brown color of the dried lamina (with the midrib noticeably paler). The lowest flowers on the inflorescence axis of *C. laxiflorum* are borne ca. 2.5 cm. from the base. The lowest pedicel scar in infructescences of *C. pervillei* is less than 1 cm. from the base of the axis; the type specimen of *C. pervillei*, which is in very young bud, has inflorescences less than 7 mm. long. *Calophyllum laxiflorum* has more robust twigs than *C. pervillei*—1.7–2.4 mm. across, rather than 0.8–1.5 mm.

Although one sheet of *Chapelier* s.n. at Paris that was labeled *Calophyllum laxiflorum* is a fruiting specimen of *C. verticillatum*, it cannot serve as type for *C. laxiflorum*. Fruits are not mentioned in the protolog, and the specimen does not have the inflorescences described for *C. laxiflorum*. *Calophyllum verticillatum* can be immediately distinguished from *C. laxiflorum*, *C. pervillei*, and the other small-leaved specimens by the pseudoverticillate arrangement of the leaves at the termination of each innovation.

The illustration of *Calophyllum sorapa* in Grandidier (*loc. cit.*) is clearly to be referred to *C. laxiflorum*; it is very similar to the type specimen of *C. laxiflorum*, except that tepals are illustrated. It is possible that the epithet *sorapa* is a misreading of the local name, “fouraha.” Perrier de la Bâthie (1948, *loc. cit.*) thought that *C. sorapa* was to be equated with *C. pervillei*; later (1951, *op. cit.*) it was placed in synonymy under *C. chapelieri*, with *C. sorapa* and *C. chapelieri* typified by the same specimen. However, in leaf arrangement and inflorescence type the illustration of *C. sorapa* is very different from *C. chapelieri*, which is another species with pseudoverticillate leaves at the end of each innovation.

Perrier de la Bâthie (1948, *loc. cit.*) was rather confused over the whole complex. He thought that Drake del Castillo separated *C. pervillei* from *C.*

laxiflorum by the umbelliform inflorescence of the former. Drake did not mention such inflorescences in his description of *C. pervillei*; he noted only that the inflorescences were cymose and shorter than the leaves. Perrier de la Bâthie may have been confused by the inclusion of specimens of *C. verticillatum* in *C. pervillei*.

30. **Calophyllum pervillei** Drake, Bull. Soc. Linn. Paris 2: 1220. 1896, in Grandid. Hist. Phys. Nat. Polit. Madagascar 35: pl. 358, 3. 1896. TYPE: Madagascar, Ste. Marie, 23 April 1849, *Pervillé* 229 (holotype, p; isotypes, k, p).

C. laxiflorum auct., non Drake; H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s. 24: 79. 1948, *pro parte*, in Humbert, Fl. Madagascar Comores, Fam. 136: 12. 1951, *pro parte*.

Tree; trunk and bark not known.

Twigs flattened, 0.8–1.5 mm. across, strongly 4-angled, drying dark brown, glabrous when mature; axillary innovations lacking basal scars; basal internodes of innovation 1.5–4 cm. long, others (0.3–)0.5–3 cm. long; uppermost pair of axillary buds rounded, less than 0.5 mm. long, erect, inconspicuous; terminal bud rather narrowly conical, 1–2 mm. long, with short, grayish indumentum (hairs, FIGURE 13, h), underdeveloped internode absent. Petiole 1.5–2 mm. long, rather deeply concave above, convex below, glabrous; lamina obovate to subrhombiform or subelliptic, 0.9–6 by 0.5–2.4 cm., bluntly pointed to rounded at apex, narrowly cuneate to acute at base, slightly undulate or recurved at margin or slightly recurved at very base, coriaceous, drying sepia and nitid above, umber below, margin often discolored at base, glabrous, the midrib above gradually narrowed from base, raised, strongly sulcate, at least in basal part, 0.15–0.25 mm. wide at midpoint, disappearing ca. 2 mm. short of apex, below slightly raised, obscurely angled, the venation obscure to subapparent above, slightly raised, below usually subobscure, 7 to 11 veins/5 mm., angle of divergence 50–60(–65)°. Infructescences from foliate axils along stem, with scars of 5 to 9 flowers, unbranched, the axis ca. (?)2 cm. long, lower part brown-puberulent when young, lowest internode at most 6 mm. long; bracts ovate, ca. 2 mm. long; pedicels 4–8 mm. long, stout, to 1.8 mm. across. Flower unknown. Fruit spherical, 1.7–2.2 cm. long and across, obscurely pointed at apex or not, drying smooth, dark brown; outer layer detaching easily from stone when ripe, 2–2.5 mm. thick, compact; stone spherical, 1.3–1.8 cm. long and across, rounded at apex, the walls ca. 2 mm. thick, less than 1 mm. thick to one side of base, smooth, unmarked; spongy layer probably thin.

DISTRIBUTION. Madagascar.

SELECTED SPECIMENS SEEN. **Madagascar:** Farafangana, Efetz [Efatsy], Analazaha, 15384 SF (p); sine loco, *Boivin s.n.* (p).

ECOLOGY. Fruiting in August.

Calophyllum pervillei is a poorly known taxon that can be characterized by its short terminal bud; strongly 4-angled twigs; small, obovate leaf blades with steeply ascending venation and a raised midrib disappearing just short of the apex; few-flowered, rather short inflorescence with a basal internode less than 6 mm. long; and thick-walled stone.

Calophyllum pervillei is perhaps related to *C. laxiflorum*; for the differences between the two, see the latter.

8773 SF, from the Col d'Ambatondradama, between Mahalevona and Sahafihitra, 700 m., may belong to *Calophyllum pervillei*, but the fruit is ovoid, ca. 2.2 by 1.5 cm., and sharply pointed at the apex; pedicels of this specimen are up to 2.3 cm. long. However, the fruits are quite immature, since the stone is very weak and the embryo is undeveloped, so the shape differences of the fruit may be unimportant.

Calophyllum aff. *pervillei*

There are a number of small-leaved collections of *Calophyllum* from Madagascar that cannot presently be assigned to species. Some of the variation shown by these specimens is described below.

28357 SF, from the Col du Maningotry, 300–600 m., is vegetatively almost identical to the specimens described as *C. pervillei*, but its ovoid fruits are ca. 4 by 2.4 cm., prominently beaked, and drying sharply and densely wrinkled. The outer layer of the fruit is 2–2.8 mm. thick, and the ovoid stone is ca. 2.7 by ca. 1.8 cm., with the walls 2.7 mm. thick.

There are three specimens that have the same fruit type, with the outer layer moderately thick (1.2–2.5 mm.) and compact; however, the stone walls are rather thin (0.2–0.9 mm.). Although the lamina varies considerably in size (2.2–6.4 by 1.2–3.4 cm.), variation in venation is less (7 to 11 veins/5 mm., angle of divergence 55–70°), and the terminal bud is always plump, being 3–4 mm. long. The inflorescence axes and pedicels are puberulent. The three specimens differ greatly in fruit size and shape: the fruit may be spherical or ovoid, 1.6–3.3 by 1.4–2.5 cm., and either beaked or rounded at the apex. The status of this group is uncertain. (Specimens: 28905 SF, Amborompotsy (à l'O. d'Ambatafinandrantana); 5217 SF, Ambositra, Itremo, Lamamby; 11563 SF, Mont Ambatomenaloha, à l'E. d'Itremo.)

The relatively small, spherical fruits of 11563 SF (above) are similar to those of 15037 SF (from Sarolamby, Marolambo), which, however, have very short internodes less than 1 cm. long, a terminal bud less than 2 mm. long, and a different facies.

There is a group of flowering specimens from around Ambohimirahavavy, to the north of the localities of all the other specimens discussed above, which have the growth habit of *Calophyllum milvum*, the lowest internode of an innovation being much longer than the others, although they have a terminal bud 3–4 mm. long. Otherwise, in such characters as their clear venation and their prominently raised midrib, they at least superficially approach 15037 SF. (Specimens: 992 SF, Humbert 24890 and 25155.)

31. *Calophyllum drouhardii* H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s. **24**: 79. 1948, in Humbert, Fl. Madagascar Comores, Fam. **136**: 10. fig. 2, 1, 2. 1951. TYPE: Madagascar, forêt Orientale [Andrebo, E. Imerina], *Perrier de la Bâthie* 14635 comm. *Drouhard* (lectotype, P; isoelectotype, P).

Tree 10–15 meters tall; trunk and bark not known.

Twigs slightly flattened, 0.7–1.5 mm. across, narrowly 4-alate, drying mid to dark brown, sparsely brown-farinose; axillary innovations lacking basal scars; internodes 0.7–1.7(–2.5) cm. long; uppermost pair of axillary buds less than 1 mm. long, inconspicuous; terminal bud plump, 2.5–4 mm. long, brown-puberulent, underdeveloped internode inconspicuous. Petiole 2–5 mm. long, deeply concave above, convex below, fugaceously farinose; lamina elliptic to subrhombiform or obovate, 0.9–3.7 by 0.5–2 cm., rounded to obtuse at apex, $\pm$ cuneate to acute at base, slightly recurved and not undulate at margin, coriaceous, drying near umber on both surfaces, often shiny above, sparsely and subpersistently farinose especially on midrib below, the midrib above narrowing rather abruptly near base, slightly raised, 0.1–0.3 mm. wide at midpoint, below raised, slightly striate or rounded, the venation $\pm$ apparent on both surfaces, less so below than above, raised (impressed below), 13 to 19 veins/5 mm., angle of divergence 65–70°. Inflorescences from foliate axils along stem (rarely also terminal), with (?) 1 to 3 to 15 flowers, unbranched, the axis 0.7–6.5 cm. long, subglabrous or brown-farinose, lowest internode 0.7–1.5 cm. long; bracts sometimes foliaceous and persistent at anthesis, to 10 by 7 mm.; pedicels 0.35–2 cm. long, glabrous or sparsely farinose. Flower (?) hermaphroditic; tepals 8 or 9, the outer pair broadly ovate, 4.5–6 by 3.5–5 mm., the inner ones elliptic to obovate, 7.5–8 by 3–4 mm.; stamens 135 to 180, the filaments to 3.5 mm. long, connate for up to 0.5 mm., the anthers suboblong, 0.8–1.2 mm. long, retuse at apex; ovary 1.3–1.5 mm. long, the style ca. 4 mm. long, the stigma peltate, 0.7–0.8 mm. across, not lobed. Fruit ovoid, 2–2.4 by ca. 1.5 cm., acute at apex, drying brown, with shallow, $\pm$ longitudinal wrinkles; outer layer not detaching cleanly from stone, ca. 0.8 mm. thick, compact; stone ellipsoid, ca. 1.5 by 1.1 cm., rounded at apex, the walls ca. 0.3 mm. thick, smooth, (?) unmarked; spongy layer (?) thin.

DISTRIBUTION. Central Madagascar (MAP 13).

SELECTED SPECIMENS SEEN. **Madagascar**: Manerinerina sur le Tampoketsa, entre l'Ikopa et la Betsiboka, 1600 m., *Perrier de la Bâthie* 16740 (P); Ambatondrazaka, E. Mambatovositra, Manaka, 10561 RN (P); Moramanga, Savoka, 900 m., 26776 SF (P); Ambatovy, 28373 SF (P); Autanditra, Perinet, 8338 SF (P); à l'ouest d'Itremo (O. Betsileo), 1500–1700 m., *Humbert* 28355 (P); près d'Ankaloza, *Boiteau s.n.* anno 1968 (P); Ambohimombo forest, 1350–1440 m., *Forsyth-Major* 341 (BM, K); Fianarantsoa, Fandrandava, Ampamaherana, 13638 SF (P); Sambalahy, 13530 SF (P); Andramabovata, 13270 SF (P), Tolongoina, Fort Carnot, 13538 SF (P).

ECOLOGY. Colline or montane forest, 900–1700 m. alt. (*Morat* 3258 taken from tree growing in area with podzol pan; base of tree under water (“sur curaisse, pied dans l’eau’’)). Flowering mostly December to February, rarely March and October; fruiting November and January.

LOCAL USE. The wood is used in construction.

Calophyllum drouhardii can be recognized by its slender, narrowly 4-alate twigs, small leaf blades with dense venation and obtuse to retuse apices, and relatively very large, beaked fruit with a thin woody layer. The epithet commemorates E.-J. Drouhard, whose daughter married Perrier de la Bâthie.

A sheet of *Perrier de la Bâthie* 14635 (collected by Drouhard) at Paris has been designated the lectotype of *Calophyllum drouhardii*. This specimen has some terminal inflorescences, and the venation on the underside of the lamina is subimpressed.

32. *Calophyllum paniculatum* P. F. Stevens, sp. nov.

FIGURE 15, m–o.

A speciebus aliis *Calophylli* in lamina magna (oblongo-)ovata in siccitate concava marginibus valde recurvatis venulis lateralibus subdensis, inflorescentiis axillaribus ramosis, et fructu plerumque ellipsoideo, differt.

Tree ca. 20 meters tall, d.b.h. to 50 cm.; trunk and bark not known.

Twigs slightly flattened, 3–4 mm. across, 4-angled, sometimes with 4 additional raised lines, drying dark brown to blackish, when young sparsely farinose; axillary innovations probably lacking basal scars; internodes 1–4 cm. long; uppermost pair of axillary buds subacute, 1.5–7.5 mm. long, spreading; terminal bud plump, 1.1–2.4 cm. long, with gray to brown, subcrustaceous indumentum, underdeveloped internode 3–10(–14) mm. long. Petiole 1.7–2.4 cm. long, broadly and deeply concave above and convex below, glabrescent; lamina narrowly ovate to oblong, 9.5–30 by 3.3–7 cm., acute at apex, acute to attenuate at base, distantly undulate and recurved at margin, drying broadly convex, sepia or olivaceous above and sabelline to fulvous-umber below, glabrous at maturity, the midrib above generally quickly narrowed near base, at first only margins raised, 0.2–0.3 mm. wide at midpoint, becoming raised toward apex, below raised, striate, the venation subobscure to subapparent on both surfaces, raised, sometimes impressed above or flat below, 11 to 16 veins/5 mm., angle of divergence 75–80°. Inflorescences from foliate axils, with 15 to numerous flowers, usually with branches to 3 cm. long and with 5 flowers, the axis 4.5–14 cm. long, farinose toward base, lowest internode 1.8–4 cm. long; bracts not known; pedicels 1–2.5 cm. long, glabrous or sparsely farinose. Flower (?)hermaphroditic; tepals 8 (rarely 9), the outer pair broadly elliptic to ovate, 5–6.5 by 4.5–6 mm., the inner ones elliptic to obovate, 7.5–11 by 3.5–7 mm.; stamens 380 to 400, the filaments to 5 mm. long, the anthers oblong, 0.6–1.2(–1.4) mm. long, retuse at apex; ovary ca. 2 mm. long, the style ca. 3.5 mm. long, the stigma peltate, 0.8–1 mm. across, $\pm$ 3-radiate. Fruit ellipsoid (rarely ovoid), 2.4–2.6(–4.2) by 1.9–2.2(–2.6) cm.; $\pm$ acute at apex, drying vinaceous-brown,

irregularly striate; outer layer detaching cleanly (?always) from stone, 2–2.3(–3) mm. thick, compact; stone ellipsoid to ovoid-ellipsoid, 1.9–2.4(–3.5) by 1.6–1.75(–1.9) cm., rounded to obtuse at apex, the walls 0.8–0.9(–1.2) mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Madagascar, Maromiandra, Ambanja, 6 Oct. 1954, 11078 SF (holotype, P).

DISTRIBUTION. Northwestern Madagascar (MAP 13).

ADDITIONAL SPECIMENS SEEN. **Madagascar:** Nossi-Bé, 5518 RN (P), 8278 RN (P), Boivin s.n., March 1851 (P); Ambanja, Ambodimanga (3 km. de Renavony), 1297 RN (P); Andampy, 10673 SF (P); Sambirano, Massif du Manongarivo, 500 m., 11484 SF (P).

ECOLOGY. Light forests, to 500 m. alt., sometimes near sea. Flowering January, February, and June; fruiting in November.

LOCAL USE. The wood is used in carpentry.

Calophyllum paniculatum can be recognized by its long terminal bud; long, narrowly ovate lamina with rather sharply recurved margins; axillary and usually branched inflorescences; and usually ellipsoid fruits. The epithet *paniculatum* alludes to the axillary, branched inflorescences of this species, an unusual combination in the genus.

There are three specimens with fruits: 10673 SF, 11078 SF, and 11484 SF. 11484 SF is the only specimen with ripe fruits; they are very much larger than those of the other specimens (measurements in parentheses in the description above), although they are of the same type. The fruits of 10673 SF and 11078 SF have a well-developed woody layer, although the embryo is still small.

The specimen cited above collected by Boivin from Nossi-Bé was included in *Calophyllum spectabile* by Perrier de la Bâthie (1951).

A sterile specimen collected by Boivin from "forêt de Ravine-Tsara, Île Ste. Marie" is superficially like *Calophyllum paniculatum*, although it has more distant venation (only 9 veins/5 mm.).

There are a number of other specimens with large leaves, long terminal buds, axillary, sometimes branched inflorescences, flowers with usually more than eight tepals, and rather large fruits. The specimens may provisionally be called *Calophyllum* aff. *paniculatum*, but much careful field work is needed here, as with the other Madagascan species. They are discussed below.

***Calophyllum* aff. *paniculatum* 1**

FIGURE 15, p, q.

Tree 25–40 meters tall, d.b.h. to 100 cm.; outer bark brown, slightly fissured; latex yellow.

Twigs 3.5–5 mm. across, with ca. 8 raised lines; terminal bud 1.4–2.5 cm. long. Petiole 1–2 cm. long; lamina elliptic to suboblong, (8.5–)10–13 by (3–)4–6.5 cm., shallowly retuse to obtuse at apex, (shortly) acute at base, strongly recurved at margin, entire lamina ± concave, the midrib above abruptly

narrowed at base, very narrow and obscured by lamina, the venation raised, 15 to 19 veins/5 mm., angle of divergence 70–80°. Inflorescence branched, with farinose indumentum; pedicels 0.5–1.6(–2) cm. long. Flower with (10 to) 12 to 14 tepals; stamens 185 to 325, the anthers oblong, 0.8–1.4 mm. long; stigma peltate, ca. 1.3 mm. across. Fruit spherical, ca. 3.2 cm. long and across, apiculate, drying brown, wrinkled; outer layer not detaching very cleanly from stone, 4.5–6.5 mm. thick, compact; stone spherical, 2.3–2.7 by 2.1–2.3 cm., apiculate, the walls ca. 2 mm. thick, smooth, unmarked, developed at base.

DISTRIBUTION. Northeastern Madagascar (MAP 13).

SPECIMENS SEEN. **Madagascar:** Massif de Marojejy, près du col de Doan-yanala, 800–1200 m., *Humbert 23120* (P); Massif de l'Anjanaharibe, haute Andramonta, bassin de la Lokoho, 700 m., *Humbert et al. 24526* (P); vallée de l'Andramonta, *917 SF* (P); Andapa, Ampontsilahy, *14578 SF* (P).

ECOLOGY. Large tree, 700–1200 m. alt. Flowering and fruiting in December (flower scented).

Calophyllum aff. paniculatum 2

FIGURE 15, r, s.

Tree 15–20 meters tall; trunk and bark not known.

Twigs 2.5–3 mm. across, strongly 4-angled or with ca. 8 raised lines; terminal bud 8–10 mm. long. Petiole 0.8–1.1 cm. long; lamina oblong to subelliptic, 5–12 by 2.2–4.1 cm., rounded to retuse (rarely mucronate) at apex, acute to $\pm$ attenuate at base, broadly recurved at margin, entire lamina $\pm$ concave, the midrib above abruptly narrowed at base, ca. 0.25 mm. across at midpoint, the venation raised, 7 to 12 veins/5 mm., angle of divergence 70–80°. Inflorescences unbranched [rarely flabellate toward base], subglabrous [or densely subfarinose]; pedicels [0.6–] 1.5–3 cm. long. Flower with [8 to 10 or] 12 to 14 tepals; stamens [250 to 305 or] 690 to 720, the anthers oblong, 1–1.3 mm. long; stigma peltate, [1–1.5 or] 2–3 mm. across. Fruit ellipsoid, 3–3.7 cm. long, ca. 1.5 cm. across, rounded at apex, drying brown, with broad, rounded wrinkles; outer layer not detaching cleanly from stone, 2–3 mm. thick, compact; stone ellipsoid, 2.5–2.7 by 1.2–1.3 cm., obtuse at apex, the walls ca. 1.2 mm. thick, smooth, unmarked, not developed at base.

DISTRIBUTION. Northeastern Madagascar (MAP 13).

SPECIMENS SEEN. **Madagascar:** Nantoraka, au sud de Maroantsetra, *22855 SF* (P); Antalaha, Ambohitralana, *5290 RN* (P); Ampanavoana, *7254 RN* (P); Fénériver, Analalava, circa 4 km. ouest de Foulpointe, 20–50 m., *20158 SF* (P); Tampolo, *15212 SF* (P).

ECOLOGY. Sublittoral forest on sand (*22855 SF*), also on “montagne” (*5290 RN*). Flowering June and July; fruiting October and November.

Calophyllum aff. paniculatum 3

Tree ca. 12 meters tall, d.b.h. ca. 40 cm.; bark not known.

Twigs 3–3.5 mm. across, usually 4-angled to 4-subulate; terminal bud (0.7–)1.2–1.5 cm. long. Petiole 0.6–1.2 cm. long; lamina elliptic to oblong, 5.5–14 by 2.7–5.1 cm., retuse (rarely subacute) at apex, cuneate to attenuate at base, strongly to slightly recurved at margin (entire lamina $\pm$ concave), the midrib above abruptly narrowed at base, 0.3–0.8 mm. wide at midpoint, the venation raised, (6 to) 12 to 15 veins/5 mm., angle of divergence 70–75°. Inflorescences branched or unbranched, puberulent; pedicels 0.7–2 cm. long. Flower with (?11 or) 12 to 15 tepals; stamens ca. 390, the anthers oblong, 0.6–1.1 mm. long; stigma peltate, ca. 0.7 mm. across. Fruit ellipsoid, 2.9–3.3 by 1.9–2.1 cm., $\pm$ acute at apex, drying pruinose-brown to dark brown, $\pm$ longitudinally wrinkled; outer layer not detaching cleanly from stone, 2.5–3.2 mm. thick, compact; stone ellipsoid, 2.1–2.4 by ca. 1.4 cm., obtuse at apex, the walls ca. 1 mm. thick, smooth, unmarked, developed at base.

DISTRIBUTION. Eastern Madagascar (MAP 13).

SPECIMENS SEEN. **Madagascar:** forêt d'Anche-Diego, 178-R-6 [SF] (small leaves) (P); Antanimenabaka, 26-R-202 [SF] (P); vallée de la Manampanihiny, environs d'Ampasimena, *Humbert 20607bis* (P); bassin de la Manampanihiny, mont Vohimano, au nord d'Ampasimena, 600–700 m., *Humbert 20682bis* (P); Antalaha, Ampanavoana, Vinanivao, 19183 SF (P); Maroantsetra, Farofandina, 15745 SF (P); Moramanga, forêt ouest d'Ampandroantraka, 16954 SF (P); Marolambo, Androrangavola, Sandranamby, 15036 SF (P); forêt Infanadiana, 13819 SF (?) (P), 14239 SF (?) (P); Fianarantsoa, Rindry, Fort Carnot, 7301 SF (P), 4804 SF (P); Fort Dauphin, Mahatalaky, forêt Lepourbe, 14545 SF (P); sine loco, *anon.* 279 (P).

ECOLOGY. Flowering September and December; fruiting June and September.

The specimens cited as *Calophyllum* aff. *paniculatum* 1 are the most distinct group. They are characterized by robust twigs and terminal buds, branched, puberulent inflorescences, and spherical fruits with a thick outer layer and stone. The specimens collected by Humbert cited under *C.* aff. *paniculatum* 3 are in some ways similar, but have thinner, 4-angled twigs and less dense venation (8 to 10 veins/5 mm.).

Calophyllum aff. *paniculatum* 2 is less robust than *C.* aff. *paniculatum* 1, and its leaves have only seven to twelve veins/5 mm. (vs. 15 to 19 veins/5 mm.). The inflorescence is generally less robust and is unbranched, but the flowers have more numerous stamens. The fruit of *C.* aff. *paniculatum* 2 looks somewhat like a superannuated sausage and differs in numerous particulars from that of *C.* aff. *paniculatum* 1 (FIGURE 15, p-s). The often subglabrous inflorescences and the large stigma of *C.* aff. *paniculatum* 2 are also noteworthy. The terminal bud of *C.* aff. *paniculatum* 2 is more or less enclosed in a pocket formed from the concave petioles and lower part of the midribs of the rather persistently erect terminal pair of leaves.

The specimens from Fénérive cited under *Calophyllum* aff. *paniculatum* 2 may not belong there; both are in flower and differ from the other specimens

in the description above by the measurements enclosed in brackets.

Calophyllum aff. *paniculatum* 3 is not a cohesive taxon. Four of the specimens cited are in fruit; in all of these the stone lacks the fibrous base characteristic of *C.* aff. *paniculatum* 2. The fruits of 4804 SF and 15036 SF are rather sharply wrinkled and have a 2.5–3.2 mm. thick outer layer with obvious latex canals; the stone is obtuse at the apex. In 15745 SF the outer layer is only ca. 1 mm. thick, although the fruits are younger. The outer layer of the fruit of 19183 SF is ca. 2.5 mm. thick but lacks obvious latex canals. The last two specimens have a more or less flat-drying lamina, and the terminal bud is not enclosed by the erect terminal pair of leaves.

Possible Hybridization with *Calophyllum inophyllum*

19184 SF (P; from Antalaha, Ampanavoana, Maraontsoro; collected near a river on sandy, clayey soil) was possibly taken from a hybrid between a member of the *Calophyllum* aff. *paniculatum* complex and *C. inophyllum*. Although the specimen has the facies of *C. inophyllum*, the color of the dry leaf, its strongly recurved margin, more or less invisible midrib, and high venation density (10 to 14 veins/5 mm.) are atypical, as is the terminal bud, which is ca. 1 cm. long. The pedicels in fruit are up to 2.8 cm. long. The fruit is ovoid, ca. 2.6 by 1.9 cm., and beaked at the apex; the outer layer is 1.5 mm. thick; the stone has walls ca. 1.2 mm. thick and a basal plug. Apart from the absence of a thick, persistent, spongy layer, the fruit is very similar to that of *C. inophyllum*.

33. *Calophyllum chapelieri* Drake, Bull. Soc. Linn. Paris 2: 1220. 1896; Drake in Grandid. Hist. Phys. Nat. Polit. Madagascar 35: pl. 358, 1. 1896; H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s. 24: 79. 1948, in Humbert, Fl. Madagascar Comores, Fam. 136: 10. fig. 2, 4, 5. 1951. TYPE: Madagascar [environs de Tamatave], *Chapelier s.n.* (holotype, P).

Tree 3–15 meters tall, d.b.h. to 80 cm.; outer bark grayish.

Twigs flattened, 3–4(–5) mm. across, rounded or with 4 obscure raised lines, becoming striate, drying brownish black, glabrous when mature; axillary innovations lacking basal scars; internodes in lower part of innovation (2–)3–7.5 cm. long, penultimate internode 0.5–1.5(–2) cm. long, ultimate internode ca. 3 mm. long; uppermost pair of axillary buds very small and inconspicuous; terminal bud plump, 2–2.5 mm. long, with brown, ± crustose indumentum (hairs, FIGURE 13, 1), underdeveloped internode absent. Petiole 2.2–4 cm. long, deeply concave above, convex below, glabrous; lamina obovate (rarely elliptic), 8.6–12.7 by 1.7–6.5 cm., rounded or slightly retuse at apex, narrowly acute at base, not undulate but strongly recurved at margin, coriaceous, drying umber above and cinnamon-sabelline below, glabrous when mature, the midrib above gradually narrowed from base, raised, strongly sulcate at first, 0.3–0.5 mm. wide at midpoint, below raised, angled toward apex, striate toward base, the venation ± apparent above, apparent below, raised, 4 to

7 veins/5 mm., angle of divergence 35–55°. Inflorescences from uppermost foliate axils (sometimes two together), with 7 to 11 flowers, unbranched, the axis 3–8 cm. long, glabrous, lowest internode 2–4.5 cm. long, the flowers tending to be in fours, with two pairs separated by a short internode, the groups of four separated by a longer internode; bracts ovate, to 3 mm. long, deciduous; pedicels 1–2.5 cm. long, glabrous. Flower (?) hermaphroditic; tepals 8 (rarely 9), the outer pair suborbicular, 7.5–9 by 7.5–8 mm., strongly concave, sometimes persisting in fruit, the inner ones elliptic to oblong, 9–14 mm. by 4.5–6.5 cm.; stamens 230 to 360, the filaments to 5 mm. long, the anthers oblong, (0.8–)1.3–2 mm. long, slightly retuse at apex; ovary ca. 1.5 mm. long, the style 3.5–4 mm. long, the stigma peltate, 1.5–1.8 mm. across, $\pm$ 4-radiate. Fruit ellipsoid, ca. 1.8 by 1.5 cm., apiculate or not, drying grayish brown, rather broadly wrinkled; outer layer separating $\pm$ cleanly from stone when ripe, 2–3.5 mm. thick, compact except for air spaces developing under skin; stone ellipsoid, 1.2–1.4 by 1–1.2 cm., apiculate or not, the walls 0.4–0.6 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Madagascar, the eastern coast (MAP 12).

SELECTED SPECIMENS SEEN. **Madagascar:** Mananara nord, Ant[an]ambe, 12864 SF (p); Fénérive, Amposina, Tanambao-Tampolo, Tampolo, 16101 SF (p); près de Brickaville, Perrier de la Bâthie 14077 (p); Ambila-Lemaitso, Antomanala, 8311 SF (p); Mahanoro, Tambola, 4901 SF (p); Ambilabe, Ambinany, 21530 SF (p); Mananjary, F. Marohita, 19538 SF (p); Pangalona, 9511 SF (p); Andranomanry, 5628 SF (p); Faraony, Perrier de la Bâthie 11571 (p).

ECOLOGY. Sandy soil near coast, low elevations. Flowering January, September, November, and December; fruiting July, September, November, and December.

Prominent, elliptic, crateriform galls (projections ca. 3.5 by 3 by 2 mm.) sometimes occur on the lower side of the lamina, either irregularly distributed or in a row often near the margin (FIGURE 5, g).

LOCAL USES. The wood is used in construction, and oil is sometimes extracted from the seed.

Calophyllum chapelieri can be recognized by its moderate-sized leaves more or less grouped together at the end of an innovation, and its flowers, which are borne in fours along the inflorescences. The epithet commemorates L. A. Chapelier, a collector who died in Madagascar at the age of 23.

Calophyllum chapelieri is closely related to *C. verticillatum*; the differences separating the two species are discussed under the latter.

There are two collections from Ambila-Lemaitso (4929 SF (p), Boiteau 1127 (p)) that appear to be intermediate between *Calophyllum inophyllum* and *C. chapelieri*. Their leaf blades are thinner than those of *C. chapelieri* and are more acute at the apex, the midrib on the upper surface of the lamina is rather abruptly narrowed at the base, and the margin of the lamina is less strongly recurved. The internodes at the end of the innovation are longer, and the fruits (Boiteau 1127) have stone walls ca. 0.8 mm. thick

and a thin, but well-marked, spongy layer. In all these characters, apart from the leaf apex, these specimens approach *C. inophyllum*. However, they differ from that species in having rather narrow leaves that are loosely aggregated at the ends of the innovations and narrowly recurved at the margins, and in the fruits, which have only a thin spongy layer and apparently lack a basal plug.

A sterile specimen (Geay 7582 (MO (s.n.), P), from Mananjary), cited as *Calophyllum spectabile* by Perrier de la Bâthie (1951, *op. cit.*), also has pseudoverticillate leaves. However, this specimen has a terminal bud up to 2.5 cm. long enclosed in a pocket formed by the concave petiole and the lower part of the midrib, and the lamina is ca. 25 by 5–7.5 cm. with a rounded to subcordate base.

34. ***Calophyllum verticillatum*** P. F. Stevens, sp. nov.

FIGURE 15, j–l.

C. laxiflorum auct., non Drake; H. Perr. in Humbert, Fl. Madagascar Comores, Fam. 136: 12. fig. 2, 6–8. 1951, *pro parte*.

A speciebus aliis *Calophylli* (*C. chapelieri* excepto) in paribus duobus vel tribus foliarum apice innovationis pseudoverticillatis dispositis et floribus inflorescentiarum necnon pseudoverticillatis dispositis differt, et a *C. chapelieri* in ramulis gracilioribus, foliis inflorescentiis floribusque minoribus, staminibus 120 ad 150 (non 230 ad 360), et parietibus putaminis 0.2–0.35 mm. crassis (non 0.4–0.6(–1) mm. crassis), differt.

Tree 10–20 meters tall, d.b.h. to 40 cm.; bark not known.

Twigs slightly flattened, 1–1.5 mm. across, 4-angled when young, soon becoming rounded, drying brown, glabrous; axillary innovations lacking basal scars; internodes 1–4 cm. long, terminal internode of innovation ca. 2 mm. long; uppermost pair of axillary buds very small and inconspicuous; terminal bud plump, 1.3–1.7 mm. long, with short, brown indumentum (hairs, FIGURE 13, i), underdeveloped internode absent. Petiole 0.3–1.5 cm. long, concave above and convex below, glabrous; lamina obovate, (2–)3–5.3(–8) by (0.45–)1–2.2(–3.1) cm., rounded to slightly retuse at apex, acute to cuneate at base, not undulate and not recurved to narrowly so at margin, coriaceous, drying fulvous-umber above and sabelline below, glabrous or transiently farinose on midrib below, the midrib above gradually narrowed from base, $\pm$ raised, 0.2–0.35 mm. wide at midpoint, below slightly raised (margins sometimes slightly depressed), substrate, the venation apparent on both surfaces, raised, 5 to 7 veins/5 mm., angle of divergence 30–50°. Inflorescences from uppermost foliate axils, with 5 to 7 flowers, unbranched, the axis (0.5–)1.5–5.5(–7) cm. long, glabrous, the lowest internode (0.5–)1–3.5 cm. long, the next internode not developing, the uppermost, if present, well developed; bracts ovate, ca. 2.5 mm. long, soon deciduous; pedicels 0.7–2.7 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8, the outer pair broadly ovate, 5.5–6.3 by 4–5.5 mm., strongly concave, the inner ones elliptic to suboblong, 7–10.2 by 2.6–5 mm.; stamens 120 to 150, the filaments to 4 mm. long, connate for up to 0.5 mm., the anthers oblong, 1.6–2.2 mm. long,

retuse at apex; ovary 1.8–2 mm. long, the style ca. 3.7 mm. long, the stigma peltate, 1.2–1.4 mm. across, $\pm$ 3-lobed. Fruit ovoid to subspherical, 1.3–2 by 1.2–1.6 cm., mucronulate, drying pale brown, drying closely and sharply wrinkled when young, smooth when older; outer layer not detaching cleanly from stone, 2.5–3.3 mm. thick, compact apart from air spaces developing under skin; stone ellipsoid, 0.9–1.4 by 0.8–1.2 cm., rounded at apex, the walls 0.2–0.35 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Madagascar, Fénérive, Ampasina, Tampolo, 8 Jan. 1957, 16487 SF (holotype, P; isotypes, P).

DISTRIBUTION. Madagascar, the eastern coast (MAP 12).

ADDITIONAL SPECIMENS SEEN. **Madagascar:** Antalaha, Ambohitralanana, 8060 RN (P), Vavasaha, 9109 RN (P), 9125 RN (P); Anfanavoana, Ajanazana, Laninhiny, 7490 SF (P); Anandrovola, S. de Rantabe, 8933 SF (P); Maroantsetra, Ambodipaka, 12133 SF (P); Soanierana Ivongo, 2456 SF (P), Forêt Sahavolawena, 7929 SF (P); Fénérive, Amposina, Tampolo, 3 m., 17702 SF (P); Forêt de Mangalimaso, à l'ouest de Foulpointe, 22104 SF (P); Ambila-Lemaitso, Tampila, 6476 SF (P); Farafangana, Thorombe, Analazaha, 4833 SF (P); vallée de la Manampanihy, aux environs d'Ampasimena, 20–100 m., *Humbert* 20607 (P); sine loco, *herb. du Petit-Thouars* (P), *Chapelier s.n.* (P).

ECOLOGY. Lateritic or sandy soils, low altitudes. Flowering October, December, and January; fruiting July (fruit not quite mature), September to December.

Ellipsoid, crateriform galls ca. 2 by 1.5 mm. occur on the lower surface of the lamina on some specimens.

LOCAL USE. The wood is used in construction.

Calophyllum verticillatum and *C. chapelieri* are similar in their distinctive inflorescence type, with the flowers in pseudowhorls or at least close together, and in the arrangement of leaves at the ends of the twigs, and they have similar fruits and crateriform galls. However, *C. verticillatum* is consistently smaller in all its parts, its lamina has an at most slightly recurved margin, the arrangement of flowers in fours along the inflorescence axis is more regular, the thick sepals are rarely persistent around the base of the fruit, the stamens are only half as numerous, and the ovoid to subspherical fruit has a stone about half the thickness of that of *C. chapelieri*. (The almost whorled leaves and flowers of *C. verticillatum* suggested its specific epithet.) The distribution of *C. verticillatum* is somewhat more northerly than that of *C. chapelieri*, but it has also been collected to the south of the known range of *C. chapelieri*.

7490 SF, from Antalaha, is the only specimen more or less intermediate between the two species. It has larger leaves than is usual for *Calophyllum verticillatum* (the measurements in parentheses in the description above), ellipsoid fruit, and subsistent sepals. However, the facies and infructescence type are more those of *C. verticillatum*; *C. chapelieri* is not known from Antalaha.

The relationship between *Calophyllum verticillatum* and *C. chapelieri*, although undoubtedly close, needs to be investigated in the field; specific rank for the two taxa seems most appropriate at present.

35. ***Calophyllum fibrosum*** P. F. Stevens, sp. nov.

A speciebus aliis Calophylli in lamina parva nervis lateralibus infra planis vel leviter impressis marginibusque costarum depressis, et in fructu strato exteriore fibris prominentibus subpersistentibus circa putaminem, differt.

Tree 6–30 meters tall, d.b.h. to 35 cm.; bark not known; latex yellow.

Twigs slightly flattened, 0.7–1.7 mm. across, strongly 4-angled, drying brown, glabrous; axillary innovations lacking basal scars; internodes 0.5–5 cm. long; uppermost pair of axillary buds rounded, ca. 0.7 mm. long, $\pm$ spreading; terminal bud plump, 1–1.5 mm. long, with short, brown hairs, underdeveloped internode to 1 mm. long. Petiole 0.3–1.5 cm. long, somewhat concave above and convex below, glabrous; lamina obovate to subelliptic, 2.9–5.8(–8.5) by 0.9–3.3(–4.5) cm., subacute to subretuse at apex and narrowly cuneate to acute at base, slightly undulate and strongly recurved at margin, coriaceous, drying brown to greenish brown and shiny above, paler brown and subpruinose below, glabrous at maturity, the midrib above narrowing gradually from base, raised, center $\pm$ sulcate, 0.1–0.25 mm. wide at midpoint, below slightly raised, margins depressed, angled, somewhat inconspicuous, the venation apparent above, raised, subobscure below, $\pm$ impressed, (4 to) 6 to 12 veins/5 mm., angle of divergence (55–)60–70°. Inflorescences from uppermost foliate axils (rarely from lower down), with 5 to 11 flowers, (flowers flabellately arranged), unbranched, the axis (0.5–)1–4.2 cm. long, glabrous or puberulent toward base, lowest internode (0.2–)0.5–1.8 cm. long; bracts not known; pedicels 0.7–1.5 cm. long, glabrous, slender, to 2.7 cm. by 1.5 mm. in fruit. Flower (?)hermaphroditic; tepals 8 (rarely 10), glabrous, the outer pair suborbicular to broadly ovate, 4.7–5.7 mm. long and across, the inner ones oblong to elliptic, 7.5–9 by 2–4 mm.; stamens 140 to 155, the filaments to 3.5 mm. long, the anthers oblong, 0.9–1.3 mm. long, slightly retuse at apex; ovary 1–1.4 mm. long, the style 3.5–3.7 mm. long, the stigma peltate, 0.7–1.2 mm. across, $\pm$ 3-radiate. Fruit ellipsoid, 1.6–2 by 1.3–1.6 cm. (rarely obovoid, ca. 2.3 by 1.25 cm.), rounded or mucronulate at apex, drying brown to pale brown, smooth; outer layer not detaching cleanly from stone, 3–4 mm. thick, subcompact, very fibrous; stone $\pm$ ellipsoid, 1.3–1.6 by 0.8–0.9 cm., $\pm$ obtuse at apex, the walls 0.4–0.9 mm. thick, smooth, unmarked, fibrous at base; spongy layer thin.

TYPE: Madagascar, Antalaha, Ambohitralanana, 16 Nov. 1956, 8594 RN coll. Ranzokiny (holotype, p; isotype, p).

DISTRIBUTION. Northeastern Madagascar (MAP 12).

ADDITIONAL SPECIMENS SEEN. **Madagascar:** Vohemar, Anahomana, 4218 SF (p); Sambava, 8076 RN (p), Antsahovy, Antongondriha, 859 SF (p); entre Tsaratanana et Analamanara (route de Sambava et Vohemar, entre Nosiarina

et Antsirabe-N.), 27644 *SF* (p); S. d'Analamanara (près de Tsaratanana), entre Sambava et Antsirabe-N., forêts entre la Bemarivo et la Mahanara, 27177 *SF* (p); Antalaha, Ankorodomo, 7041 *RN* (p); Maroantsetra, Andranofotsy, Farankaraina, 15526 *SF* (p), 15710 *SF* (p), 16357 *SF* (p), 15 m., 17726 *SF* (p); Mananara, Ambatomiloma 5802 *SF* (p); côte est de Madagascar au Nème, *Chapelier s.n.* (p).

ECOLOGY. Flowering March and December (flower scented); fruiting March, July, August, November, and December (outer layer of fruit quite pleasant to eat (859 *SF*)).

LOCAL USES. The wood is used in construction and canoe building.

Calophyllum fibrosum is a distinctive species, even when sterile, because of its small, usually obovate lamina. The venation on the lower surface is subobscure and often impressed, and the midrib is rather inconspicuous since it is raised and has depressed edges. Fibers of the outer layer of the fruit persist around the stone after the epicarp has fallen away, hence the specific epithet. Branching is profuse, and the terminal bud may not be functional.

36. *Calophyllum eputamen* P. F. Stevens, Jour. Arnold Arb. 57: 168. 1976.

TYPE: Mauritius, Pétrin, 600 m., 3 Dec. 1973, *Coode 4263* with *Guého & Badré* (holotype, κ ; isotype, λ). FIGURE 6, f, g.

Tree 5–6 meters tall, d.b.h. to 30 cm.; trunk without buttresses; for details of bark see varieties.

Twigs not flattened or slightly so, 2.5–6.5 mm. across, 4-angled, drying brown to dark brown, glabrous; axillary innovations lacking basal scars, although often with pair of scars ca. 1 cm. from base; internodes 0.3–2.5 cm. long; uppermost pair of axillary buds unknown; terminal bud plump, 4.5–10 mm. long, with grayish, crustaceous indumentum (hairs, FIGURE 16, a, b), underdeveloped internode absent. Petiole 0.5–1.5 cm. long, broadly and shallowly concave above, convex below, glabrous; lamina elliptic to suborbicular or obovate (rarely ovate), 5.7–17.4 by (3.3–)3.9–9.8 cm., obtusely pointed to retuse at apex, cuneate to acute at base, not undulate to distantly so, slightly recurved at margin, coriaceous, drying cinnamon to honey color above and below, glabrous when mature, the midrib above narrowed gradually from base, flat to slightly raised, striate, 0.9–3 mm. wide at midpoint, often disappearing ca. 5 mm. short of apex, below flat to raised, striate, the venation obscure to apparent above, apparent below, raised, 6 to 13 veins/5 mm., angle of divergence 60–75°. Inflorescences from foliate axils (very rarely terminal), with 9 to 17 flowers, unbranched, the axis 4.5–11 cm. long, glabrous, lowest internode 0.5–3 cm. long; bracts broadly ovate to suborbicular, 0.3–2 cm. long, subpersistent, subfurfuraceous below; pedicels 0.9–3.4 cm. long, glabrous. Flower (?) hermaphroditic; tepals 8 to 12 (or 13), the outer pair suborbicular to broadly ovate, 6.5–10 by 5–9 mm., sometimes glabrous, the inner ones elliptic to obovate, 9–13 by (1.5–)3.5–9 mm., innermost tepals much smaller than outer ones; stamens 270 to 410, the filaments to 7.5 mm. long, connate for up to 1 mm., the anthers oblong, 1.3–2 mm. long, $\pm$ truncate

at apex; ovary 2–2.7 mm. long, the style 4–5.5 mm. long, the stigma peltate, 1.2–1.7 mm. across, (2- to) 4-radiate. Fruit ellipsoid to ovoid, 2.4–4 by 2–2.5 cm., $\pm$ acute at apex, drying brown, finely wrinkled; the outer layer (?2–)3–3.5 mm. thick, at apex and base to 7.5 mm. thick, compact; stone and spongy layer absent; embryo to 2.2 by 1.5 cm.

Key to the Varieties of *Calophyllum eputamen*

1. Terminal bud 4.5–7 mm. long; petiole 5–10 mm. long; lamina 5.7–10.5 cm. long. 36a. var. *eputamen*.
1. Terminal bud 8–10 mm. long; petiole 8–15 mm. long; lamina (7–)9.5–17.5 cm. long. 36b. var. *grandis*.

36a. *Calophyllum eputamen* P. F. Stevens var. *eputamen*

Outer bark light red-brown, fissured; inner bark red, paler pinkish straw toward cambium; latex yellow, clear, sticky.

Twigs 2.5–5 mm. across; terminal bud 4.5–7 mm. long. Petiole 0.5–1 cm. long; lamina broadly obovate or elliptic to suborbicular (rarely ovate), 5.7–10.5 by 3.9–8 cm., rounded to retuse at apex, the midrib above 1.5–3 mm. across at midpoint, below flat to slightly raised, 6 to 11 veins/5 mm., angle of divergence 60–70°. Fruit to 4 by 2.4 cm.

DISTRIBUTION. Mauritius.

SPECIMENS SEEN. **Mauritius:** see Stevens, *loc. cit.*

ECOLOGY. Small tree of stunted forests and heathlands on very shallow soil, often in swampy and marshy places; 450–600 m. alt. Flowering January to March; fruiting August and December (fallen fruit brown or black).

Elliptic galls—outgrowths from the leaf—sometimes occur in a line 0.6–1.3 cm. in from the edge of the lamina and may distort the whole leaf (e.g., Coode 3951).

36b. *Calophyllum eputamen* P. F. Stevens var. *grandis* P. F. Stevens, Jour. Arnold Arb. 57: 169. 1976. TYPE: Mauritius, Bassin Blanc, 500 m., 6 Dec. 1973, Coode 4290 with Guého & Lorence (holotype, κ ; isotype, A).

Outer bark yellow-gray, with vertical fissures 2.5–5 cm. apart when older, the inner surface yellow-brown; under bark red, creamy under cracks; inner bark salmon pink, almost white near cambium; latex yellow, clear, sticky.

Twigs 3.5–6.5 mm. across; terminal bud 8–10 mm. long. Petiole 0.5–1.5 mm. long; lamina elliptic or oval to obovate, (7–)9.5–17.4 by (3.3–)4.4–9.8 cm., subretuse to obtuse at apex, the midrib above 0.9–2 mm. wide at midpoint, below $\pm$ raised, 8 to 13 veins/5 mm., angle of divergence 65–75°. Fruit 2.4–3.5 by 2–2.5 cm.

DISTRIBUTION. Mauritius.

SPECIMENS SEEN. **Mauritius:** see Stevens, *loc. cit.*

ECOLOGY. Small tree, sometimes common in valleys or in forests on windswept ridges, 500–720 m. alt. Regeneration reported in disturbed valley forests (Coode 4290). Fruiting in December.

Calophyllum eputamen can be recognized by its medium-sized to large lamina with a broad, flat, striate midrib and rather distant venation, and its ovoid fruits that have a thick outer layer and lack a stony layer, at least at maturity. The specific epithet refers to the absence of a stony layer in the ripe fruit.

The differences between the two varieties recognized are mainly in the sizes of the parts. *Calophyllum eputamen* var. *eputamen* may grow in less well drained habitats than var. *grandis*, but this must be confirmed.

Calophyllum eputamen is probably related to *C. parviflorum*. For the differences between these species, see the latter.

37. ***Calophyllum parviflorum*** Bojer ex Baker, Fl. Mauritius, 16. 1877; P. F. Stevens, Jour. Arnold Arb. 57: 173. 1976; *C. tacamahaca* Willd. var. *parviflorum* (Bojer ex Baker) Vesque in C. DC. Monogr. Phanerog. 8: 548. 1893. TYPE: Mauritius, herb. *Justice Blackburn* (lectotype, κ).

Tree 1.5–5 meters tall; trunk without buttresses; outer bark yellow when young, becoming pink and gray with vertical, pustular, lenticellar lines, finally becoming fissured, the inner surface bright orange-brown to deep brown; under bark salmon to dark red-brown; inner bark pinkish brown; latex yellow, clear.

Twigs not flattened or slightly so, 1–3 mm. across, with 4 or 6 raised lines, drying brownish, sparsely subfarinose when young; axillary innovations lacking basal scars; internodes 0.2–1(–2.5) cm. long; uppermost pair of axillary buds rounded, to 1 mm. long, $\pm$ spreading; terminal bud plump, 4–6 mm. long, with gray-brown, crustaceous indumentum (hairs, FIGURE 16, c–e), underdeveloped internode to 1 mm. long. Petiole 3–7 mm. long, broadly concave above, convex below, soon glabrescent; lamina elliptic to obovate, 2–5.5(–7.5) by 1.3–3.5(–4.8) cm., rounded to obtuse at apex, rounded to cuneate or subtruncate at base, not undulate to distantly so, slightly recurved at margin, coriaceous, drying $\pm$ sabelline on both surfaces, soon glabrescent apart from sparse, farinose-puberulent indumentum on midrib below, the midrib above gradually narrowed from base, flat to somewhat depressed, 0.3–1 mm. across at midpoint, below raised, $\pm$ angled toward apex, striate toward base, the venation above subobscure, below subapparent, raised, 8 to 15 veins/5 mm., angle of divergence ca. 60°. Inflorescences from foliate axils, with 5 to 11 flowers, unbranched, the axis 0.5–7.5 cm. long, $\pm$ glabrous, lowest internode (0.3–)1–2.5 cm. long; bracts often foliaceous, ovate to obovate, 1.5–10 mm. long, caducous to subpersistent; pedicels 4–17 mm. long, glabrous. Flower (?)hermaphroditic; tepals 8 to 12, sometimes glabrous, the outer pair suborbicular, 4.5–6 by 4–5.5 mm., the next two (when more than 8) ca. 5.5 by 3.5–4.3 mm., the inner ones $\pm$ elliptic, 7–9.5 by 2.5–5 mm.; stamens 85 to 255 (to 320), the filaments to 3 mm. long, connate for up to 0.6 mm., the anthers suboblong, 0.6–1.3 mm. long, rounded to retuse

at apex; ovary 1.3–2.5 mm. long, the style 2–3.5 mm. long, the stigma peltate, 0.7–1.3 mm. across, 1- to 3-radiate. Fruit ellipsoid, ca. 2.5 by 1.2 cm., acute to beaked at apex, beak to 7 mm. long, drying brown, smooth; outer layer ca. 0.4 mm. thick, compact, hard; stone and spongy layers absent in mature fruit; seed ca. 1.5 by 1 cm.

DISTRIBUTION. Mauritius.

SPECIMENS SEEN. Mauritius: see Stevens, *loc. cit.*

ECOLOGY. Common in colline forests and shrubbery, sometimes in exposed conditions; 240–660 m. alt. Flowering February, March, and July to September; fruiting in September.

Calophyllum parviflorum is characterized by its rather small leaf blades, which are rounded to obtusely pointed at the apex and which have a flat to more or less depressed midrib on the upper surface, and by its ovoid fruits, which are sharply beaked to acute at the apex and which lack a woody layer when mature. The epithet refers to the flowers, which are small—at least when compared with those of the widespread *C. inophyllum*.

Calophyllum parviflorum is most closely related to *C. eputamen*. However, in the latter species the leaf blades are larger (5.7–10.5 cm. long); the midrib on the upper surface of the blade is depressed and (0.8–)1.5–3 mm. across at the midpoint; and the midrib on the lower surface of the lamina is usually little raised. The axis of the inflorescence is 4.5–11 cm. long, and the fruit is up to 4 by 2.4 cm., with the outer layer (?2–)3–3.5 mm. thick. Two specimens, MAU 15475 and MAU 16670, are perhaps more or less intermediate between the two species.

There is relatively little infraspecific variation in *Calophyllum parviflorum*. The young fruit has a distinct, but very thin, woody layer, but this disappears by the time the fruit has ripened. Further variation in the fruit is detailed in Stevens, *loc. cit.* The sapling may have oval to oblong leaf blades up to 11.2 by 3.5 cm.

The lectotypification of *Calophyllum parviflorum* was discussed in Stevens, *loc. cit.*

Reports of *Calophyllum parviflorum* from Madagascar are referable to *C. milvum*. The two species do not seem to be closely related; *C. milvum* differs most obviously from *C. parviflorum* in its axillary innovations, which have long basal internodes, and in its fruits, which have thick-walled stones.

38. *Calophyllum inophyllum* L. Sp. Pl. 513. 1753; Burman f. Fl. Indica, 120. 1768; G. Forster, Fl. Ins. Austral. Prodr. 41. 1768; DC. Prodr. 1: 562. 1824; Blume, Bijd. Nederl. Indië 5: 217. 1825; Blanco, Fl. Filip. 612. 1837; Wight, Ic. Pl. Indiae Orient. pl. 77. 1839; Miq. Fl. Indiae Batavae 1(2): 510. 1859; Thwaites, Enum. Pl. Zeyl. 51. 1858; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 282. 1862; Bentham, Fl. Austral. 1: 183. 1863; T. Anderson in Hooker f. Fl. Brit. India 1: 273. 1874; F. Mueller, Descr. Notes Pap. Pl. 36. 1875; Hillebr. Fl. Hawaiian Is. 40. 1888; Vesque, Epharmosis 2: t. 1. 1889, in C. DC. Monogr.

Phanerog. **8**: 544. 1893; Drake in Grandid. Hist. Phys. Nat. Polit. Madagascar **35**: pl. 355. 1894; Brandis, Indian Trees, 54. fig. 43. 1907; Pitard in Lecomte, Fl. Gén. Indo-Chine **1**(4): 324. 1910; K. Schum. & Lauterb. Fl. Deutschen Schutzgeb. Südsee, 499. 1911; Heckel, Ann. Mus. Colon. Marseille, sér. 2. **10**: 262. pl. 25. 1912; Koord.-Schum. Syst. Verzeich. **1**(Fam. 187): 4. 1912; Merr. Enum. Philip. Fl. Pl. **3**: 79. 1923; Craib, Fl. Siam. Enum. **1**: 120. 1931; Kanehira, Fl. Micronesica, 234. fig. 106. 1933; Merr. Trans. Am. Philos. Soc. **24**(2): 269. 1935; Kanehira, Formosan Trees. rev. ed. 473. fig. 433. 1936; Sastri *et al.* Wealth India **2**: 18. 1950; Heyne, Nutt. Pl. Indonesië. ed. 3. **1**: 1083. 1950; Sarlin, Bois Forêt Nouv.-Caléd. 207. pl. 92. 1954; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 314. pl. 1C. 1956; Robson in Exell & Wild, Fl. Zambes. **1**: 394. t. 76. 1961; H.-L. Li, Woody Fl. Taiwan, 601. fig. 235. 1963; Backer & Bakh. f. Fl. Java **1**: 386. 1965; T. C. Whitmore, Guide Forests Brit. Solomon Is. 77. 1966, Tree Fl. Malaya **2**: 186. 1973; P. F. Stevens, Austral. Jour. Bot. **22**: 374. 1974; A. C. Smith & Darwin, Jour. Arnold Arb. **55**: 223. figs. 6-8. 1974; Troup, Silv. Indian Trees. ed. 2. **1**: 234. 1975; P. F. Stevens, Jour. Arnold Arb. **57**: 170. 1976; Perry, Med. Pl. E. SE. Asia, 173. 1980. TYPE: Ceylon, *Hermann s.n.* (lectotype, BM, herb. *Hermann* 2.82).

- Balsamaria inophyllum* Lour. Fl. Cochinch. **2**: 469. 1790. ed. Willd. **2**: 574. 1793.
- C. bintagor* Roxb. Hortus Bengal. 41. 1814; G. Don, Gen. Syst. **1**: 622. 1831; Roxb. Fl. Indica. ed. 2 (W. Carey, ed.). **2**: 607. 1832. TYPE: based on Rumph. Herb. Amboin. **2**: t. 71. 1741.
- C. blumei* Wight, Illus. Indian Bot. **1**: 128. 1840 ("*C. blumii*"); Walp. Rep. Bot. Syst. **1**: 397. 1842; *C. inophyllum* L. β [var.] *blumei* (Wight) Hassk. Pl. Jav. Rar. 276. 1848. TYPE: based on Bl. Bijl. Nederl. Indië **5**: 217. 1825.
- C. inophyllum* L. β [forma] *obovata* Miq. Pl. Jungh. 291. 1854. TYPE: Java, ad sinum maris Wijnkoopersbaai, [*Junghuhn s.n.*] (lectotype, L, sheet no. 903,343-103).
- C. inophyllum* L. γ [forma] *oblongata* Miq. Pl. Jungh. 291. 1854. TYPE: Java, sine loco, *Junghuhn s.n.* (lectotype, L, sheet no. 903,343-55).
- C. wakamatsui* Kanehira, Bot. Mag. Tokyo **48**: 401. 1934, Jour. Dept. Agr. Kyushu Imp. Univ. **4**: 371. 1935. TYPE: Palau, Amiriik, ca. 200 m., 1 Aug. 1933, *Kanehira* 2343 (isotype, NY).
- C. inophyllum* L. var. *takamaka* Fosberg, Kew Bull. **29**: 255. 1974. TYPE: Aldabra Atoll, South Island, Takamaka Grove, 9 Feb. 1968, *Fosberg* 49272 (holotype, us; isotype, k).
- C. tacamahaca* auct., non Willd.; Montrouzier, Mém. Acad. Roy. Soc. Lyons Sci. Lett. **10**: 188. 1860, Flora, n.s. **20**: 345. 1862.
- C. ovatifolium* Norona, Verh. Batav. Genootsch. **5**(4): 13. 1790. *Nomen*.

Tree 7-25(-35) meters tall, d.b.h. to 150 cm; trunk without buttresses, often twisted, not erect; outer bark brown to gray (blackish), often mottled, with discrete boat-shaped fissures becoming confluent vertically, inner surface

orange; under bark reddish; inner bark reddish; latex yellow, clear, very sticky.

Twigs slightly flattened, 3–5.5(–7) mm. across, 4-angled, sometimes with two additional raised lines, or rounded, drying brown to dark brown, glabrous; axillary innovations lacking basal scars; internodes (0.4–)1–3(–5) cm. long; uppermost pair of axillary buds rounded to pointed, ca. 1 mm. long, spreading; terminal bud plump, 4–9 mm. long, with grayish to brownish, puberulent to subcrustaceous indumentum (hairs, FIGURE 16, f–m), underdeveloped internode to 4 mm. long. Petiole 1–2.5(–3.2) cm. long, broadly concave above, convex to angled below, glabrous; lamina elliptic to ovate, obovate, or oblong, (5.5–)8–20(–23) by (3.4–)4.6–11.5 cm., rounded to retuse or subacute at apex, cuneate to rounded and finally decurrent at base, rather distantly undulate and slightly recurved at margin, coriaceous, drying olivaceous above to sabelline(-sepia) below, glabrous, the midrib above quickly narrowed at base or not, at first depressed, margins raised or not, 0.2–0.9 mm. wide at midpoint, becoming raised toward apex, below raised, angled (striate) toward base, the venation apparent on both surfaces, raised, 4 to 10 veins/5 mm., angle of divergence (60–)70–80°. Inflorescences from foliate axils, with 5 to 15 (to 31) flowers (rarely with flowers arranged flabellately), usually unbranched (sometimes with 3-flowered branches), the axis 2.5–15 cm. long, glabrous (minutely puberulent toward base), lowest internode (0.2–)0.5–2(–3.8) cm. long; bracts ovate, 3–4 mm. long, very soon deciduous; pedicels (1–)1.5–4.5 (–6.3) cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 (rarely to 13), the outer pair ovate to suborbicular, 5.5–10 by 4.5–8 mm., the next pair subelliptic, 9–15 by (5–)7.5–10 mm., the inner ones obovate to elliptic or oblong, 9–16 by (3–)5–10 mm., rarely glabrous; stamens (175 to) 210 to 360 (to 440), the filaments (3–)5–7 mm. long, connate for up to 2 mm., the anthers oblong, 0.7–2 mm. long, rounded to retuse at apex; ovary 1.5–3.5 mm. long, the style (2.5–)4.5–9 mm. long, the stigma peltate, 0.7–2 mm. across, 3- to 5-radiate. Fruit spherical to obovoid, 2.5–5 by 2–4 cm., apiculate to rounded at apex, sometimes with stipe to 12 mm. long, drying grayish brown, sharply wrinkled; outer layer usually not detaching cleanly from stone, (0.5–)1–2(–3.6) mm. thick, compact; stone subspherical, (1.7–)2–3.9 by 1.9–3.4 cm., rounded (very rarely apiculate) at apex, the walls 0.7–1.2 mm. thick, smooth, unmarked, the basal plug 4–10 mm. across; spongy layer persistent even in mature fruit.

FIGURE 16. Hairs (from terminal bud). a, b, *Calophyllum eputamen* var. *grandis* (Coode et al. 4284). c–e, *C. parviflorum* (Coode et al. 4057). f–m, *C. inophyllum*: f, Degener & Ordonez 13786; g, Parker 2156; h–k, Schmutz 1160 (k, from above); l, Bois 172 coll. Barreau; m, Sumithraachchi & Davidse 589. n, *C. recedens* (Hildebrandt 3324). o, *C. vernicosum* (Baron 6258). p, *C. tacamahaca* (Coode et al. 4174). q–cc, *C. wallichianum*. q–w, var. *incrassatum*: q, SFN 34911; r–u, Soepadmo 71; v, Stevens et al. 108; w, FRI 12646. x, y, var. *wallichianum* (Wallich dist. 4843). z, aa, var. *tahanense*: z, FRI 7256; aa, SFN 20601. bb, cc, var. *wallichianum* (FRI 5450). Scale = 60 μ m. (in o, scale = 30 μ m.).

MAP 14. Distribution of *Calophyllum inophyllum* (circles, probably native; squares, possibly introduced).

DISTRIBUTION. Eastern Africa to Taiwan, the Ryukyu and Line islands, and New Caledonia; often planted both within its range and in West Africa and the tropics of the New World (MAP 14).

SELECTED SPECIMENS SEEN. **Guinea:** Conakry, jardin du Gouvernement, *anon.* 15 (cult.) (κ). **Ivory Coast:** Abidjan, *Greeners* 695 (cult.) (g). **Ghana:** bay to the W. of Axim, *Morton* A2090 (cult.) (κ). **Camerouns:** shore of Kribi, *de Wilde c.s.* 2116A (cult.) (κ, mo). **Nigeria:** Ibadan, *FHI* 22476 (cult.) (κ). **Kenya:** Mombasa Distr., Shanzu Beach, *Greenway* 13093 (κ). **Tanzania:** Mafia Is., *Ferne s.n.*, June 1873 (κ); Kisimania Mafia, Dundani, 6 m., *Greenway* 5327 (κ); Pemba, *Vaughan* 382 (BM); Panza Is., SW. of Pemba, *Greenway* 1401 (κ); Pagan, Chengene, Nwera, *Tanner* 2855 (κ). **Mozambique:** at S. of Muamizi Is., near Ponta Messangi, *Gomes e Sousa* 4458 (κ, w). **Madagascar:** Vohémar, Ampanafena, 10278 *SF* (p); Antalaha, Ambohitralanana, 6623 *RN* (p); Maroantsetra, Andramofotsy, Farankaraina, 3491 *SF* (p); Tampina, au S. de Tamatave, *de Cary* 17725 (p); Mananjary, *Geay* 8187 (p); Nossi-Vé, *Humblot* 154 (BM, p, κ, w); Nossi-Bé, 4329 *RN* (p); presqu'île d'Ambato, *Perrier de la Bâthie* 5307 (p); Ambanja, Antafiabé, Nosy Faly, 10442 *SF* (p). **Mauritius.** Port Louis, *Ayres s.n.*, Dec. 1860 (GH, κ). **Rodrigues:** sine loco, *Balfour s.n.* (BM, κ). **Réunion:** Ste. Marie, *Cadet* 5157 (κ). **Comores:** Johanna Is., *Hildebrandt* 1687 (BM, κ, p, w). **Aldabra:** South Is., *Renvoize* 1011 (B, κ). **Farquhar:** North Is., settlement, *Stoddart* 1384 (κ). **Seychelles:** Mahé, Mamelles, *Jeffrey & Zelia* 492 (BO, κ). **Chagos:** Diego Garcia Atoll, *Stoddart* 790 (κ, US). **Maldives:** Addu Atoll, *Sigee* 56 (κ, US); Malé Atoll, Kuda Bados Islet, 1 m., *Fosberg* 36887 (US). **Ceylon:** Panadura, 2-4 m., *Comanor* 1003 (GH, κ, US). **India.** MAHARASHTRA: Concan, *Stocks & Law s.n.* (BM, E, G, K, NY, P, W). MYSORE: Mangalore, *Meebold* 10264 (E). TAMILNADU: Tranquebar, *Didrichsen* 3866 (A, c); Madras, Marciam, *Thompson s.n.* (C, FI, K (sub 524), M, P). WEST BENGAL: Calcutta, *Kamphövener* 429 (c). **Burma:** Amherst, *Wallich dist.* 4841F (G, κ); Tenasserim, *Packman* 43 (BM). **Japan:** Okinawa Prefecture, Kinikami-Son, *Amano* 6060 (A, US); Yaeyama Gunto, Irimito Is., Sunai, *Walker*

& *Tawada* 6558 (A, US). **Hainan:** Yaichow, Nam Shan Ling, 60 m., *C. L. Tso* 23001 (A, B, E, K, P, US); Ching Mai Distr., Pak Shik Lang & vicinity, Ku Tung Village, *C. I. Lei* 1031 (B, BO, K, P, SING, US, W). **Vietnam:** secus flumen Saigon, 25–30 m., *Pierre* 3652 (A, AAU, C, K, MO, P, US, SING); Nhatrang, Hoa Cat, *Poillane* 4735 (P). **Cambodia:** Pnomh Penh, Khutung, *Béjaud* 287 (P); Koh Kong, presqu'île Smach, *J. E. Vidal* 4984 (P). **Laos:** Luang Pralang, *Dupuy* 207 (P). **Thailand.** Koh Kadat, *Schmidt* 546 (C); Bangkok, less than 5 m., *Kerr* 4344 (K). **Andaman and Nicobar Islands:** Teressa Is., *King's collectors s.n.*, 26 Feb. 1894 (A); North Reef Is., *Prain's collectors s.n.*, 24 Nov. 1903 (A). **Malaya.** KEDAH: Baling, *KEP* 32983 (A, K, KEP). PINANG: Batoo Phungie [Batu Ferenghi], *Curtis* 133 (K). PERAK: Taiping, bottom of Maxwell's Hill, 150 m., *FRI* 13601 (?cult.) (A, K, KEP, SING). SELANGOR: Kuala Lumpur, Public Gardens, *KEP* 4982 (cult.) (K, KEP, SING). NEGRI SEMBILAN: Cape Rachado area, sea level, *KLU* 13209 (AAU, KLU, MO). MALACCA: sine loco, *Maingay* 1064 (*Kew dist.* 164) (K). KELANTAN: Kuala Kelantan, near Kota Bahru, *Ridley s.n.*, 15 Feb. 1917 (K). PAHANG: Telok Berhala, Pulau Tioman, sea level, *SFN* 18530 (BO, KEP, SING, UC). JOHORE: Padang Mulud, SE. coast of Johore, *Shah & Shukor* 2466 (C, SING, UC). **Singapore:** Pulau Senang, 45 m., *Sidek bin Kiah* 67 (A, C, LAE, SING). **Sumatra and adjacent islands.** RIAU: Lingga, Pulau Singkep, 2 m., *bb* 2005 (BO, L); Berhala, 2–5 m., *Lörzing* 6926 (BO). SELATAN: Verlaten Eil., *Backer* 32087 (BO, K, L); Anak Krakatau, *Borssum-Waalkes* 1080 (L); S. Enggano, Boea-Boea, 0 m., *Lütjeharms* 4205 (BO, F, K, P). BARAT: Is. of Sipora, *Boden Kloss (SFN)* 14763 (BM, BO, K, SING). ATJEH: Is. Beras, bij Benteng, *Koorders* 10621 (BO). BANGKA: Pulau Lepar, 50 m., *Bünnemeijer* 2449 (BO, L). BELITUNG: sine loco, *van Rossum* 39 (BO). ANAMBAS AND NATOENA: Ranai, *van Steenis* 1321 (L). **Borneo and adjacent islands.** SARAWAK. 1st Division: Sematan, *Purseglove & Shah* 4621 (K, L, SAR, SING). 4th Division: Baram Distr., Miri, *Hose* 693 (BM, K, P, UC). 5th Division: Lawas, Tagai sawmill, 3 m., *S* 1793 (cult.) (BO, K, L, SAR, SING). BRUNEI: Jerudong beach, *BRUN* 5408 (A, KEP, L, SAR). SABAH. Kuala Penyu: Pulau Tiga, *SAN* 25816 (K, KEP, L, SAN, SAR, SING). Kota Kinabalu: Gaya Is. F.R., 1.5 m., *A* 331 (A, BO, CANB, K, KEP, SING). Kudat: Balembangan Is., sea level, *SAN* 25768 (K, L, SAN, SING). Sandakan: Elopura forest distr., 3 m., *A* 726 (A, BO, K, KEP, P, SING, US). Lahad Datu: Pulau Sakar, S. shore, sea level, *SAN* 21672 (SAN). Semporna: Malanta, *SAN* 1664 (A, BO, K, US). **KALIMANTAN.** Selatan: Pleihari, Sungei Taboenio, *Dachlan* 2392 (K). Tengah: Sampit, Kuala Pemboeang, Patoelat, *bb* 2159 (BO). Barat: Palo, sea level, *Becking* 63 (BO); Île Ste. Barbe [?Pulau Pedjantan], *Langlassé* 277 (G, P). **Philippines.** PALAWAN: Mangsi Is., *anon. s.n.* (US); Palawan Is., *BS* 1361 (A, BO, BM, G, P, SING). MINDORO: Lagondian, Puerta Galera, *Bartlett* 13729 (A, MICH). LUZON. Ilocos Norte: Bangui, *BS* 27642 (P). La Union: sine loco, *BS* 21087 (GH). Isabela: sine loco, *FB* 29360 (UC). Nueva Ecija: sine loco, *FB* 8486 (SING). Pangasinan: San Carlos, *Gates* 8372 (MICH). Zambales: Botolan, *Merrill* 2929 (K, US). Bataan: Limay, *Species Blancoanae* 936 (A, BM, BO, K, MO, NY, P, US, W). Quezon: Guinayangan, *BS* 20779 (A, BM, MO, SING, US). Camarines Sur: Pasacao, *Ahern* 22 (BO, K, NY, US). Albay: Batan Is., *FB* 28447 (A). CATANDUANES: sine loco, *FB* 28101 (BM, SING). MASBATE: sine loco, *FB* 1010 (K, NY, US). LEYTE: sine loco, *FB* 26215 (SING). BOHOL: sine loco, *BS* 1232 (BO, LY, NY, US). NEGROS: Negros Oriental, Dumaguete (Cuernos Mts.), *Elmer* 10130 (A, BISH, BM, BO, FI, G, K, LY, MO, NY, US, W). PANAY: Capiz, *FB* 24596 (MO). MINDANAO. Agusan: sine loco, *FB* 23668 (GH, US). Davao: Santa Cruz, *Williams* 2733 (A, K, NY, US). Cotabato: sine loco, *FB* 18259 (BO, LY). Lanao: sine loco, *FB* 20609

(A, UC). Zamboanga del Norte: Pasanan, sea level, *PNH 36270* (CANB). **BASILAN:** sine loco, *BS 16327* (BM, K, P, US). **SULU ARCHIPELAGO.** Jolo: Mt. Bayao, *PNH 36886* (BISH). **Java and adjacent islands.** **BARAT:** Pulau Panaiten (Prinseneiland), N. of mouth of Tjihasarahas, *Borssum-Waalkes 268* (A, BO, K, SING). **TENGAH:** Banjoemasin, Tjilatap, Noesakambangan, *Koorders 24109* (BO). **TIMUR:** Soerabaja, Daoen Laut (Eil. Bawean), *Ja 4206* (BO); Kangean Is., N. van Ardjasa, sea level, *Backer 26786* (BO, K, L). **COCOS KEELING ISLAND:** sine loco, *Guppy s.n.* (K). **CHRISTMAS ISLAND:** East. Terraces, 75 m., *Powell 57* (L). **Lesser Sunda Islands.** **BALI:** Banjie Poh, 32 km. W. van Singaradje, *Dillweijn & Demandt s.n.*, Oct. 1929 (L). **LOMBOK:** bij Laboehan Hadji, 2 m., *Bloembergen 3064* (A, BO, K). **SOEMBAWA:** Podja, 2 m., *Soejarto 85* (A, BO). **FLORES:** W. coast, near Nisar, 1-10 m., *Schmutz 1160* (L). **SUMBA:** Solo, Watoewiti, 10 m., *bb 15970* (BO, L). **TIMOR:** S. Belu, Kampong Natarain (Bolan), sea level, *Kooy 837* (L). **WETAR:** Massapoen, 2 m., *bb 27280* (L). **KAI ISLANDS:** Little Kei Is., *Moseley s.n.*, Sept. 1874 (BM, K). **TANIMBAR ISLANDS:** Makatian, 1 m., *bb 24401* (BO, L). **Celebes.** **SULAWESI:** Minahassa, Menado, *Koorders 17289* (BO, L). **KABAENA:** Balo, Eempuhu, *Elbert 3399* (A, BO, FI). **BUTUNG:** Paisir Kadjo, 0-100 m., *Elbert 2820* (A, BO, FI). **SALAJAR:** Saleijer, *Docters van Leeuwen 1848* (BO, U). **Moluccas.** **TALIABU:** Waloi, *Atjeh (exp. van Hulstijn) 128* (BO, L). **SANANA:** sine loco, *Atjeh (exp. van Hulstijn) 400* (BO, L). **HALAMAHERA:** Hokoe2 Kijé (Djailolo), 50 m., *Pleyte 131* (A, BO, K, SING). **TERNATE:** Monge, 35 m., *Bish 15* (A, BO, K, L, SING). **OBI:** Woori, *bb 23833* (BO, L). **BANDA:** Neira, 2 m., *bb 13433* (BO). **BURU:** Namlea, *bb 24171* (BO, L). **SERAM:** Gaoer Serani, 1 m., *bb 25958* (BO, SING). **AMBON:** Ft. Nieuw Victoria, *Rant 725* (BO). **Papuasia:** see Stevens, 1974, *loc. cit.* Also, **IRIAN JAYA.** **Aru:** Pulau Kibroör, Selibatabata, *Buwalda 5246* (BO, K). **Australia.** **QUEENSLAND:** Rockingham Bay, *Dallachy s.n.* (BM, BO, FI, G, P). **NORTHERN TERRITORY:** Wessel Is., *Latz 3216* (CANB). **Pacific Islands.** **BONIN ISLANDS:** Hahajima, 0-500 m., *E. H. Wilson 8290* (cult.) (A, K, US). **MARIANA ISLANDS:** Guam, Pego R., *Nelson 261* (P); Rota Is., *Grether 4449* (US); Merizo and vicinity, *Fosberg 25394* (BISH, US). **CAROLINE ISLANDS:** Palau, sine loco, *Kanehira & Nisida 2767* (US); Yap, Colonia, 90 m., *Evans 301* (GH, NY, US); Ponape, *Ledermann 13889* (K); Ulithi Atoll, Fassera Islet, *Fosberg 25454* (BISH, US); Truk, Natsushima (Dublon Is.), *Takamatsu 76* (BISH, US); Kusaie, Utua, *Takamatsu 370* (BISH, US); Mortlok Group, Lukunor Atoll, *D. Anderson 2174* (BISH, US). **MARSHALL ISLANDS:** Jaluit Atoll, Medyado Islet, *Fosberg 26788* (BISH, NY, P, US); Arno Atoll, Ine Islet, *D. Anderson 3613* (BISH, NY, US); Rongelap Atoll, Burok Is., *Taylor 46-1463* (old clearing) (A, G, NY, US); Jerno Is., *Fosberg 33871* (cult.) (BISH); Major Atoll, Majuro Is., *Fosberg 26945* (BISH). **GILBERT ISLANDS:** Tarawa, Tabonimata, *Adaire 36* (K, LAE). **ELLICE ISLANDS:** Nanumea Is., Haumaefa Village, *Chambers 68* (BISH). **NAURU:** Yarren, *Burges K5* (K). **FIJI.** **Mamanuthas.** Malolo Group: Nggalito Is., *Degener 32219* (E, NY). Viti Levu. Ovalau: Thawathi, *A. C. Smith 8101* (BO, GH, K, NY, P, US). Vanua Levu. Taveuni and Lakemba, *Seemann 48* (BM, G, GH, K, P). **HORNE ISLANDS:** Alofi, Mt. Vaisei, *Yen X58* (BO). **WALLIS ISLANDS:** Uvea, *Graeffe 33* (BM). **TONGA:** Tongatapu, Sopo, *Yuncker 15024* (BM, GH, U, US). **NIUE:** near Alofi, *Yuncker 9738* (A, K). **SAMOA:** Savaii, Matauta Bay, *Reinecke 506A* (BO, E, G); Swains Is., *Bryan 1354* (BISH). **MARQUESAS:** Noukahiva, *Batard 48* (P); Fautuhiva, Omoa, *F. B. H. Brown 930* (BISH); Hiva Oa, Atuona Village, 20 m., *Mumford & Adamson 445* (BISH). **TUAOMOTU ARCHIPELAGO:** Makatea, 100 m., *W. B. Jones 881* (BISH, BO); Anaa, Ole Pipi, 2 m., *St. John 14277* (cult.) (BISH); Ngake Tkume Atoll, *Doty & Newhouse 12326* (BISH). **SOCIETY ISLANDS:** Tahiti, Pare, Papeete, 3 m., *Grant 4322* (BO);

Tautira, Vaionifa, 0 m., *Grant 4003* (BISH, BO); Meetia, Fatia-po to Fareura, 100 m., *St. John 14223* (US); Mangariva, *Seurat s.n.*, 25 Nov. 1902 (P); Raiatea, Uturoa, 1 m., *Moore 122* (BISH, KLU, LAE); Moorea, Afareaitu Village, *H. M. Smith 139* (A, BISH, MO, NY); Tahaa, Haamene Bay, *Fosberg & Cooke 12140* (A, BISH, P). MANGAREVA ISLANDS: Aukena Is., Pt. Mata Kuiti, 3 m., *St. John 14650* (BISH); Taravai Is., 5 m., *St. John 14815* (BISH); Mangareva Is., Mt. Duff, 90 m., *St. John 14190* (BISH). TUBUAI ISLANDS: Rurutu, N. side of Mauo, 50 m., *St. John 16702* (BISH); Raivavae, Pic Rouge, 130 m., *St. John & Fosberg 15948* (BISH, US); Rimatara, Anapoto, 10 m., *St. John & Fosberg 16791* (BISH, US); Maria Is., 3 m., *Fosberg 12117* (BISH); Tapapatavai Is., 1 m., *St. John 16409* (BISH). COOK ISLANDS: Rarotonga, *Cheeseman 510* (K); Avatiu, *Wilder 917* (BISH); Aitutaki, *Stoddart 2262* (BISH, US). RENNEL ISLAND: sine loco, *Noona Dan Expedition 2886* (C). NEW HEBRIDES: Vanua Levu, Banks Group, *Kajewski 431* (A, P); Aneityum, Anelgauhat Bay, *Kajewski 783* (A, P, US). HAWAII: Molokai, near dock at Pulsoo, *Degener 8672* (G, K, MASS, MO, NY, US); Oahu, Waikiki, *Rock 2540* (GH); Lanai, *Remy 564* (GH, P); Midway Atoll, Sand Is., *Lamoureux 2218* (US). PHOENIX ISLANDS: Canton Is., Paa Hotel Garden, *Luomala 18* (BISH). LINE ISLANDS: Flint Is., *St. John & Fosberg 17444* (cult.) (BISH); Fanning Is., copra station, 1 m., *Christophersen 15* (BISH); Palmyra Atoll, Papali Is., *Dawson 19863* (BISH). PITCAIRN ISLAND: Adamstown, *Fosberg 11261* (cult.) (BISH, US). NEW CALEDONIA: presq'île de Nouméa, *Balansa 1774* (P); Prony, *Franc 1706A* (G, K, P); île d'Oro (île des Pins), *Virot 1037* (P); coast between Balade and Amos, *McKee 4814* (E).

ECOLOGY. Often common by seashore, sometimes inland (especially on islands) on sandy soils, to 200 m. alt.; also on basaltic outcrops (Christmas Island; Ridley, 1930). Even in cultivation, trunk soon begins to lean; when near sea, main trunk may become prostrate and lean out over sea (lateral branches then more or less erect). Flowering probably throughout year; possibly two bursts of flowering on Madagascar (November to February—17 specimens; April to June—9 specimens; cf. Perrier de la Bâthie, *loc. cit.*, who mentioned flowering September to December). Volkens (1912) noted several bursts of flowering yearly in Java (Buitenzorg), with local synchronicity in flushing. Flower sweet scented. Fruiting throughout much of year; fruit grayish green. When outer layer of fruit has rotted away, fruit floats easily (up to 126 days according to Schimper; reference not seen) and is dispersed by sea currents, although how long seed remains viable not known (Ridley, 1930). Fruit eaten and dispersed by fruit bats (Troup, 1921; Ridley, 1930; van der Pijl, 1957). Immature fruit in Singapore eaten by squirrels (Burkill, *loc. cit.*).

Revolute leaf-roll galls caused by the psyllid, *Leptynoptera sulphurea*, are known from much of Malesia. Somewhat curved, elongate excrescences on the underside of the lamina caused by a lepidopteran occur on Verlaten Island (Docters van Leeuwen-Reijnvaan & Docters van Leeuwen, 1926).

GERMINATION AND YOUNG PLANT. The radicle breaks the stone just to one side of the base and also pushes out the basal plug. The seedling has three or four pairs of leaves separated by well-developed internodes; the lowest pair of leaves (or, when four pairs altogether, the lowest two pairs) may be small (ca. 2 cm. long) and drop off early. Subsequently produced internodes

are longer, the terminal bud is functional, and the plant is erect. (Germination similar in plants from Malaya, Sarawak, the Philippines, New Guinea, and Australia; see also Stevens, 1974, *loc. cit.*; Lubbock, 1892, p. 234 & *fig. 209*.) The young seedling illustrated by Burger (1972, *fig. 19A*) is similar to those described above, but I have not seen the variation in phyllotaxy that he described from the somewhat older plant (see his *fig. 19B*); this variation is probably exceptional.

SELECTED LOCAL NAMES AND USES. "M'tondoo" and variants (Tanzania (Segeju, Zigua, Digo), Mozambique, the Comores); "foraha" (Madagascar); "takamaka" and variants (Seychelles, Mauritius, Aldabra; recorded by Perrier de la Bâthie (*loc. cit.*) as the name used in Madagascar, but probably an error); "takamaka de Madagascar" (Mauritius); "nagachampa," "punnaga" (Sanskrit); "punnai Pinnay" (Tamil); "vuma," "nonne" (Kanara); "ponnyet," "ph'ông" (Burma); "kating" (Siam); "cây mun" (Vietnam); "penaga laut," "penaga ayer," "pudek" (Malaya, Christmas Island); variants of "penaga" to Bali ("poenaga"), Sabah ("poenajoh," "punagao"), and Makassar ("poenago"); "njamplong" and variants (Java, Bali, southern Borneo); "bangkalan" and variants (eastern Sabah; common in Philippines; Celebes); "palo maria (de playa)" (Philippines, Mariana Islands); "dalo" (Kwara'ae, Solomons); "ndilo" (Fiji); "fifau" (Rotuma); "tsilo," "tilo" (Horne Islands); "liwej" and variants (Marshall Islands); "ragick" and variants (Caroline Islands); "fetau" and variants (Wallis, Ellice, Tonga, Niue, Samoa, Carolines); "tamanu" and variants (Bonin Islands, Nauru, Cook, Hawaii, Rarotonga, Tahiti, New Caledonia); "Alexandrian laurel" (formerly widely used, "a transferred and inappropriate name"—Burkill, *loc. cit.*).

Calophyllum inophyllum is a very useful plant. "To boil bark with water can be used as dye for fish net. Fruit produces oil called Bitter Oil used as oil for lighting purposes, fuel for automobile, airplane, and generating electricity. To mix with acid makes electric oil. It can also be used to make candle and medicine" (*Fung 20261*, from Hainan). Although some of these uses are apocryphal, most parts of the plants are important to local peoples throughout the range of the species.

The wood is moderately heavy and fairly strong and has a closely interlocked grain; it is especially durable under water. Canoes and small boats are frequently made of *Calophyllum inophyllum*, and it provides wood for ship building (mostly keels, knees, and pulley blocks). The wood is used in various other aspects of construction, as well as in making cart wheel hubs, food vessels, and bowls (the latter apparently mostly in the Pacific).

Oil can be extracted from the seeds by heating them either cut and with water or finely crushed. The oil contains resin; the purified oil contains approximately 49.7% oleic acid, 23.8% linoleic acid, 16.8% palmitic acid, and 9.7% stearic acid (see Sastri *et al.*, *loc. cit.*). It is used in soap making and is important as an illuminant. It is also used against rheumatism and skin infections when applied externally. Injected into the muscles, the refined oil relieves the pain in leprosy. In parts of Oceania the oil is used to anoint the body, as either a substitute for, or a pleasant-smelling additive

to, coconut oil. Mixed with the resin of *Vateria* Roxb. (Dipterocarpaceae), the oil is used for caulking boats (India).

Defatted protein from the seeds is of some nutritional value (Venkatasan & Rege, 1973).

The round stones are used as marbles.

The pounded bark may be used in cases of orchitis; the juice as a purgative; a decoction of the bark against indolent ulcers. The aromatic latex exuding from the bark is an emetic and a purgative, or it may be used as a scent (Tahiti); it has also been used as a dye and in the treatment of wounds. An infusion of the leaves is frequently used as an eye wash, but it has many other uses (e.g., against chicken-pox). The juice exuding from squeezed leaves has been used against hemorrhoids; the Cambodians inhale over leaves when they have headaches. *Calophyllum inophyllum* contains saponins, hydrocyanic acid, and also poisonous coumarin derivatives (Kawazu *et al.*, 1968), and is sometimes used as a fish poison. There are numerous other medicinal and quasi-medicinal uses of the plant (see especially Sastri *et al.*, *loc. cit.*; Heyne, *loc. cit.*; Burkill, *loc. cit.*; Perry, *loc. cit.*).

Calophyllum inophyllum is quite widely planted as an ornamental tree and is known as "Alexandrian laurel."

Calophyllum inophyllum is a distinctive species readily recognizable by its medium-sized to large, oval to elliptic leaf blades that are more or less rounded at the apex and have relatively distant and distinct venation; its large, long-pedicel flowers that nearly always have eight tepals; and its fruits, which dry grayish and sharply wrinkled. The only species of *Calophyllum* habitually found on sandy beaches, it is a characteristic species of such habitats in the Indian and western Pacific oceans. The epithet *inophyllum* means "fiber leaf" and refers to the closely set veins that are characteristic of the genus as a whole.

The major infraspecific variation in *Calophyllum inophyllum* is in fruit size. *Calophyllum inophyllum* var. *takamaka* was described from a small-fruited form from Aldabra Island (western Indian Ocean) with fruits less than 25 mm. across; fruits from the Pacific were supposed to be 27–40 mm. across (Fosberg, *loc. cit.*). All 19 fruiting specimens of *C. inophyllum* from Madagascar seen at Paris (except for a possibly incorrectly localized sheet in the Richard herbarium) have fruits less than 27 mm. across; the fruits of *C. inophyllum* in the Mascarenes may be similar in size (Stevens, 1976, *loc. cit.*), while those from the Seychelles are less than 3 cm. across. Although the fruits of specimens from Ceylon and India eastward are usually more than 3 cm. across, there are numerous exceptions with fruits that are ca. 25 mm. or less in diameter (e.g., Vietnam (*Pierre* 3652), Sabah (*S* 1644, *A* 726—the latter cited by Fosberg, *loc. cit.*), Ryukyu Islands (*Wilson* 8020), Hainan (*Lau* 5631), Java (*Koorders* 28793), and Timor (*Kooy* 837)). Thus, although it seems best not to recognize the small-fruited variant of *C. inophyllum* formally, it is nevertheless of considerable interest that this small-fruited form should be predominant in the western Indian Ocean, when it is less frequent elsewhere.

Throughout the range of *Calophyllum inophyllum*, some specimens may have more or less strongly stipitate dried fruits with the stipe up to 12 mm. long, and the fruit may also be subacute at the apex. In neither case is the variation clear-cut, nor is it correlated with other characters. A few specimens from the Moluccas (e.g., *Pleyte 131*) have a lamina that is suboblong and rather abruptly narrowed at the base, with the midrib on the upper surface also abruptly narrowed at the base. Although such specimens are very distinctive at first sight, all intermediates between them and more typical specimens occur.

Although *Calophyllum wakamatsui* is clearly referable to *C. inophyllum*, its status is unclear. Fruits of specimens of *C. wakamatsui* growing inland on the Caroline Islands have a remarkably thick (to 3 mm.) outer layer; the leaves are also more coriaceous than is usual. If this taxon is recognized as a variety, the name *C. inophyllum* var. *wakamatsui* Fosberg & Sachet (Smithson. Contr. Bot. 45: 12. 1980) is available.

The exact boundaries of the natural distribution of *Calophyllum inophyllum* are unclear. It was earlier suggested (Stevens, 1976, *loc. cit.*) that *C. inophyllum* might be introduced in the Mascarenes; both seedlings and regeneration occur there, and at least seedlings are found in places where introduction is more obvious, as at Abidjan, Ivory Coast. *Calophyllum inophyllum* seems to be native on the East African mainland (see Robins, 1976; Robson, *loc. cit.*). Hillebrand (*loc. cit.*) noted that *C. inophyllum* was planted in groves on Hawaii and was probably an early introduction; elsewhere in the Pacific it has been recorded as occurring in sacred groves (often cut down by the early missionaries). The wide distribution of *C. inophyllum* in the Pacific may in part have been caused by man—see MAP 14.

Nomenclature

Roxburgh's *Calophyllum bintagor* is based on the plant illustrated and described by Rumphius (Herb. Amboin. 2: 211. t. 71. 1741). This plant, *Bintagor maritima*, is clearly *C. inophyllum*, and Rumphius gave much interesting information about it.

Blume mentioned in his description of *Calophyllum inophyllum* that the flowers had twelve tepals (four sepals and eight tepals; Blume, *loc. cit.*). Wight thought that Blume's plant could not be the same as *C. inophyllum*, which usually has eight tepals, and so described *C. blumei*, basing it on Blume's description. Hasskarl (*loc. cit.*) reduced *C. blumei* to a variety of *C. inophyllum* (taxa that Hasskarl designated by lower-case Greek letters appear from his discussion to be varieties). Although *C. inophyllum* usually has eight tepals, an occasional flower has up to thirteen, and infraspecific taxa based on tepal number cannot be maintained.

Miquel described two forms of *Calophyllum inophyllum*, formae β *obovata* and γ *oblongata*. There are several sheets of *C. inophyllum* (*obovata*) at Leiden and Utrecht; sheet 903,343-104 at the former herbarium is designated the type of forma *obovata*. One shoot on this sheet has the leaves damaged and strongly retuse just to one side of the apex (perhaps leading to Miquel's mention of the apices being "perspicue emarginatis"); on a label both the

height of the tree ("40'") and the type locality are written. The plant was almost certainly collected by Junghuhn, although this is not mentioned on the sheet. I did not see any sheets of *C. inophyllum* γ (*oblongata*) from Utrecht; sheet no. 903,343-55 at Leiden is made the lectotype of this name. It agrees with the original description and was collected by Junghuhn.

Balsamaria inophyllum was correctly considered to be the same as *Calophyllum inophyllum* by Willdenow in his edition of Loureiro's *Flora Cochinchinensis*. There is a specimen labeled *Balsamaria inophyllum* in the British Museum collected by Loureiro from Cochinchina; it is *C. inophyllum*.

References to *Calophyllum inophyllum* in the literature are numerous; only a few are cited above. Anyone interested in a more complete summary of the literature should write to the author.

39. *Calophyllum tacamahaca* Willd. Sitzungsber. Ges. Naturf. Fr. Berlin Mag. 5: 79. 1811; Choisy, Mém. Soc. Hist. Nat. Paris 1: 228. 1823, in DC. Prodr. 1: 562. 1824, *pro parte*; Sprengel, Syst. Veg. ed. 16. 2: 571. 1825; Camb. Mém. Mus. Hist. Nat. Paris 16: pl. 17C. 1828; G. Don, Gen. Syst. 1: 622. 1831, *pro majore parte*; Bojer, Hortus Maurit. 52. 1837; Wight, Illus. India Bot. 1: 128. 1840; Choisy, Rev. Guttif. Inde, 43. 1849, Mém. Soc. Phys. Hist. Nat. Genève 12: 423. 1851, *pro parte*; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 286. 1862; Vesque, Epharmosis 2: t. 2. 1889, in DC. Monogr. Phanerog. 8: 547. 1893, *pro parte*; Cordemoy, Fl. Île Réunion, 333. 1895; P. F. Stevens, Jour. Arnold Arb. 57: 177. 1976. TYPE: Bourbon [Réunion], *du Petit-Thouars s.n.* (holotype, B, herb. Willd. 10115).
- C. spectabile* Willd. Sitzungsber. Ges. Naturf. Fr. Berlin Mag. 5: 79. 1811; Choisy, Mém. Soc. Hist. Nat. Paris 1: 228. 1823, in DC. Prodr. 1: 562. 1824, *pro parte*; Sprengel, Syst. Veg. ed. 16. 2: 571. 1825; G. Don, Gen. Syst. 1: 622. 1831, *pro parte*; Bojer, Hortus Maurit. 52. 1837. TYPE: Île de France [Mauritius], *du Petit-Thouars s.n.* (holotype, B, herb. Willd. 10116).
- C. lanceolatum* Blume, Bijl. Fl. Nederl. Indië 4: 217. 1825; Miq. Fl. Indiae Batavae 1(2): 511. 1859. TYPE: described from cultivated material originating from Mauritius.
- C. lanceolatum* Roxb. Fl. Indica. ed. 2 (W. Carey, ed.). 2: 608. 1832; Roxb. Hortus Bengal. 41. 1814; G. Don, Gen. Syst. 1: 623. 1831, *nomina*; Hooker & Arnott, Bot. Beechey Voy. 173. 1833; Wight, Illus. Indian Bot. 1: 129. 1840. TYPE: described from cultivated material originating from Mauritius (BM).
- C. inophyllum* auct., non L.; Lam. Encycl. Méth. Bot. 1: 552. 1785, *pro parte*; Baker, Fl. Maurit. 16. 1877, *pro syn.*

Tree 10–15 meters tall, d.b.h. to 25 cm.; trunk without buttresses; outer bark yellowish or gray in patches, smooth, inner surface brown; under bark brownish red; inner bark pink; latex yellow, clear, sticky (Coode 4174).

Twigs slightly flattened, 1.5–3.5 mm. across, $\pm$ 4-angled at first, soon striate, drying brown to dark brown when young, grayish when older, glabrous or sparsely brown-farinose when young; axillary innovations lacking basal

scars; internodes 0.5–2.7(–4.5) cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long, spreading; terminal bud plump, 4–8 mm. long, with gray to brown, furfuraceous to subcrustaceous indumentum (hairs, FIGURE 16, p), underdeveloped internode absent. Petiole (0.7–)1.1–2.5 cm. long, concave to V-shaped above, convex below, glabrous when mature; lamina elliptic (ovate to oblong), (6.3–)8–18 by (2–)3.4–5.5(–6.8) cm., $\pm$ acute (rarely subrounded) at apex, broadly cuneate to acute (narrowly decurrent) at base, undulate and slightly recurved at margin, coriaceous, typically drying greenish olivaceous above and olivaceous below, midrib and margins brownish, shiny (rarely near umber on both surfaces), glabrous (rarely sparsely subfarinose) on midrib below, the midrib above gradually narrowed from base, depressed, 0.3–1 mm. across at midpoint, becoming raised toward apex, below raised, $\pm$ striate, the venation apparent above and below, raised, with (5 to) 7 to 12 veins/5 mm., angle of divergence 60–80°. Inflorescences from foliate axils, with 7 to numerous flowers, unbranched, or with 3-flowered branches to 2 cm. long, the axis 3–11 cm. long, glabrous or sparsely farinose toward base, lowest internode (0.2–)0.6–2.6 cm. long; bracts unknown; pedicels (0.6–)1.3–2.1 cm. long, glabrous or almost so. Flower (?)hermaphroditic; tepals 7 to 9, the outer pair broadly ovate, 7.5–11 by 6.5–9.5 mm., the inner ones obovate to elliptic, 11–17 by 4.5–9 mm.; stamens 200 to 355, the filaments to 7 mm. long, connate for up to 1 mm., the anthers oblong, 1.5–1.9 mm. long, $\pm$ retuse at apex; ovary 2–3 mm. long, the style 4.5–5 mm. long, the stigma peltate, 1–1.3 mm. across, 3- or 4-radiate. Fruit ovoid, 3.7–4.3 by 2–2.3(–3.7) cm. across, $\pm$ acute at apex, drying grayish to light brown, deeply wrinkled; outer layer not detaching very cleanly from stone, 2.5–4 mm. across, compact; stone ovoid to ellipsoid, 1.8–2.6(–3.1) by 1.4–2.1(–2.5) cm., (obtusely) pointed at apex, the walls 0.9–1.5 mm. thick, smooth, unmarked, with basal plug 4(–8?) mm. across; spongy layer (?)rather well developed, to 1 mm. thick.

DISTRIBUTION. Mauritius and Réunion (MAP 13).

SPECIMENS SEEN. See Stevens, *loc. cit.*

ECOLOGY. Rocks, recent lava flows, or primary or secondary forest, (0–)100–600(–900) m. alt. Flowering February and March (reported April and May, Bojer, *loc. cit.*); fruiting May, October, and November (fruit tastes like an apricot—*Maillot & Jules 3*).

Coode 4174 has galled leaves; the galls are pustular outgrowths of the lamina and sometimes completely deform it.

GERMINATION AND YOUNG PLANT. The radicle emerges just to one side of the basal plug, at a point where the stone is about half as thick as it is elsewhere. The basal plug is pushed out; the area of thin stone lost during germination—similar in size and shape to the basal plug—may also be delimited by a line of weakness. Three to five pairs of seedling leaves are produced, each pair separated by internodes (0.5–)1–4 cm. long. The lowest pair of leaves, which is probably sometimes reduced, had been lost in two of the

five seedlings seen. The seedling has a prominently four-angled stem. (Details from *Coode 4175* and *MAU 2851*.)

LOCAL NAMES. "Tatamaca," "tatamaca rouge," "tatamaca des hauts" (Mauritius and Réunion).

Calophyllum tacamahaca can be recognized by its striate, grayish-drying older twigs; its ovate-elliptic lamina that is more or less acute at the apex and that usually dries a characteristic olivaceous color and with a depressed midrib on the upper surface; and its fruit. The fruit is pointed at the apex and has a thick (2.5–4 mm. across) outer layer; the pointed stone has a plug at the base. The epithet *tacamahaca* is taken from the Mauritian name for the plant.

The relationship between *Calophyllum tacamahaca* and *C. inophyllum* has been discussed earlier (Stevens, *loc. cit.*); it should be noted that the length of the lower internode of the inflorescence is similar in the two species (cf. *loc. cit.*, table 1). The two species are clearly related to one another. (The name *C. inophyllum* var. *takamaka* has been given to the small-fruited form of *C. inophyllum* that is common in the western Indian Ocean; for further details, see the discussion after *C. inophyllum*).

Details of the synonymy and infraspecific variation of *Calophyllum tacamahaca* are given in Stevens (*loc. cit.*). *MAU 14546* has fruits similar to those characteristic of *C. tacamahaca*, and although they are less deeply wrinkled (due to their immaturity), they have a well-developed woody layer. However, the leaves are more coriaceous, the apex of the lamina is subrounded, and the midrib and petiole are broad; as a result, the specimen approaches *C. eputamen* in appearance.

40. *Calophyllum comorense* H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s.

24: 78. 1948, in Humbert, Fl. Madagascar Comores, Fam. 137: 8. fig. 1, 1–3. 1951. TYPE: Comoro Islands, Grande Comore, May 1886, *Humboldt 1542* (holotype, P; isotypes, BM, P, W).

Tree ca. 20 meters tall; trunk and bark unknown.

Twigs slightly flattened, 2–3.5 mm. across, strongly 4-angled when young, soon becoming striate, drying brown, farinose-puberulent at first; axillary innovations apparently lacking basal scars; internodes 0.5–2 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, $\pm$ spreading, inconspicuous; terminal bud plump, 3–4 mm. long, with grayish brown, crustose indumentum, underdeveloped internode absent. Petiole 3.5–10 mm. long, broadly and shallowly concave above, convex below, glabrous; lamina elliptic to obovate, 4.3–7.8 by 2.2–3.8 cm., obtuse to rounded at apex, attenuate at base, distantly undulate and slightly recurved at margin, coriaceous, drying $\pm$ fulvous-umber on both sides, glabrous when mature, the midrib above gradually narrowed from base, depressed, 0.6–0.8 mm. wide at midpoint, below raised, striate, the venation above and below apparent, raised, 8 or 9 veins/5 mm., angle of divergence 65–70°. Inflorescences terminal and (?)axillary, with ca. 15 flowers, branches 3-flowered and ca. 1 cm. long, the axis ca. 3.5 cm. long,

puberulent toward base, lowest internode ca. 8 mm. long; bracts $\pm$ elliptic, to 6 mm. long, foliaceous, not persistent; pedicels 5–6 mm. long, sparsely puberulent when young. Flowers known only in bud, (?)hermaphroditic; tepals 8, the two outer broadly ovate, ca. 6 by 4.5 mm.; stamens ca. 120, the anthers oblong, ca. 1 mm. long, strongly retuse at apex; ovary ca. 1.5 mm. long, the stigma peltate, ca. 0.6 mm. across, 3-radiate. Immature fruit subellipsoid, ca. 1.6 by 1.3 cm., obtuse at apex, drying smooth, brown; outer layer ca. 2 mm. thick, compact; stone ca. 10.5 by 8.5 mm., rounded at apex, the walls less than 0.2 mm. thick, smooth, (?)unmarked; spongy layer unknown.

DISTRIBUTION. The Comoro Islands (MAP 12); known only from the type specimen.

ECOLOGY. Type specimen has much moss on twigs, so was perhaps collected at 1000–1200 m. alt. in montane forest (see below).

Calophyllum comorense is a poorly known species best characterized by its small terminal bud, elliptic-obovate leaves separated by short internodes, terminal inflorescences, and ellipsoid fruits with a thick outer layer and an apparently thin stone wall. The epithet *comorense* is derived from the Comoro Islands, where this plant grows.

Calophyllum comorense is perhaps related to *C. tacamahaca*, which, however, has a longer terminal bud, axillary inflorescences, and a thick-walled stone. If *C. comorense* has ripe fruit with a thin stone wall, as seems probable, *C. eputamen* may prove to be its closest relative, although the terminal bud of that species is longer, its midrib and lamina are broader, its inflorescences are usually axillary, and its fruit is much larger.

Perrier de la Bâthie cited *Humblot 1442* as the type specimen of *Calophyllum comorense* and thought that it was collected at 1000–1200 meters on Mt. Karthala, Grand Comore, since the twigs were covered with mosses. *Humblot 1442* seems to be a misprint for 1542; the duplicate of this number at the British Museum has a stamped label with the locality given as "Angouan, Comoro Is." (probably Anjouan Island).

41. *Calophyllum recedens* Jumelle & H. Perr. Ann. Sci. Nat. Bot. IX. 11: 281. 1910; H. Perr. Mém. Mus. Nat. Hist. Nat. Paris, n.s. 24: 78. 1948, in Humbert, Fl. Madagascar Comores, Fam. 136: 2. fig. 1, 4–7. 1951, *pro parte*. TYPE: Madagascar, Firingalava, sur l'Ikopa, entre Maevatanana et Andriba, Sept. 1897, *Perrier de la Bâthie 327* (holotype, P; (?)isotype, K (*s.n.*)).

C. tacamahaca auct., non Willd.; O. Hoffmann, Fest. 200 Jarh. Werder's. Gymn. Berlin, 319. 1881; Vesque in C. DC. Monogr. Phanerog. 8: 547. 1893, *pro parte*; Engler in Engler & Prantl, Nat. Pflanzenfam. ed. 2. 21: fig. 81, g–j. 1923.

Tree 3–15(–?30) meters tall, d.b.h. to 30 cm.; outer bark blackish, becoming fissured; inner bark reddish; latex yellow, odorous (19291 SF, *Perrier de la Bâthie 327ter*).

Twigs somewhat flattened, 1.5–2.8 mm. across, not or obscurely 4-angled, drying brown to dark brown (grayish and striate when old), glabrous; axillary innovations lacking basal scars; internodes 0.5–2.5 cm. long; uppermost pair of axillary buds subrounded, less than 1 mm. long, $\pm$ spreading; terminal bud plump, 4–8 mm. long, with grayish (rarely subferrugineous), $\pm$ crustaceous indumentum (hairs, FIGURE 16, n), underdeveloped internode to 8 mm. long. Petiole 1–1.8(–2.6) cm. long, broadly and rather shallowly concave above, convex below, glabrous when mature, slender; lamina ovate to suboblong, 4–11.7 by 1.6–4.4 cm., acuminate at apex, abruptly attenuate or rounded to acute at base, undulate but slightly or not recurved at margin, coriaceous, drying $\pm$ olivaceous-sepia and nitid above, sepia below, glabrous when mature, the midrib above gradually narrowed from base, $\pm$ sulcate at first (edges usually $\pm$ clearly demarcated from rest of blade), 0.2–0.35 mm. wide at midpoint, becoming raised toward apex, below raised, $\pm$ angled, venation above and below $\pm$ apparent, slightly raised, 8 to 10 veins/5 mm., angle of divergence 60–75(–85)°. Inflorescences from foliate axils along twigs, with 7 to 15 flowers, unbranched, the axis 2.2–7.5 cm. long, sometimes transiently brown-puberulent, especially in lower part, lowest internode (0.35–)0.7–2 cm. long; bracts ovate, ca. 2.5 mm. long, puberulent below, soon deciduous; pedicels 0.6–2 cm. long, glabrous or sparsely puberulent. Flower (?)hermaphroditic; tepals 8 (to 13), the outer pair suborbicular, 5–6 by 4.5–5 mm., the inner ones elliptic to obovate or oblong, 9–12 by 2.7–6 mm.; stamens 170 to 280, the filaments to 5.5 mm. long, connate for up to 2 mm., the anthers ellipsoid to oblong (0.5–)0.7–1(–1.5) cm. long, rounded to retuse at apex; ovary 1.2–2 mm. long, the style 3.5–5 mm. long, the stigma peltate, 0.5–0.9 mm. across, obscurely 3-radiate. Fruit ovoid to ellipsoid, 2.4–2.8 by 1.8–2.2 cm., $\pm$ obtuse at apex, drying pruinose vinaceous-brown, $\pm$ wrinkled (smooth when young); outer layer not detaching cleanly from stone, 1.6–2.5 mm. thick, compact; stone ellipsoid, 1.4–2 by 1.4–1.7 cm., rounded at apex, the walls 0.3–0.6 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. North-central Madagascar (MAP 13).

SELECTED SPECIMENS SEEN. **Madagascar:** vallée d'Ifasy, *Perrier de la Bâthie* 8153 (P); Vavatobe [Ambavatobe], *Hildebrandt* 3324 (G, M, P, US); Andranofasika, Ampasimatera, Mampikony, 19291 SF (P); Maevatanana, bassin moyen du Bemarivo (Boina), *Perrier de la Bâthie* 3274 (P); Beritsoka, E. du Maevatanana, *Perrier de la Bâthie* 327bis (P); Ambalanjanakomby, Bentaly-Maevatanana, 14942 SF (P); Besalampy, Bekodoka, Sahondra, 15235 SF (P); Ankorika, Ankarafantsika, 150–200 m., *Ursch* 147 (P); Morataitra, près de Maevatanana, *Perrier de la Bâthie* 5308 (P); forêt Bitomandry, 5349 SF (P); Maintirano, forêt Andranomena, 14781 SF (P); forêt Ambatomanga, N. du Anjozorobe, *Boiteau s.n.* (P).

ECOLOGY. Locally common in seasonal forest, usually along river banks on siliceous ground; low alt. Flowering February to April and August, September, and November; fruiting September and January (fruit somewhat fleshy; eaten by lemurs (*Perrier de la Bâthie* 3274), despite a somewhat terebinthlike taste).

TABLE 8. Differences between *Calophyllum vernicosum* and *C. recedens*.

	<i>C. vernicosum</i>	<i>C. recedens</i>
WHITISH WAXY COVERING ON TWIGS	Usually present	Absent
TERMINAL BUD LENGTH (mm.)	2.5-4	4-8
TERMINAL BUD INDUMENTUM	Reddish brown, short-tomentose	Usually grayish, subcrustaceous
LAMINA BASE	Acute	Abruptly attenuate or rounded to acute
MIDRIB ON UPPER SURFACE OF LAMINA	Indistinct	Usually distinct
VENATION DENSITY (veins/5 mm.)	(6 to) 8 to 12 (to 14)	8 to 18
ANTHER LENGTH (mm.)	0.9-1.8	(0.5-)0.7-1(-1.5)
OUTER LAYER OF FRUIT, THICKNESS (mm.)	0.6-1	1.6-2.5
APEX OF STONE	Apiculate	Rounded

LOCAL USES. The wood is used in the manufacture of furniture and canoes, and the latex has apparently been used in the local pharmacopeia (Perrier de la Bâthie, 1951, *loc. cit.*).

Calophyllum recedens can be recognized by its medium-sized leaf blades that are acuminate at the apex, often attenuate at the base, and with moderately dense venation. The terminal bud has subcrustaceous indumentum; the twigs are slightly angled. The inflorescences are angled, and the flowers usually have eight tepals. The ovoid to ellipsoid fruits are 2.4-2.8 cm. long, subobtusate at the apex, and with a compact outer layer 1.6-2.5 mm. thick. The epithet *recedens* means "receding" or "differing," possibly a simple allusion to the fact that the species was distinct.

Calophyllum recedens is perhaps related to *C. tacamahaca*, from the Mascarenes; Vesque (*loc. cit.*) cited Hildebrandt 3324 under the latter species. However, there are numerous differences between the two in twig, leaf, and fruit (Stevens, 1976, *table 1*). It should also be noted that *C. tacamahaca* has longer anthers (1.5-1.9 mm. vs. (0.5-)0.7-1(-1.5) mm.). The stone of the fruit of *C. tacamahaca* has a basal plug; such a plug has not been noticed in *C. recedens*. *Calophyllum recedens* has also been confused with *C. vernicosum*; for the differences between the two, see the latter species (TABLE 8).

42. *Calophyllum vernicosum* P. F. Stevens, sp. nov.

FIGURE 15, t.

C. recedens auct., non Jumelle & H. Perr.; H. Perr. in Humbert, Fl. Madagascar Comores, Fam. 136: 2. 1951, *pro parte*.

A speciebus aliis Calophylli in gemma terminalis 2.5–4.5 mm. longa indumento subfulva praedita, innovationes axillaribus cicatricibus basalibus haud ornatis, ramulo tegenti albescenti subpersistenti praedito, pagina superiore laminae nitida costa indistincta, et fructu ovoideo vel ellipsoideo apice plerumque acuto strato exteriori 0.6–1 mm. in transverso, differt.

Tree 9–12 meters tall; outer bark smooth at first, becoming similar to that of a pine (?fissured).

Twigs flattened, 1.3–2.7 mm. across, $\pm$ rounded, drying blackish, color obscured by whitish (?)waxy covering, transiently rufous-puberulent; axillary innovations lacking basal scars; internodes 0.5–2.5(–4) cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, spreading; terminal bud plump, 2.5–4 mm. long, with short-tomentose, rufous indumentum (hairs, FIGURE 16, o), underdeveloped internode to 2 mm. long. Petiole 1.2–2.3 cm. long, broadly concave above and convex below, glabrous; lamina ovate (elliptic), 5–11 by 1.6–3.5(–4.7) cm., acuminate at apex, acute at base, strongly but distantly undulate and not recurved at margin, coriaceous, drying $\pm$ concave, shiny, greenish brown above and brownish below, glabrous at maturity, the midrib above gradually narrowed from base, at least margins raised, surrounding lamina also raised, sulcate, 0.25–0.7 mm. wide at midpoint, below slightly raised, $\pm$ striate, not very conspicuous, the venation subobscure to apparent above and subapparent below, raised, (6 to) 8 to 12 (to 14) veins/5 mm., angle of divergence 60–75°. Inflorescences from foliate axils, with 7 to 15 flowers, unbranched, the axis 2.9–9 cm. long, puberulent, especially toward base, lowest internode (0.1–)0.4–1.5(–2.3) cm. long; bracts ovate, ca. 2 mm. long, soon deciduous; pedicels 0.5–2.4 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8, the outer pair broadly ovate, 3.8–4.5 by 4.2–4.5 mm., the inner ones elliptic to lingulate, 6–9 by 2.5–6 mm.; stamens 75 to 180, the filaments to 4 mm. long, the anthers oblong, 0.9–1.8 mm. long, subretuse at apex; ovary 1.2–1.4 mm. long, the style 3.5–4 mm. long, the stigma peltate, 0.7–1 mm. across, obscurely 3- or 4-radiate. Fruit ellipsoid to ovoid, (1.9–)2.5–3.4 by 1.6–1.9 cm., acute (rarely rounded) at apex, drying brown, wrinkled (almost smooth at maturity); outer layer detaching $\pm$ cleanly from stone, 0.6–1 mm. thick, air spaces developing at maturity; stone $\pm$ ellipsoid, 1.7–2.5 by 1.4–1.65 cm., apiculate, the walls 0.3–0.9 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: Madagascar, Ambilobe, forêt dégradée au nord d'Ambilobe, 10 Nov. 1958, 18934 SF coll. Capuron (holotype, P; isotype, P).

DISTRIBUTION. Northern Madagascar (MAP 12).

ADDITIONAL SPECIMENS SEEN. **Madagascar:** Ambilobe, Mt. Ambohipiraka, près d'Ambilobe, *Perrier de la Bâthie* 18754 (P), 300–400 m., *Humbert & Cours* 32881 (P), 32903 (P), village d'Ankatoto, *Cours* 5650 (P), 100–300 m., 5671 (P); Ambilobe, *de Cary* 14842 (G, P), 5408 SF (P); plaine d'Ambilobe, 10507 SF (P); Beramanja, route Tafiana-Ambohimanjy, 1286 RN (P), 1287 RN (P); Massif de l'Ankarana, *de Cary* 14522 (BM, K, P, US), 14563 (L, MO, P); Diego Suarez, *Ursch* 264 (P); Sambirano, *Morat* 1416 (P); sino loco, *Baron* 6258 (BM, K, P).

ECOLOGY. Locally fairly common in light, sometimes rather dry colline forest, 100–400 m. alt. Flowering July, August, October, and November; fruiting January, August, October, and November (fruit yellowish green).

Elliptic, disk-shaped galls to 4.5 by 3 mm. with a slightly raised margin and a raised center sometimes occur on the lower surface of the lamina in a line at, or a little in from, the margin.

Calophyllum vernicosum can most readily be recognized by its short terminal bud; dark-drying twigs with a more or less transient whitish covering; leaf blades that dry very shiny, especially on the upper surfaces, and with a midrib not sharply distinguished from the rest of the lamina; and ellipsoid-ovoid fruits with a rather thin (less than 1 mm.) outer layer in which air spaces develop. The epithet *vernicosum* alludes to the shiny, varnished appearance of the upper surface of the dried lamina; this may also be noticeable in the living leaf, as the field label of *Cours 5650* suggests.

I originally included the specimens described above as *Calophyllum vernicosum* in *C. recedens*, but the resultant "taxon" was uncomfortably variable. However, when the specimens were re-sorted on the bases of bud size and color, such other characters as leaf type, anther size, and fruit type were found to show correlated variation. In addition, the uppermost internode of the innovation in *C. vernicosum* tends to be notably shorter than the others (although this is not nearly as marked as in *C. verticillatum*); there is not this size disparity in *C. recedens*. The differences between the two taxa are listed in TABLE 8; although there is some overlap in a few of the characters, many characters are involved and even sterile material can be identified easily. The two species have distinct geographic ranges (cf. MAPS 12, 13).

43. ***Calophyllum wallichianum*** Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 277. 1862. TYPE: Malaya, Penang, *Wallich dist. 4843, pro parte* (holotype, G; isotypes, BM, FI, G, K).

Tree (3–)15–36 meters tall, d.b.h. to ca. 160 cm.; trunk usually unbuttressed; outer bark brown or gray to yellow-gray or mottled yellow, with vertical lines of lenticels or shallowly fissured, hoop marked or not, inner surface brown-orange to orange or yellowish and greenish mottled; under bark reddish orange to red; inner bark red; latex white, often turning yellowish (rarely clear yellow), rather sticky.

Twigs slightly flattened, (1.5–)2.3–6 mm. across, obscurely to strongly 4-angled, drying blackish to yellowish brown, rather inconspicuously gray to brown farinose-puberulent (rarely subtomentose) when young; axillary innovations lacking basal scars; internodes (0.7–)1–5 cm. long; uppermost pair of axillary buds rounded to pointed, to 4.5 mm. long, $\pm$ erect to spreading; terminal bud plump to conical, (1.2–)1.6–3 cm. long, with gray to brown, crustaceous to subtomentose indumentum (hairs FIGURES 16, q–cc; 18, a–j), underdeveloped internode 1–6 mm. long. Petiole 1.2–2.5(–3.5) cm. long, broadly concave above, convex below, often drying blackish, glabrous or with indumentum obscure; lamina oblong to ovate, (5.3–)8.5–25(–32.5) by (2.1–)3–

6.8(-8) cm., acute to subacuminate at apex, acute or cuneate to rounded at base, distantly undulate and not recurved to moderately so at margin, coriaceous to thickly coriaceous, drying bay to sabelline above and fulvous to olivaceous below, subpersistently farinose-puberulent on midrib below and often above, the midrib above narrowing gradually or fairly quickly from base, often $\pm$ depressed at first, becoming raised (surrounding lamina sometimes raised), 0.2-0.8 mm. wide at midpoint, below strongly raised, striate to angled, the venation subobscure to apparent above and below, $\pm$ raised, (8 to) 10 to 17 veins/5 mm., angle of divergence 65-85°. Inflorescences from foliate axils, with 7 to 15 (to 19) flowers, unbranched (rarely with 5-flowered branches to 1.5 cm. long), the axis 1.7-7 cm. long, usually puberulo-tomentose toward base, puberulent toward top, lowest internode 4-11 mm. long; bracts ovate to elliptic, 4-10 mm. long, sometimes subpersistent, with dense, fawn-colored indumentum on both surfaces; pedicels 0.5-2(-2.5) cm. long, subglabrous to puberulent, slender in flower, to 4 mm. thick in fruit. Flower (?)hermaphroditic; tepals 4 (rarely 6), the outer pair ovate to elliptic, 5-7 by 3-3.5 mm., puberulent on back, the inner pair elliptic to obovate, 5.5-6 by 3.5-4 mm., sparsely puberulent in band down back, or glabrous, additional ones, if any, much smaller; stamens 90 to 185, the filaments to 3.5 mm. long, the anthers oblong, 0.5-1 mm. long, $\pm$ retuse at apex; ovary 1.3-1.7 mm. long, the style ca. 1.7 mm. long, the stigma peltate, 0.6-0.8 mm. across, 2- or 3-lobed. Fruit ellipsoid, $\pm$ ovoid or spherical, or obovoid, 2-3(-3.5) by 1.5-2.5(-3) cm., strongly apiculate or not, drying brown to blackish, sharply and shallowly wrinkled; outer layer detaching cleanly from stone, 1-3(-4) mm. thick, compact; stone broadly ovoid to subspherical or ellipsoid, 1.3-2.3 by 1.2-1.9 cm., rounded to apiculate at apex, the walls 0.3-1.1 mm. thick, smooth, usually unmarked (with discoloration at base to 4 mm. across); spongy layer thin.

Key to the Varieties of *Calophyllum wallichianum*

1. Lamina usually very coriaceous, the midrib on upper surface surrounded by raised blade, indistinct. 43c. var. *tahanense*.
1. Lamina usually coriaceous, the midrib on upper surface practically never surrounded by raised blade, distinct.
 2. Petiole (1-)1.2-2.2 mm. across; twigs (1.5-)2-3(-3.5) mm. across. 43a. var. *wallichianum*.
 2. Petiole (2-)2.5-5 mm. across; twigs 2.8-6 mm. across. 43b. var. *incrassatum*.

43a. *Calophyllum wallichianum* Planchon & Triana var. *wallichianum*

C. wallichianum Planchon & Triana; T. Anderson in Hooker f. Fl. Brit. India 1(2): 273. 1874, *pro parte*; Vesque in C. DC. Monogr. Phanerog. 8: 599. 1893, *pro parte*; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 303. 1956, *pro parte*; Kochummen, Malayan Forest Rec. ed. 2. 17: 216. 1965, *pro parte*; T. C. Whitmore, Tree Fl. Malaya 2: 193. 1973, *pro parte*.

C. spectabile auct., non Willd.; Curtis, Jour. Straits Branch Roy. Asiatic Soc. **25**: 78. 1894, *pro majore parte*; Ridley, Fl. Malay Penin. **1**: 185. 1922, *pro parte*.

C. tetrapetalum Wall. Catal. 4843. 1831, non Roxb. ex G. Don (1831). *Nomen*.

Tree 12–30 meters tall; latex milky white, turning yellow on exposure, or opaque lemon-yellow.

Twigs (1.5–)2–3(–3.5) mm. across. Petiole (1–)1.2–2.2 mm. across; lamina ovate, coriaceous, the margins undulate, the midrib on upper surface usually raised, even at base, distinct, 0.15–0.3(–0.35) mm. wide at midpoint. Bracts not persistent.

DISTRIBUTION. Northwestern Malay Peninsula (MAP 15).

SELECTED SPECIMENS SEEN (“f” denotes specimen with fruits). **Malaya.** KEDAH: Kuala Muda, Puah Reserve, *KEP* 59630 (KEP); Kuala Nerang, Kampong Kuala, 120 m., *KEP* 73532 (?) (KEP). PINANG: Government Hill, 366 m., *Curtis* 1153 (f) (BM, K, SING); Pantai Acheh F.R., 150 m., *KEP* 72564 (KEP); Pulau Pinang, 610 m., *FRI* 20534 (KEP); Telok Bahang F.R., *KEP* 66368 (KEP); Pulau Boetong Reserve, *Curtis* = 1153 (SING). PERAK: Pangkor F.R., 120 m., *FRI* 3021 (A, K, KEP, SAN, SING); Pangkor Is., S. Pinang F.R., 75 m., *FRI* 3057 (A, K, KEP, SAN, SING); Kelidang Saiong F.R., *KEP* 33634 (KEP, SING); Kinta, Tualang F.R., *KEP* 63253 (KEP); Telok Kopia F.R., Dindings, 150 m., *FRI* 3105 (A, K, KEP, SAN, SING); Dungun, Sagari-Melintang F.R., *KEP* 69418 (f) (KEP, SING); Sembilan Is., 30 m., *KEP* 76530 (f) (A, K, KEP, SING); Telok Muroh F.R., *KEP* 76733 (KEP); Batu Undan F.R., *KEP* 54225 (KEP); Gunong Bubu F.R., 914 m., *FRI* 17585 (L, SAR); G. Bubu, 396 m., *FRI* 11748 (K, KEP, L, SAR, SING); Sumpitan, *KEP* 10407 (K). NEGRI SEMBILAN: Kuala Pilah, *KEP* 93800 (KEP). KELANTAN: Kuala Mersing, Sungei Brok, 210 m., *FRI* 5450 (f) (A, K, KEP, SING).

ECOLOGY. Colline forest, 30–610(–914) m. alt. Flowering and fruiting in January.

MAP 15. Distribution of *Calophyllum wallichianum* var. *wallichianum* (circles) and *C. wallichianum* var. *incrassatum* (squares) in Malesia.

GERMINATION AND YOUNG PLANT. The radicle breaks the stone to one side of the base. The seedling has two pairs of leaves separated by an internode less than 1 cm. long. (*KEP* 10407, from Perak; *FRI* 6166, from Kelantan.)

43b. *Calophyllum wallichianum* Planchon & Triana var. *incrassatum* (Henderson & Wyatt-Smith) P. F. Stevens, comb. nov.

C. incrassatum M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 302. pl. 2. 1956; Wyatt-Smith, Malayan Forest Rec. **17**: 113. 1952, *nomen*; Kochummen, Malayan Forest Rec. ed. 2. **17**: 216. 1965; T. C. Whitmore, Tree Fl. Malaya **2**: 183. 1973; H. Keng, Gard. Bull. Singapore **28**: 244. 1976; Corner, Gard. Bull. Singapore Suppl. **1**: 104. 1978. TYPE: Singapore, Bukit Timah, "low" alt., 31 Dec. 1937, *SFN* 34647 coll. *Ngadiman* (holotype, SING; isotypes, A, BO, K, KEP, LAE, P, SING).

C. griffithii auct., non King; Ridley, Jour. Straits Branch Roy. Asiatic Soc. **33**: 47. 1900.

Tree (3-)15-36 meters tall; latex white, often turning yellowish (perhaps rarely initially yellow).

Twigs 2.8-6 mm. across. Petiole (2-)2.5-5 mm. across; lamina oblong to subovate (rarely ovate), coriaceous (rarely thickly coriaceous), the margins usually notably undulate, the midrib on the upper surface often more or less depressed at first, becoming raised, usually distinct, 0.3-0.8 mm. wide at midpoint. Bracts often subsistent.

DISTRIBUTION. Eastern Malaya to Borneo and perhaps Sulawesi (MAP 15).

SELECTED SPECIMENS SEEN. **Malaya.** SELANGOR: Bukit Lagong F.R., 455 m., *KEP* 83729 (KEP); Semangkok, 915 m., *KEP* 115248 (KEP). MALACCA: Pulau Besar, 13 km. from Malacca, *Stone* 9033 (KLU); Bukit Sadanan, *Derry* 515 (SING); S. side of Selandar Forest, *Burkill* 2010 (BO, K, SING). KELANTAN: Kemahang F.R., *KEP* 93580 (KEP). TRENGGANU: Jerengau State Land, *KEP* 79859 (KEP); along Sungei Pelong, foothill, *FRI* 14818 (K, KEP, SING); 59th Mile K. Trengganu-Khota Bharu road, *FRI* 2524 (?) (K, KEP, SAR, SING); Ulu Dungun, 270 m., *FRI* 9652 (KEP); Bukit Kajang, Kemaman, 150 m., *Corner s.n.*, 2 Nov. 1935 (SING); G. Padang Exped., Ulu Brang, 1219 m., *FRI* 12646 (?) (A, K, KEP, SING). PAHANG: Bukit Santong, Rompin iron mine, 365 m., *FRI* 3605 (A, K, KEP, SAR, SING); Lesong F.R., 180 m., *FRI* 20008 (KEP, SAR); Kuantan, Bukit Goh Reserve, *KEP* 3628 (K, SING); Kallam Ayer Reserve, *KEP* 17250 (KEP, SING); G. Tapis, 575 m., *FRI* 17692 (KEP); Tasek Bera F.R., 75 m., *FRI* 16960 (KEP); Baloh F.R., *KEP* 66645 (KEP); Temerloh, *KEP* 5473 (SING). JOHORE: Mawai-Jemaluang road, *SFN* 34911 (A, BO, K, KEP, LAE, P, SING); Kluang F.R., 90 m., *FRI* 7536 (A, KEP, SAR, SING); Ulu Endau, summit of Bukit Kendok, 396 m., *KEP* 105015 (A, K, KEP, SING); Banang F.R., *KEP* 79420 (KEP); G. Ledang, 396 m., *FRI* 19202 (A, KEP, SAN); Gunong Arong F.R., *KEP* 84582 (KEP); Bukit Jelaboi, *FRI* 9831 (KEP); G. Pulai, 610 m., *FRI* 9919 (KEP); Jemaluang F.R., *KEP* 69971 (KEP); Labis, 60 m., *KEP* 104953 (KEP); Ma'Okil F.R., 6 m., *KEP* 71279 (KEP); Renggam F.R., 75 m., *KEP* 71269 (KEP); G. Panti F.R., 395 m., *KEP* 93775 (KEP). **Singapore:** Sungei Morai, *Ridley* 5071 (BM, SING); Bukit Timah, *SFN* 38846 (LAE, SING); Changi, *Ridley s.n.*, anno 1893 (P); Botanic Gardens, *SGN* 1692 (SING). **Sumatra and adjacent islands.** RIAU: Koeantan, Poelau Kedondong, 100 m., *bb* 24801 (BO, L, SING);

Upper Riau, Pakanbaru, Tenajan R., *Soepadmo* 71 (BO, C, L, SING). UTARA: Hoogl. van Toba, Pandoemaan, 900 m., *bb* 5695 (BO); Silindoeng, 1040 m., *bb* 6620 (BO). BORNEO. SARAWAK. 1st Division: Semengoh F.R., 30 m., *Stevens et al.* 282 (A); Serian, G. Penrissen, *S* 16375 (A, L, SAN, SAR, SING). 3rd Division: Hose Mts., Bt. Lumut, Ulu Amau, 950 m., *S* 21255 (A, BO, K, KEP, L, SAN, SAR, SING); Ulu Kapit, Pelagus Protected Forest, *S* 33191 (KEP, KLU, SAN, SAR). SABAH. Kinabatangan: Karamuak, Bukit Meliau, 150 m., *SAN* 39310 (SAN, SAR, SING); Lamag, E. of Sungei Meliau, 30 m., *SAN* 53252 (SAN), Bukit Tavai, 240 m., *SAN* 53316 (SAN). KALIMANTAN. Timur: Tidoengsche Landen, 7 m., *bb* 18354 (A, BO); Tandjong Redeb, Labanan, *bb* 11511 (BO). CELEBES. SULAWESI: Manado, Bol. Mangadan, Bonko, 50 m., *bb* 13751 (BO).

ECOLOGY. Usually in well-drained, mixed dipterocarp lowland rainforest, sometimes in swamp forest or in mossy heath forest (*S* 21255); 6–400(–1220) m. alt. Flowering November to February (flower scented); fruiting March to May, sometimes September and November (fruit orange (*S* 21255)).

GERMINATION AND YOUNG PLANT. The seedling has two pairs of leaves separated by an internode less than 1 cm. long. Subsequently produced internodes are much longer, the terminal bud is functional, and the plant is erect. (*Stevens et al.* 103, 106 (Johore, Malaya), 282 (Sarawak).)

The epithet *incrassatum* ("thickened") was coined because the pedicel becomes thickened in fruit.

43c. ***Calophyllum wallichianum*** Planchon & Triana var. ***tahanense*** (Henderson & Wyatt-Smith) P. F. Stevens, comb. nov.

C. tahanense M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 305. pl. 4. 1956; T. C. Whitmore, Tree Fl. Malaya 2: 168. 1973. TYPE: Malay Peninsula, Pahang, Gunong Tahan, Wray's Camp, ± 3500 feet [1067 m.], 27 Aug. 1928, *SFN* 20601 coll. *Holttum* (holotype, SING; isotypes, A, BO, UC).

C. spectabile auct., non Willd.; Ridley, Jour. Fed. Malay States Mus. 2: 110. 1909.

Tree 6–20 meters tall; latex yellow or pale yellow, clear.

Twigs 2–5 mm. across. Petiole 1.5–3 mm. across; lamina ovate, slightly undulate at margin, thickly coriaceous, the midrib on upper surface slightly sunken at base, surrounded by raised lamina, indistinct, 0.2–0.4 mm. wide at midpoint. Bracts not persistent.

DISTRIBUTION. Malay Peninsula (MAP 16).

SELECTED SPECIMENS SEEN. **Malaya.** NEGRI SEMBILAN: G. Angsi, 455 m., *FRI* 17345 (K, KEP, SING). KELANTAN: Ulu Kelantan, Realai [Relai] F.R., *FRI* 7256 (A, K, KEP, SAR, SING); path to G. Rabong, 762–975 m., *Shah* 2510 (A, BRI, KEP, SING); Sungei Kerbut, Jeram Keteh, ca. 2 km. below K. Trenggan, 335 m., *FRI* 20281 (K, KEP, L, SAN). PAHANG: G. Tahan, 1067 m., *SFN* 8020 (BO, K, SING).

ECOLOGY. Colline or montane forest, 335–1067 m. alt. Flowering August

and September; fruiting February, March, June, and October (fruit dull yellow-green).

The type specimen was collected on Gunong Tahan, and this suggested the epithet.

Calophyllum wallichianum can be recognized by its plump terminal buds over 1 cm. long; its rather large, elliptic to ovate to oblong lamina with moderately dense venation; its unbranched inflorescence with farinose-puberulent to subtomentose indumentum; its flowers that usually have only four tepals, with the backs of the outer pair puberulent; and its medium-sized fruits that dry wrinkled and have a well-developed, compact outer layer 1-3(-4) mm. thick and stone walls 0.3-1.1 mm. thick. The hairs usually have a single, basal branch. The specific epithet commemorates the indefatigable botanist, N. Wallich.

Circumscription of *Calophyllum wallichianum*

The taxa and their limits in the *Calophyllum wallichianum*/*incrassatum*/*tahanense* complex have been quite troublesome. My original intention was to follow Henderson and Wyatt-Smith's treatment, although it was clear that, as they realized, *C. wallichianum* could be separated into northern and western (Kedah, Pinang, Perak) and southern and eastern (Trengganu, Johore, Singapore) parts, the former having basically opaque, white to yellow exudate and sparsely tomentose terminal buds, and the latter with clear, yellow exudate and more tomentose terminal buds. There were also slight differences in

MAP 16. Distribution of *Calophyllum wallichianum* var. *tahanense* (stars), *C. scriblitifolium* (circles), and *C. lowii* (half-circles) in Malaysia. Inset: *C. lowii*.

leaf shape and terminal bud. *Calophyllum incrassatum* was separated from *C. wallichianum* by its more persistent bracts, usually white latex, smooth bark, and more prominent midrib. The northern populations of *C. wallichianum* are clearly intermediate between the southern populations and *C. incrassatum* in these characters, except those of the leaf, in which they agree with the southern populations.

However, the northern populations of *Calophyllum wallichianum* have basically spherical, moderate-sized fruits with the walls of the stones usually less than 0.8 mm. thick, like those of *C. incrassatum*, while the southern populations (with the partial exception of those in Trengganu) have large, often ellipsoid fruits with stone walls at least 1.3 mm. thick. Indumentum studies confirmed this relationship: the northern populations and *C. incrassatum* have hairs that are slightly birefringent, with apical cells little longer than the others; the southern populations have highly birefringent hairs, with the apical two cells much enlarged and very thick walled (FIGURE 18, a, b).

Specimens referable to *Calophyllum tahanense* have been variously identified as *C. incrassatum*, *C. wallichianum*, *C. flavo-ramulum*, or *C. austrocoriaceum*. *Calophyllum tahanense* is separated from the first two species by the key in Henderson and Wyatt-Smith (*op. cit.*) only because it grows at generally higher elevations than do these species. In both indumentum and fruit type it is similar to the northern populations of *C. wallichianum* and to *C. incrassatum*.

Hence, the complex must be reorganized taxonomically. The small-fruited form must bear the name *Calophyllum wallichianum*, because the type of that name came from such a specimen (see below). The erstwhile *C. incrassatum* can be distinguished varietally from *C. wallichianum* sensu stricto mainly by its broader twigs and petioles; it also has a more southerly distribution in Malaya. The erstwhile *C. tahanense* is also reduced to varietal rank. It can be distinguished by its more coriaceous leaves, its midrib type, and possibly also by bark differences; it is basically a montane form (but see below). For the plants that formed the southern group of *C. wallichianum*, I have taken up Henderson and Wyatt-Smith's manuscript name, *C. rufigemmatum*; *C. wallichianum* and *C. rufigemmatum* are readily distinguished by morphology, indumentum, and bark characters (TABLE 9). In the southern part of the Malay Peninsula (e.g., Renggam Forest Reserve, Johore) and on Singapore (e.g., Bukit Timah), the two species grow together.

It is clear that much work still has to be done on this complex, both to ascertain the variation within *Calophyllum wallichianum* as here defined, especially in Sumatra and Borneo, and also to establish more clearly the relationships between *C. rufigemmatum* and its probable relatives, and *C. lanigerum* and *C. ferrugineum* and their relatives, since all taxa have similar, very distinctive hairs. Seedling type and germination, practically unknown in *C. rufigemmatum* and in *C. lanigerum* and its relatives, is potentially significant. Growth patterns may also be important (does *C. rufigemmatum* produce one or two pairs of leaves per flush, and *C. wallichianum* more?), as is, of course, a better knowledge of the basic morphology of many of the taxa involved.

TABLE 9. Differences between *Calophyllum rufigemmatum* and *C. wallichianum*.

	<i>C. rufigemmatum</i>	<i>C. wallichianum</i>
LATEX	Clear yellow, rarely brown	Opaque white, often turning yellowish, rarely clear yellow
INDUMENTUM	Short-tomentose to tomentose	Crustaceous to short-tomentose, rarely tomentose
HAIR TYPE	Two apical cells much elongated, thick-walled, birefringent	Apical cells practically never much elongated, but if so, not thick-walled
TWIGS	Often with obscure transverse line at nodes	Obscure transverse lines not seen
INFLORESCENCE		
AXIS LENGTH (cm.)	0.3-1.3	1.7-7
NUMBER OF FLOWERS	5 to 7	7 to 15 (to 19)
PEDICEL LENGTH (cm.) AT ANTHESIS	0.35-0.7	0.5-2
FRUIT LENGTH (cm.)	(2.6-)3-4.4	2-3(-3.5)
STONE WALL THICKNESS (mm.)	(1-)1.3-2	0.3-1.1

Variation within *Calophyllum wallichianum* var. *incrassatum*

The majority of specimens of *Calophyllum wallichianum* var. *incrassatum* from Sumatra and Borneo have subconical, rather than plump, terminal buds (they are plump in *Soepadmo* 71); better-developed indumentum (it is even tomentose in *bb* 2971); a midrib with at least the edges raised, even at the very base; and large leaf blades (9.5-)15-32.5 by (2.8-)3.7-8 cm. In seedling type and general bark characters *Stevens et al.* 282, from Sarawak, was similar to plants seen in Malaya and Singapore, although the latex was pale yellow and opaque, rather than white (as might be expected, the latex of the twigs was white). Other specimens from the Sumatra-Borneo area are reported to have yellow (*Soepadmo* 71; *S* 16375), whitish (*SAN* 53316), or white (*SAN* 39310) latex. The fruits of this form are similar to those of Malayan specimens, although those of *S* 16375 are reported to be yellow. An interesting specimen from the western coast of Sumatra, *bb* 2971, has young, branched infructescences with tomentose indumentum; the branches have up to seven flowers and are up to 3.5 cm. long (see also below). Specimens of *C. wallichianum* var. *incrassatum* from Sumatra and Borneo tend to have

the cells at the apex of the hairs notably larger than those toward the base (FIGURE 18, g-k).

The specimens of *Calophyllum wallichianum* var. *incrassatum* from Malacca, particularly Stone 9033, are superficially similar to *Calophyllum lanigerum* var. *austrocoriaceum*; bb 2971, from the western coast of Sumatra, has leaf blades drying the rich brown color of at least the Bornean specimens of *C. lanigerum*. However, *C. lanigerum* has better-developed indumentum, the hairs having strongly birefringent, expanded apical cells; a plumper terminal bud; usually less dense and clearer venation; an inflorescence that is glabrous toward the apex; and bark with yellow latex.

Two specimens of *Calophyllum wallichianum* var. *incrassatum* from G. Padang, Trengganu, which were collected at rather high altitudes for the species, are very robust and have a midrib approaching that of *C. wallichianum* var. *tahanense*. The fruits are spherical and sharply wrinkled and have an outer layer ca. 3 mm. thick and stone walls ca. 1 mm. thick. Henderson and Wyatt-Smith (*op. cit.*) cited SFN 31076 as *C. tahanense*, albeit with some hesitation; Whitmore determined FRI 12646 as *C. coriaceum*, which has similarly coriaceous leaves but is not otherwise comparable.

The specimens from Selangor are included with some hesitation. One specimen, anon., 19 June 1951 (KEP), has slender petioles up to 3.5 cm. by up to 2.5 mm. FRI 2524 (Trengganu, Malaya) has ovate leaf blades that are rather narrowly acute at the apex; the inflorescences are more robust than those of other Malayan specimens and are tomentose; the pedicels are only 7 mm. long. The record of *Calophyllum wallichianum* var. *incrassatum* from the Celebes also needs to be confirmed; bb 13751 is a sterile specimen.

Typification of *Calophyllum wallichianum*

Wallich dist. 4843, the type of *Calophyllum wallichianum*, was collected at Pinang and Singapore; thus, as seen from the discussion above, it might have been taken from the small- or the large-fruited element in *C. wallichianum* as previously delimited. However, as Henderson and Wyatt-Smith (*loc. cit.*) noted, the type came from Pinang; the many-flowered inflorescences, as well as the hair type (FIGURE 16, x, y), confirm this.

When Planchon and Triana (*loc. cit.*) described *Calophyllum wallichianum*, they noted that *Wallich dist.* 4843 was a mixed collection, including also *C. spectabile* (properly *C. soulattri*) and a small piece of *C. polyanthum* (which I have not seen under this number). There is yet another species under this number, represented by leaves and fruits of *C. lanigerum* var. *austrocoriaceum*; this element, at least, was probably collected in Singapore. Planchon noted on a sheet at Geneva that the fruits did not belong to "*C. insigne*," and Planchon and Triana (*loc. cit.*) suggested that Choisy had confused "*C. insigne*" with *C. wallichianum*. I have not found the name "*C. insigne*" elsewhere, and it appears to be an error for *C. spectabile* (= *C. soulattri*).

44. *Calophyllum rufigemmatum* Henderson & Wyatt-Smith ex P. F. Stevens,
sp. nov. FIGURE 17, b-h.

FIGURE 17. a, *Calophyllum* sp. 54 (bb 19334), terminal bud, $\times 3$. b-h, *C. rufigemmatum*. b-e, FRI 13796. b-d, fruit, $\times 0.75$: b, from outside; c, transverse section; d, longitudinal section. e, terminal bud, $\times 3$. f-i, FRI 3921. f-h, fruit, $\times 1$: f, from outside; g, longitudinal section; h, stone, from apex. i, terminal bud, $\times 3$. j, *Calophyllum* sp. 53 (S 24675), terminal bud, $\times 3$. k, *C. castaneum* (Stevens et al. 133), terminal bud, $\times 0.75$. l-n, *C. woodii*. l, terminal bud (SAN 42949), $\times 3$. m, n, fruit (SAN 16693), $\times 2$: m, transverse section; n, from outside.

C. wallichianum auct., non Planchon & Triana; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 303. pls. 1C, 3. 1956, *pro parte*; Maheshwari, Bull. Bot. Survey India **2**: 146. 1960, *pro parte*; Kochummen, Malayan Forest Rec. ed. 2. **17**: 216. 1965, *pro parte*; T. C. Whitmore, Tree Fl. Malaya **2**: 193. 1973, *pro parte*; H. Keng, Gard. Bull. Singapore **28**: 245. 1976; Corner, Gard. Bull. Singapore Suppl. **1**: 105. 1978.

A speciebus aliis Calophylli in gemma terminalis (0.8–)1.2–1.8 cm. longa indumento tomentoso praedita, lamina mediocra venatione densa subobscura, inflorescentia brevi, et fructu plerumque 3–4.4 cm. longo putamine parietibus 1.3–2 mm. in transversis, differt.

Tree 20–48 meters tall, d.b.h. to 240 cm.; trunk usually without buttresses or spurs; outer bark brown to gray, becoming deeply fissured, the inner surface blackish, brown and orange mottled, or dirty orange-brown; under bark red; inner bark red to pink or dull brown; latex clear, yellow, sticky, or light brown (Sumatra).

Twigs flattened, 1.5–2.5(–3.5) mm. across, obscurely 4-angled, often with inconspicuous transverse raised line at nodes, drying blackish, subpersistently rufous-puberulent to -short-tomentose; axillary innovations lacking basal scars; internodes (0.5–)1–5(–6.5) cm. long; uppermost pair of axillary buds $\pm$ pointed, to 3 mm. long, erect to $\pm$ spreading; terminal bud plump to narrowly conical, (0.8–)1.2–1.8 cm. long, with rufous-puberulent to -tomentose indumentum (hairs, FIGURE 18, k, l), underdeveloped internode to 6 mm. long. Petiole (1–)1.2–2.7 cm. long, slender, concave above, convex below, subpersistently tomentose, drying black; lamina ovate to subelliptic, 7.3–14 by 2–5 cm., gradually (sub)acuminate to retuse at apex, acute or cuneate to broadly rounded and often slightly asymmetrical at base, rather distantly undulate and not recurved to slightly so at margin, coriaceous, drying umber to sabelline above and umber to khaki below, subpersistently puberulent to short-tomentose on midrib on both surfaces, the midrib above narrow at base or narrowing fairly quickly near base, $\pm$ raised (surrounding lamina obscurely raised), 0.25–0.35 mm. wide at midpoint, below raised, striate, the venation on both surfaces usually subobscure (rarely subapparent), raised, (11 to) 13 to 18 veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils, with 5 (to 7) flowers, unbranched, the axis 0.3–1.3 cm. long, puberulent, sometimes short-tomentose toward base, lowest internode 1–5 mm. long; bracts ovate, ca. 4 mm. long, often persistent at anthesis; pedicels 3.5–7 mm. long, to 12 mm. in fruit, short-tomentose. Flower (?)hermaphroditic; tepals 4 (to 8), the outer pair elliptic to subobovate, 5–7 by 2.2–4 mm., subtomentose on back, the next pair obovate, 8–8.5 by 3.5–4.5 mm., usually with strip of indumentum down back, additional ones, if any, to 9 by 3.1 mm.; stamens 140 to 250, the filaments to 4.5 mm. long, connate for up to 0.5 mm., the anthers oblong, 0.5–1.2 mm. long, $\pm$ retuse at apex; ovary 1.2–2 mm. long, the style 2–2.2 mm. long, the stigma peltate, 0.5–0.7 mm. across, 3- or 4-radiate. Fruit ellipsoid (spherical or subobovoid), (2.6–)3–4.4 by 2.4–3.2 cm., $\pm$ rounded at apex, drying brown or grayish brown, with broad, longitudinal ridges and/or fine wrinkles; outer layer detaching cleanly

FIGURE 18. Hairs (from terminal bud). a-j, *Calophyllum wallichianum*. a, b, var. *wallichianum* (FRI 3105). c-h, var. *incrassatum*: c, d, bb 18354; e, f, FRI 3605; g, h, S 16375. i, j, cf. var. *incrassatum* (bb 24801). k, l, *C. rufigemmatum*: k, SFN 34642; l, KEP 74159. m, *C. aff. castaneum* (S 16559). n-q, *C. lanigerum*. n, o, var. *austrocoriaceum*: n, FRI 7846; o, Purseglove 5560. p, q, var. *lanigerum*: p, Kostermans 9591, hair to 600 μ m. long; q, Kostermans & Anta 490, hair ca. 550 μ m. long. r, *C. castaneum* (HLB 909, 68-72), hair ca. 540 μ m. long. Expanded apical cells in k-q all strongly birefringent in polarized light. Scale = 120 μ m.

from stone, 1.3–3.5 mm. thick, compact, $\pm$ striate on inner surface; stone ovoid to ellipsoid, 2.2–3 by 2–2.4 cm., apiculate or not, the walls (1–)1.3–2 mm. thick, smooth, often with triradiate marking at apex; spongy layer thin.

TYPE: Singapore, Bukit Timah, "low" alt., 24 Dec. 1937, *SFN* 34632 coll. *Ngadiman* (holotype, A; isotypes, K, LAE, SING).

DISTRIBUTION. Southeastern Malaya, Singapore, Sumatra (MAP 17).

SELECTED SPECIMENS SEEN ("f" denotes specimens with fruits). **Malaya.** TRENGGANU: Ulu Dungun, *FRI* 9616 (KEP); Jerengau State Land, 285 m., *KEP* 76677 (f) (K, KEP, L, SING); Bauk F.R., 210 m., *FRI* 3921 (f) (A, K, KEP, SAR, SING). PAHANG: G. Lesong F.R., Rompin, 15 m., *KEP* 80955 (f) (A, K, KEP, L, SING); Aur F.R., 15 m., *KEP* 75881 (f) (KEP); Mile 17, Jalan Pekan–Batu Balek, *KEP* 82702 (KEP); Baloh F.R., *KEP* 77974 (KEP). JOHORE: G. Panti, Panti F.R., 305 m., *FRI* 13796 (f) (A, K, KEP, SAN, SING); Renggam F.R., *KEP* 71265 (KEP); Jalan Endau, Mersing, 21 m., *KEP* 74159 (f) (A, BO, K, KEP, SING); Jemaluang, *KEP* 73457 (f) (K, KEP); G. Arong F.R., *KEP* 77889 (f) (KEP); 15 m., *Stevens et al.* 80 (A); Kluang F.R., *KEP* 69919 (KEP); G. Pulau, *SFN* 7803 (f) (KEP); 6th Mile, Kota Tinggi–Mawai road, *SFN* 30987 (SING); Mersing F.R., *KEP* 77814 (f) (KEP, SING); Ulu Sedili F.R., *KEP* 63058 (KEP); Sungei Sarah W.C., 45 m., *KEP* 77733 (f) (K, KEP). **Singapore:** Bukit Timah, *SFN* 34546 (BO, SAR, SING), *Ridley* 6333 (f) (SING, w); Gardens Jungle, *SFN* 39451 (f) (A, K, KEP, SING); Mandai Forest, *SFN* 39605 (K, SING). **Sumatra and adjacent islands.** RIAU: Afd. Lingga, P. Lingkep, Oetan Njakur (Bakong), 100 m., *bb* 2040 (BO, L); bij Oetan djalan Setawar, *bb* 2705 (BO); Sei Tokak, *bb* 3861 (L), Djago, 10 m., *bb* 3939 (f) (BO); Tanjong Batang, 8 m., *bb* 4015

MAP 17. Distribution of *Calophyllum rufigemmatum* (solid circles), *C. castaneum* (stars), *C. aff. castaneum* (open circles), *C. woodii* (squares), and *Calophyllum* sp. 54 (triangles) in Malesia. Inset: *Calophyllum* sp. 53.

(BO); B. Poempoeng, *bb* 4047 (BO); upper Riau, Pakanbaru, Tenajan R., *Soepadmo* 222 (f) (A, BO, C, E, LAE, NY, SING).

ECOLOGY. An often large tree of ridges, slopes, or other well-drained habitats in mixed dipterocarp forest, 5–305 m. alt. Flowering February, September, November, and December (flower scented); fruiting January, March to August, and October (fruit pale or brownish green). *SFN* 33561, *bb* 3939, and *Soepadmo* 222 have neat holes bored in the stone wall and the seed eaten; these appear to be the exit holes made by some insect.

GERMINATION AND YOUNG PLANT. The radicle breaks the stone to one side of the base (*KEP* 77989). The seedling has two pairs of leaves separated by an internode ca. 1.4 cm. long (one seedling, from Singapore, *SFN* 39451). Subsequent internodes are somewhat longer, the terminal bud is functional, and the plant is erect.

LOCAL USE. The wood is an important timber since the trees attain large dimensions.

Calophyllum rufigemmatum can be recognized by its relatively slender twigs and petioles, and its ovate to subelliptic lamina that is obscurely and rather distantly undulate at the margin and has a more or less raised midrib, even at the base, and close venation. The inflorescences are short and congested, and the bracts are subsistent; the short pedicels elongate markedly after anthesis. The fruits are distinctive; they are typically large, longitudinally corrugated as well as closely wrinkled, and with a stone wall usually at least 1.3 mm. thick (but see below). The epithet *rufigemmatum* ("reddish brown buds") is quite appropriate.

The circumscription of *Calophyllum rufigemmatum* is discussed under *C. wallichianum*, in which it had previously been included. The rather appropriate manuscript name that Henderson and Wyatt-Smith coined for this taxon when they thought it was specifically distinct is retained.

Although *Calophyllum rufigemmatum* is generally distinguishable from *C. wallichianum* by numerous, albeit sometimes rather inconspicuous, characters (TABLE 9), specimens from Trengganu blur this distinction somewhat in Malaya. Fruiting specimens from the Bukit Bauk Reserve have spherical, reticulate (but not longitudinally corrugated) fruits, with the outer layer and stone walls 1–1.5 mm. thick (FIGURE 17, f–h). The single fruiting collection from Jerengau is intermediate between the specimens from Bukit Bauk and the typical form (see above). In other characters, these specimens agree well with *C. rufigemmatum* (see also the discussion after *C. wallichianum* and *C. castaneum*).

I collected an interesting specimen (*Stevens et al.* 48) from the Renggam Forest Reserve, Johore, thinking it to be *Calophyllum rufigemmatum* although the latex was slightly cloudy. However, the dried specimen has a facies similar to that of *C. lanigerum* var. *austrocoriaceum* and also, but less markedly, that of *C. molle*. The inflorescences are those of *C. rufigemmatum*, but the stamens have hairy filaments and glabrous anthers. The hairs on the terminal bud are like those of *C. rufigemmatum*.

At first sight saplings of *Calophyllum rufigemmatum* from Johore look

very different from the adult trees. There is dense, tomentose indumentum on the terminal bud and the stem, as well as on the midrib on the lower surface of lamina; the lamina itself is suboblong and measures up to 30 by 9 cm.

45. *Calophyllum lanigerum* Miq. Fl. Ind. Bat. Suppl. 1(3): 498. 1961. TYPE: Bangka, prope Djebus, *Teysmann*, HB 3466 (holotype, u; isotypes, BO, K (?), *s.n.*), L).

Tree (or shrub) 2–21 meters tall, d.b.h. to 48 cm.; trunk usually without buttresses (present in montane forest in Johore); outer bark ochre to yellowish (grayish or light brown), with vertical rows of lenticels or with boat-shaped fissures, inner surface orange to dark brown; under bark deep reddish to greenish; inner bark deep red to pale pinkish; latex usually clear yellow, sticky ($\pm$ opaque, sulfur yellow, or milky).

Twigs moderately to strongly flattened, 1.5–5 mm. across, $\pm$ rounded to strongly 4-angled, drying dark brown to black (rarely yellowish), $\pm$ persistently tomentose; axillary innovations lacking basal scars; internodes 1–5(–7.5) cm. long; uppermost pair of axillary buds rounded, to 3 mm. long, $\pm$ spreading; terminal bud plump, 0.5–3 cm. long, with brown tomentose or grayish brown subtomentose indumentum (hairs, FIGURE 18, n–q), underdeveloped internode to 5 mm. long. Petiole 0.4–3 cm. long, broadly and shallowly (rarely narrowly) concave above, convex and persistently tomentose below; lamina subovate to oblong or oval, 3.8–20 by 1–6(–7.3) cm., rounded to retuse or subacute at apex, rounded to cuneate or acute at base, not undulate to distantly so and flat to slightly recurved at margin, coriaceous, drying chestnut to olivaceous (greenish) above, umber to olivaceous (greenish) below, subpersistently tomentose (soon glabrescent) on midrib on both surfaces, the midrib above gradually to fairly quickly narrowed at base, raised, (0.15–)0.2–0.35 mm. wide at midpoint, below raised, rounded to striate, the venation subobscure to clear above and below (latex canals above as prominent as veins), 6 to 13 (to 15) veins/5 mm., angle of divergence (60–)70–85°. Inflorescences from foliate axils, with 3 to 21 flowers, unbranched (rarely with branches up to 2 cm. long and with 5 flowers), the axis 0.3–7 cm. long, tomentose at base, rest of axis subglabrous (rarely with indumentum its entire length), lowest internode (0.2–)0.4–2 cm. long; bracts to 10 by 2 mm., tomentose below, subpersistent or not; pedicels 0.4–2.3 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 (rarely 6), the outer two ovate, 3.5–7 by 2.5–5 mm., sometimes with dorsal tuft of hairs at apex, the next pair elliptic to obovate, 7.5–12 by 3.5–6.5 mm., the inner ones $\pm$ lingulate to obovate, 7–12 by 2.5–5 mm.; stamens (65 to) 105 to 165, the filaments to 6 mm. long, connate for up to 1 mm., the anthers suboblong, 0.5–1 mm. long, rounded to slightly retuse at apex; ovary 1.4–2 mm. long, the style 3–3.5 mm. long, the stigma peltate, 0.6–0.8 mm. across, 2- or 3-radiate. Fruit usually $\pm$ spherical (ellipsoid to obovoid), 1.2–2.9 by 1.1–2.4 cm., usually apiculate, drying brown, sharply, closely, and shallowly wrinkled; outer layer detaching cleanly from stone, 1–3.5 mm. thick, compact; stone $\pm$ spherical, 1.1–2.1 cm. long and

across, rounded at apex, the walls 0.7–1.3 mm. thick, smooth (with obscure triradiate marking at apex), discolored area at base 3.5–8 mm. across; spongy layer thin.

Key to the Varieties of *Calophyllum lanigerum*

1. Terminal bud 5–12(–16) mm. long; twigs 1.5–2.5(–3.5) mm. across; lamina 3.8–12.5(–15) cm. long. 45a. var. *lanigerum*.
1. Terminal bud 0.9–3 cm. long; twigs 3–5 mm. across; lamina 8.5–20 cm. long. 45b. var. *austrocoriaceum*.

45a. *Calophyllum lanigerum* Miq. var. *lanigerum*

C. lanigerum Miq.; Kurz, *Natuurk. Tijdschr. Nederl.-Indië* 27: 192. 1864; F. Mueller in Walp. *Ann. Syst. Bot.* 7: 357. 1868; Scheffer, *Natuurk. Tijdschr. Nederl.-Indië* 31: 354. 1870, *ibid.* 32: 405. 1873; Vesque in C. DC. *Monogr. Phanerog.* 8: 606. 1893; Heyne, *Nutt. Pl. Indonesië*. ed. 3. 1: 1084. 1950.

C. frutescens Ridley, *Kew Bull.* 1938: 121. 1938; Masamune, *Enum. Phanerog. Born.* 475. 1942. TYPE: Dutch SE. Borneo [Kalimantan], Bangarmassing, *Motley* 54 (holotype, κ).

Shrub or tree 2–12 meters tall.

Terminal bud 5–12(–16) mm. long; twigs flattened, 1.5–2.5(–3.5) mm. across. Petiole 0.4–1.5(–1.9) cm. long; lamina oblong to oval, 3.8–12.5(–15) by 1.9–4.6(–7.3) cm., usually drying chestnut above, latex canals on upper surface not prominent, 6 to 11 veins/5 mm. Inflorescence with 3 to 7 (to 13) flowers; axis 0.3–2.5 cm. long, lowest internode (2–)4–11 mm. long. Fruit $\pm$ spherical, 1.2–1.9 cm. long; outer layer 1–2 mm. thick; stone to 1.6 cm. long, walls ca. 0.7 mm. thick.

DISTRIBUTION. Bangka, Belitung, and southeastern Borneo (MAP 18).

SELECTED SPECIMENS SEEN. **Sumatra and adjacent islands.** BANGKA: Djebus, *Teysmann, HB* 3204 (BO, L, MEL, U); Soengei Selan, Bukit Raja, 140 m., *Bünnemeyer* 2002 (BO, L); Kepo bij Toboali, 60 m., *Bünnemeijer* 2315 (BO, κ , L); Lobok Besar, 20 m., *Kostermans & Anta* 45 (A, BO, κ , L, SING); Pangkaljunang-Blinjoe, *Huitema* 35 (BO); Serdang, *de Leeuw* 5 (BO); Koela Soengei Redjein, *Burger* 28 (BO); Gunong Padang, 100 m., *Kostermans & Anta* 1000 (A, BO, κ , L, LAE, P, SING); Soengei Liat dessa Bakem, *Teysmann s.n.* (BO). BELITUNG: Tandjong Pandan, *Teysmann s.n.* (BO); Kampong Began-tang, *de Veer s.n.*, May 1949 (BO). **Borneo and adjacent islands.** KALIMANTAN. Timur: W. Koetei, Kelindjau R., near Melan, *Kostermans* 9591 (A, BO, κ , SING), bij Benoewa toewa, 20 m., *Endert* 1585 (A, BO, κ). Selatan: G. Pamatton, *Korthals s.n.* (L); km. 22 Bangarmasin to Martapura, 10 m., *Dransfield & Hamlali* 4318 (BO); Martapoera, G. Padamaran, *bb* 1211 (BO), G. Koepang, *bb* 1212 (BO). **Java.** BARAT: cult. Hort. Bogor. sub VI C 128 (BO, κ , US).

ECOLOGY. Locally abundant, rather small tree of sandy soils, sometimes in padangs; 20–140 m. alt. Flowering September, October, and December; fruiting June, September, and November.

MAP 18. Distribution of *Calophyllum lanigerum* var. *lanigerum* (circles), *C. lanigerum* var. *austrocoriaceum* (squares), *C. dasypodum* (half-circles, localized; star, unlocalized), and *C. coriaceum* (triangles) in Malasia.

GERMINATION AND YOUNG PLANTS. Saplings (e.g., *Teysmann*, HB 3260) have leaves with very short (ca. 3 mm.) stalks and blades that are broadly rounded to subcordate at the base.

LOCAL USES. The wood is used in house and ship building.

- 45b. *Calophyllum lanigerum* Miq. var. *austrocoriaceum* (T. C. Whitmore) P. F. Stevens, comb. et stat. nov.

C. austrocoriaceum T. C. Whitmore, Gard. Bull. Singapore **26**: 269. 1973, Tree Fl. Malaya **2**: 174. 1973; H. Keng, Gard. Bull. Singapore **28**: 244. 1976. TYPE: Malaya, Johore, summit Gunong Panti Barat, 1684 feet [513 m.], 6 May 1968, FRI 7846 coll. Cockburn (holotype, KEP; isotypes, A, SING).

Calophyllum sp. 10, M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 313. pl. 8. 1966.

Tree (2.1–)4.5–21 meters tall.

Terminal bud 0.9–3 cm. long; twigs rather strongly flattened, 3–5 mm. across. Petiole 1–3 cm. long; lamina narrowly ovate to oblong, 8.5–20 by 3.3–6.4 cm., usually drying umber to olivaceous above (often chestnut brown in Kalimantan), in Bornean specimens latex canals on upper surface often as prominent as veins, (5 to) 7 to 15 veins/5 mm. Inflorescences with 7 to 21 flowers; axis 3–7 cm. long, lowest internode 0.4–2 cm. long. Fruit spherical to ellipsoid or obovoid, (1.8–)2.2–2.9 by (1.7–)2–2.4 cm.; outer layer (1.8–)2.2–3.5 cm. thick; stone (1.1–)1.7–2.1 cm. long, walls 0.8–1.3 mm. thick.

DISTRIBUTION. Southern Malaya to the Lingga Archipelago, northwestern Borneo (MAP 18).

SELECTED SPECIMENS SEEN. **Malaya.** JOHORE: ridge between G. Panti E. and G. Panti W., 427 m., *FRI 13819* (A, K, KEP, SING); G. Blumut, 914 m., *FRI 7512* (A, KEP, SING); Kluang F.R., 457 m., *KEP 98038* (A, K, KEP, SING); Mersing, Jemaluang F.R., *KEP 71889* (K, KEP, SING). **Singapore:** MacRitchie Reservoir area, 30 m., *Burkill 1877* (A, K, LAE, SING); Gardens Jungle, "low" alt., *SFN 39452* (A, K, KEP, SING). **Sumatra and adjacent islands.** RIAU: Lingga, Poeloe Singkhep, Sei Manggoe, 15 m., *bb 3936* (BO); M. Tandai, *Teysmann s.n.* (BO). **Borneo.** SARAWAK. 1st Division: Bako Natl. Park, Lintang Path, 100 m., *S 19718* (K, L, SAN, SAR, SING), Sungei Selo, 60 m., *S 7664* (SAN, SING); G. Matang, 732 m., *S 12503* (BO, K, L, SAN, SAR, SING); near G. Siol, *Omar 373* (K, SING); Unjam F.R., 9 m., *S 7709* (SAR, SING); Batu 6 F.R. [Stapok], *FA 827* coll. *Egon*, 8 July 1940 (KEP). 3rd Division: Batang Igan, Sungei Tutus logging camp, *S 30169* (K, SAR). KALIMANTAN. Barat: Soengei Kenepai, *Hallier 2167* (BO, K, L); Danau Lamadgian [Seriang], *Beccari PB 3463* (FI); Poeloe Madjang, *Jaheri s.n.*, 1893 (BO), *Teysmann, HB 8042* (BO); Pontianak, *Dedi 864* (BO); Pasir Tondjong, 2 m., *bb 9779* (BO); N. of Mempawah, Pasir Pandjang, 1 m., *Polak 724* (BO, L).

ECOLOGY. Varied. Both in Johore, Malaya, and in the First Division, Sarawak, in colline forest—"occasionally one of the tallest [trees] in the forest" (*SFN 10723*, G. Blumut, Johore); at lower elevations in peat swamps (*S 30169*, Sarawak); heath forest (e.g., *S 12340*, Sarawak); sandy soil near sea (*Polak 724*, Kalimantan); or general mixed dipterocarp lowland rainforest (Johore, Singapore); to 950 m. alt. Flowering July, October, and November (Borneo); fruiting January to May (Borneo and Malaya), July (Singapore), and August (Sarawak).

GERMINATION AND YOUNG PLANT. The radicle breaks the stone wall immediately adjacent to the "plug," which is apparently not pushed out during germination. The seedling has two pairs of leaves separated by an internode of ca. 5 mm. Subsequent growth seems to be slow, with internodes less than 1 cm. long (*SFN 39452*). The young plant is erect, and the terminal bud is functional (pers. obs., Singapore). The leaves of saplings are long and narrow (11.8–50 by 1.7–5.4 cm.).

LOCAL USE. The wood is coarse grained and is used for planks.

The epithet *austrocoriaceum* ("southern coriaceous") was coined because

Calophyllum austrocoriaceum was thought to be related to *C. coriaceum* and was found to the south of it.

Calophyllum lanigerum can be recognized by its plump, usually densely tomentose terminal bud; by its coriaceous, more or less oblong lamina, which has clear, not very dense venation on at least one surface; and by its sharply wrinkled, more or less spherical fruit with a thick outer layer that detaches cleanly from the stone. The spherical, thick-walled stone often has an obscure triradiate marking at the apex and a pluglike area at the base. The epithet *lanigerum* ("wool-bearing") emphasizes the well-developed tomentose indumentum characteristic of this species.

The description of the bark of *Calophyllum lanigerum* is almost wholly based on observations of (and field notes on specimens of) *C. lanigerum* var. *austrocoriaceum*. Both varieties have yellow latex.

The type specimens of *Calophyllum lanigerum* and *C. austrocoriaceum* are very different and at first sight appear to belong to different species. However, they are connected by intermediates, although the evaluation of the variation pattern is complicated since specimens in flower are not known from Malaya or Singapore. Specimens of *C. austrocoriaceum* from high altitudes in Malaya have less dense venation and less well developed indumentum than the specimens from Borneo, and the lamina is more or less acute, rather than rounded, at the base; specimens of *C. austrocoriaceum* from Borneo, and those collected at lower altitudes in Malaya and Singapore, are more like *C. lanigerum* in these respects. Specimens of *C. austrocoriaceum* from northwestern Borneo (e.g., *S* 12503, Sarawak) have fruits the same size as those of *C. lanigerum*, and there is also general agreement in details of flower, fruit structure, and indumentum distribution on the inflorescence (dense, tomentose indumentum restricted to the lowest internode). However, the inflorescences of specimens of *C. austrocoriaceum* from Singapore have indumentum for their entire length; there is perhaps a tendency toward a similar condition in *Dedi* 864 (*C. austrocoriaceum*; Pontianak, Kalimantan). Infructescences of specimens of *C. austrocoriaceum* from Johore are glabrous above the lowest internode, but specimens in flower from the western part of the range of *C. austrocoriaceum* are needed to understand this variation. Hair structure of specimens from all areas and altitudes is similar (FIGURE 18, n-q): the base of the hair consists of often thin-walled short cells, with the walls not birefringent in polarized light; the upper part of the hair has elongated cells (often two) with strongly thickened walls that are birefringent under polarized light. The upper surface of the lamina of several specimens of *C. austrocoriaceum* from Kalimantan dries chestnut brown, as in *C. lanigerum*, rather than the lighter brown color characteristic of the other specimens of *C. austrocoriaceum*.

In view of the underlying similarity between *Calophyllum lanigerum* and *C. austrocoriaceum* and the noncorrelation of much of the variation within the complex as a whole, *C. austrocoriaceum* is reduced to varietal rank under *C. lanigerum*. *Calophyllum lanigerum* var. *austrocoriaceum* can be distinguished from var. *lanigerum* by the larger size of all its parts (except

the pedicels and the flowers) and by the frequently lighter brown color of the dried lamina.

There is little variation within *Calophyllum lanigerum* var. *lanigerum*. Specimens from mainland Borneo tend to have larger leaves than those from Bangka and Belitung; the type specimen of *C. frutescens* is a specimen of the former type. Some of the variation within var. *austrocoriaceum* has been discussed above. A few specimens from Malaya (Grubb s.n., 25 Sept. 1970; Shah & Ahmad 1923) have twigs that dry yellowish and leaf blades that dry greenish, but in other respects these specimens are unremarkable.

Specimens of *Calophyllum lanigerum* var. *austrocoriaceum* from low altitudes in Johore and Singapore were cited under *C. incrassatum* by Henderson & Wyatt-Smith (*op. cit.*, p. 202), albeit with hesitation. However, they have the densely tomentose terminal bud, the distinctive hairs, the clear and rather distant venation, and the yellow latex of the former taxon.

46. *Calophyllum castaneum* P. F. Stevens, sp. nov.

FIGURE 17, k.

A speciebus aliis Calophylli in gemma terminali magna 2.1–3 cm. longa indumento tomentoso castaneo vel badio praedita, folia magna basi cucullata venulis lateralibus densis 11 ad 22 per 5 mm., et infructescentibus ramosis pedicellis brevibus 2–3.5 mm. longis, differt.

Tree 27–38 meters tall, d.b.h. to 58 cm.; trunk without buttresses; outer bark at first yellow-brown, smooth except for long cracks, becoming brown, fissured, scaly, when freshly exposed dark brown, the inner surface orange-brown; under bark dark brown, orange-brown, or reddish; inner bark red to pale rose; latex yellow, opaque, viscous or not.

Twigs flattened, 3.5–5.5 mm. across, more or less 4-angled, drying yellowish or grayish brown, color often obscured by dense indumentum, persistently tomentose, the hairs bay to chestnut, to 1 mm. long; axillary innovation (?) without basal scars; internodes 4–6 cm. long; uppermost pair of axillary buds rounded, ca. 2 mm. long, more or less spreading; terminal bud plump, 2.1–3 cm. long, with bay to chestnut, tomentose indumentum (hairs, FIGURE 18, r), underdeveloped internode 3–8 mm. long. Petiole 1–2 cm. long, shallowly concave above, convex below, persistently tomentose; lamina elliptic to oblong, (6–)10–25 by (3.5–)4.3–9.5 cm., short-acuminate at apex, rounded to cuneate and more or less cucullate at base, slightly undulate and slightly and narrowly recurved at margin, marginal thickening ca. 0.35 mm. wide, coriaceous, drying bay to umber above and umber below, tomentose on midrib on both surfaces and over entire lower surface, the midrib above narrowing rather abruptly near base, raised, or narrowing gradually, flat at first and becoming raised toward apex, 0.25–0.4 mm. wide at midpoint, below raised, prominent, strongly striate, the venation subapparent on both surfaces, slightly raised, 11 to 22 veins/5 mm., angle of divergence 70–75°. Infructescences from foliate axils, with scars of ca. 15 flowers, branched, the branches 3-flowered, to 7.5 mm. long, the axis ca. 2.5 cm. long, sparsely tomentose, especially toward base, lowest internode 3–6 mm. long; bracts not known; pedicels 2–3.5 mm. long, $\pm$ glabrous. Flower not known. Immature fruit

ca. 1.5 by 1 cm., subacute at apex, drying vinaceous-brown, wrinkled; outer layer ca. 1 mm. thick; stone and spongy layer unknown.

TYPE: Sarawak, 3rd Division, Kapit, Sungei Mengiong, 1500 feet [457 m.], 7 Oct. 1969, *S* 29755 coll. *Suib* (holotype, SAR).

DISTRIBUTION. Northwestern Borneo (MAP 17).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: Semengoh Arboretum (Tree 4671), ca. 50 m., *Stevens et al.* 133 (A); Semengoh F.R., 30 m., *Stevens et al.* 291 (A). KALIMANTAN. Barat: Damenar Tangkawang, *de Vries* (27) HLB 909,68-60 & -72 (both L); Sambas, Perigi Limoes, 300 m., *bb* 7044 (BO). Sine loco [probably Pontianak or Sintang], *de Vries & Teijsmann s.n.* HLB 903,343-214, -216, & -217 (all L); *Teijsmann s.n.* HLB 903,343-215 (L), *de Vries s.n.* (BO, U).

ECOLOGY. Lowland and colline mixed dipterocarp forest, 30-457 m. alt. Fruiting in October.

Calophyllum castaneum is a distinctive species, even when sterile. It is recognizable by its large leaf blades that have dense venation and are cucullate at the base; its large terminal bud at least 2 cm. long; and its persistent, dark brown, tomentose indumentum on terminal bud, twig, and leaf. The very short pedicels are unusual in a species of *Calophyllum* that has fruits of a moderate size and are a noteworthy feature of *C. castaneum*. The descriptions of the infructescence and the immature fruit are taken from the type specimen, which is a unicate. The chestnut color of the indumentum suggested the specific epithet, *castaneum*.

Calophyllum cucullatum, from the Philippine Islands, also has a large leaf blade that is cucullate at the base and dries a rich brown color. However, *C. cucullatum* has a terminal bud less than 8 mm. long, very different hairs, a much smaller inflorescence, long and slender pedicels, and a fruit only ca. 1 cm. long. *Calophyllum cucullatum* is not closely related to *C. castaneum*.

There is a perplexing group of specimens from Sarawak (e.g., *S* 16599, 3rd Division), Brunei (*BRUN* 3058), and adjacent Sabah (e.g., *SAN* 36872, Beaufort) (MAP 17) that in many ways resembles *Calophyllum castaneum*. The specimens have castaneous indumentum with hairs similar to those of *C. castaneum* in that the two apical cells are much enlarged and are birefringent; however, the cells are not as much enlarged as they are in that species (FIGURE 18, m). The leaves have similarly dense venation, and the lamina base is rounded and slightly cucullate. The pedicels seem to be short, and the fruit moderate in size. However, the specimens are much more gracile in appearance, the twigs are less than 3 mm. across, and the terminal bud is less than 1.5 cm. long. Although these specimens are possibly related to *C. castaneum* (and perhaps to *C. rufigemmatum*), their identification awaits better collections. Meijer (Bot. Bull. Herb. Forest Dept. Sabah 7: 15. 1967) used the name *C. rotundatum* for these specimens; this is a *nomen nudum*.

47. *Calophyllum coriaceum* Symington ex M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 323. pl. 10. 1956; Wyatt-Smith, Malayan

Forest Rec. 17: 113. 1952, *nomen*; Kochummen, Malayan Forest Rec. ed. 2. 17: 216. 1965; T. C. Whitmore, Tree Fl. Malaya 2: 177. 1973, *pro parte*. TYPE: Malaya, Pahang, Cameron's Highlands, Robinson's Falls, 12 July 1928, KEP 13627 coll. Mead (holotype, SING; isotype, KEP).

C. ?spectabile auct., non Willd.; Henderson, Jour. Malay Branch Roy. Asiatic Soc. 5: 243. 1927.

C. near griffithii auct., non King; Henderson, Gard. Bull. Straits Settl. 4: 93. 1927.

Tree 4–30 meters tall, d.b.h. to 58 cm.; trunk without buttresses; outer bark yellowish, slightly fissured; under bark deep red-brown; inner bark pink; latex white, sticky or rather fluid, or yellow, thick (smelling like soup stock—KEP 51818).

Twigs slightly flattened, 3–4.5 mm. across, $\pm$ 4-angled, drying brown to blackish, reddish farinose to subtomentose when young; axillary innovations lacking basal scars; internodes 2–5 cm. long; uppermost pair of axillary buds $\pm$ rounded, to 1.5 mm. long, suberect; terminal bud plump, 1–1.8(–2.7) cm. long, with brown, subcrustaceous to puberulo-tomentose indumentum (hairs, FIGURE 19, a–c), underdeveloped internode to 4 mm. long. Petiole 1–3.1 cm. long, broadly and shallowly concave above, convex below, glabrous when mature; lamina elliptic to oblong, 8–18.5 by 4.6–8.3 cm., broadly rounded to shallowly retuse and finally short-acute to obtuse at apex, rounded and finally short-acute to acute or cuneate at base, not undulate and slightly to strongly recurved at margin, marginal thickening to 0.8 mm. wide, very coriaceous, drying olivaceous-honey to umber above and honey to umber below, puberulent on midrib on both surfaces when young, glabrescent or not, the midrib above narrowing gradually from or rather quickly near base, $\pm$ level at first, becoming raised, (0.35–)0.5–0.7 mm. wide at midpoint, center sulcate, below strongly raised, striate or subangled, the venation obscure on both surfaces, slightly raised, 5 to 12 veins/5 mm., angle of divergence 70–80°. Inflorescences terminal and/or from adjacent foliate axils, with many flowers, branched, the axis at least 6 cm. long, farinose-puberulent, lowest internode ca. 2 cm. long; bracts unknown; pedicels 0.7–2.2 cm. long, puberulent, in fruit to 2 mm. thick. Flower (?)hermaphroditic; tepals 8 (reportedly also 9), the outer pair elliptic-ovate, ca. 10 by 6.5 mm., $\pm$ puberulent on back, the next pair broadly elliptic, ca. 14 by 10.5 mm., $\pm$ puberulent toward base on back, the inner ones probably ca. 14 by 17 mm.; stamens ca. 370, the filaments ca. 7 mm. long, the anthers oblong, 0.9–1.3 mm. long, subretuse at apex; ovary ca. 2.5 mm. long, the stigma peltate, ca. 1 mm. across, 3-radiate. Fruit ellipsoid, 3–4.5 by 2–2.3 cm., subcuneate to apiculate at apex, drying vinaceous-brown, with deep, rounded wrinkles; outer layer detaching cleanly from stone, 1.5–3 mm. thick, compact except for air spaces developing under skin; stone ellipsoid, 2.4–2.7 by 1.7–1.8 cm., rounded at apex, the walls 1–1.3 mm. thick, smooth, unmarked; spongy layer thick at first.

DISTRIBUTION. Malay Peninsula, the Main Range (MAP 18).

SELECTED SPECIMENS SEEN. **Malaya.** SELANGOR: G. Nuang F.R., Ulu Langat, *KEP 51818* (BO, KEP, SING). PAHANG: Fraser's Hill, 1219 m., *KEP 87303* (A, BO, K, KEP, SING); Cameron's Highlands, 1402 m., *SFN 23653* (A, BO, K, KEP, SING); Sungei Parang, Jalan Kuda, *KEP 27192* (KEP); Berenchang, *KEP 34015* (K, KEP); trail to G. Jesar, 1463 m., *FRI 15459* (KEP, SAN, SAR); Sungei Insar, *KEP 25174* (KEP).

ECOLOGY. Montane rain forest, 1219–1463 m. alt. Flowering in July (flower scented); fruiting May and November (fruit green, eaten by birds (*KEP 51818*)).

Calophyllum coriaceum can be recognized by its rather large, very coriaceous lamina with more or less broadly recurved margins, profuse, terminal inflorescence, and ellipsoid fruit that has a stone with walls at least 1 mm. thick. The very coriaceous leaf blades suggested the epithet *coriaceum*.

Calophyllum coriaceum does not seem particularly closely related to any other species. It is vegetatively similar to *C. scriblitifolium*; this is discussed further under the latter species. Whitmore (1973) believed that *C. austrocoriaceum* was related to *C. coriaceum*. *Calophyllum austrocoriaceum*, however, has axillary inflorescences and hairs of a very different structure; it is here reduced to varietal rank under *C. lanigerum*.

Whitmore (*loc. cit.*) reported *Calophyllum coriaceum* from Gunong Padang, Trengganu. The specimens on which this report was based (e.g., *FRI 12646*) are referred here to *C. wallichianum* var. *incrassatum*, although their very coriaceous leaf blades are somewhat atypical. The inflorescences are axillary, and the subspherical fruits are closely wrinkled—both characters of *C. wallichianum* var. *incrassatum*.

48. ***Calophyllum dasypodum*** Miq. Fl. Indiae Batavae 1(2): 511. 1859, *nomen novum* for *C. lanceolatum* Teijsm. & Binn.; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868; Backer & Bakh. f. Fl. Java 1: 386. 1963, *excl. syn.*; *C. teysmannii* Zoll. ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 275. 1862, non Miq. 1861, *excl. descr. et spec. cit.*, *nomen novum* for *C. lanceolatum* Teijsm. & Binn.; *C. lanceolatum* Teijsm. & Binn. Nat. Tijdschr. Nederl.-Indië 4: 398. 1853, non Blume, 1825; Kreyenb. Bull. Soc. Imp. Nat. Moscou 27: 259. 1854; Teijsm. & Binn. Nederl. Kruidk. Arch. 3: 395. 1855; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868. TYPE: Java, Duizend gebergte, *van Gesker s.n.* (L, U).

C. hasskarlii Teijsm. & Binn. ex Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 273. 1862; Vesque in C. DC. Monogr. Phanerog. 8: 581. 1893,

FIGURE 19. Hairs (from terminal bud, unless otherwise mentioned). a–c, *Calophyllum coriaceum*: a, b, *Stevens et al. 17*; c, *KEP 78303*, persistent base only. d–g, *C. dasypodum*: d, e, *Kostermans 6882*; f, g, *Marche B 371*. h–p, *C. canum*: h, *S 23960*; i, *A 859*; j, *Clemens 31859*; k, *KEP 99519*; l, *SAN 83502*; m, *Kostermans 10369*; n, o, *Soepadmo 39*; p, *S 23968*, from axillary bud. q, r, *Calophyllum* sp. 53 (*S 24675*). Scale = 60 μ m. (in q, r, scale = 120 μ m.).

pro parte; Koord. & Valetton, Meded. s'Lands Plant. 61(Bijd. Booms. Java 9): 384. 1903; Koord.-Schum. Syst. Verzeich. 1(Fam. 187): 4. 1912; Koord. Exkursionsfl. Java 2: 618. 1912; Heyne, Nutt. Pl. Indonesië. ed. 3. 1: 1082. 1950. TYPE: Java, in sylvis, Zollinger 3457, *pro parte* (holotype, G; isotypes, BM, G, P).

C. pulcherrimum auct., non Wall. ex Choisy; Choisy in Zoll. Syst. Verzeich. 2: 149. 1854, Pl. Javan. 9. 1858.

C. tomentosum auct., non Wight; Miq. Pl. Jungh. 291. 1854, Fl. Indiae Batavae 1(2): 514. 1859; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 294. 1862.

Tree 20–30 meters tall, d.b.h. to 50 cm.; trunk without buttresses; outer bark yellow-brown with short, boat-shaped fissures, or dark gray, deeply fissured, the inner surface orange-straw; under bark dark red; inner bark pale pinkish; latex clear yellow, sticky.

Twigs slightly flattened, 1.8–3 mm. across, strongly 4-angled, soon becoming subterete, drying blackish brown, subpersistently grayish to brownish puberulent to subtomentose; axillary innovations lacking basal scars; internodes (0.2–)1–2.5 cm. long; uppermost pair of axillary buds plump, 2–5 mm. long, suberect; terminal bud plump, 6–8 mm. long, with brown, puberulent indumentum (hairs, FIGURE 19, d–g), underdeveloped internode 1–4 mm. long. Petiole 0.7–1.1 cm. long, concave above, convex and $\pm$ persistently puberulent below; lamina ovate to elliptic, 5.5–12.5 by 1.5–3.4 cm., acute to acuminate at apex, cuneate to acute at base, strongly and distantly undulate and flat to slightly recurved at margin, coriaceous, drying umber and shiny above, umber to sepia below, glabrescent or persistently puberulent on midrib below (also above), the midrib above gradually narrowed from base, margins usually somewhat raised but $\pm$ sulcate at first, 0.2–0.8 mm. across at midpoint, becoming raised in top $\frac{1}{3}$, below raised, striate, the venation $\pm$ apparent on both surfaces, slightly raised, 8 to 15 veins/5 mm., angle of divergence 60–75°. Inflorescences from foliate axils along stem, with 7 to 11 flowers, unbranched, the axis 3–5.5 cm. long, puberulent, lowest internode 1–5 mm. long; bracts $\pm$ ovate, ca. 2.5 mm. long; pedicels 0.4–1.3 cm. long, puberulent. Flower (?)hermaphroditic; tepals 4 or 6, or 8 in terminal flowers, sometimes glabrous, the two outer $\pm$ ovate, ca. 4.5 by 3 mm., the inner ones slightly larger; stamens 30 to 55, to 70 in terminal flowers, the filaments to 2 mm. long, the anthers suboblong, 0.6–0.9 mm. long, slightly retuse at apex; ovary ca. 1 mm. long, the style ca. 1.5 mm. long, the stigma peltate, ca. 0.5 mm. across, slightly lobed. Fruit spherical, 1.4–1.7 cm. long and across, rounded at apex, drying vinaceous-brown, smooth; outer layer detaching cleanly from stone, 2–3 mm. thick, compact; stone spherical, 1.1–1.5 by 1–1.4 cm., rounded at apex, the walls 0.5–0.6 mm. thick, smooth, unmarked or with obscure triradiate apical lines, with a lighter-colored area (?plug) up to 5 mm. across at base; spongy layer thin.

DISTRIBUTION. Southern Sumatra, western Java, southern Borneo, (?)Philippine Islands (Map 18).

SELECTED SPECIMENS SEEN. **Sumatra.** SELATAN: Lematang Oeloe, 150 m.,

Lambach 1258 (BO, L (s.n.)); Sepoetik, Soewikis, 25 m., *bb 2851* (A, BO). **Borneo and adjacent islands.** KALIMANTAN. Timur: Sebatik Is., 10 m., *Kostermans 9154* (A, BO, K, NY, P, SING); Nunukan Is., N. part, *Kostermans 8958* (BO, L); Lot Haur, W. of Samarinda, 40 m., *Kostermans 6882* (A, B, BO, CANB, K, LAE, NY, P, SING). Selatan: Pleihari, Kintap, 25 m., *bb 2748* (BO); (?)Doesson, *Korthals s.n.* (BO, L, U). **Philippine Islands.** CALAMIAN. Busuanga: Malbato, *Marche 371* (?) (A, P). **Java.** BARAT: Djasinga, Tjurug, *Meijer 2894* (BO); Salak, *Zollinger 1711* (L ("fragm. ex herb. P")); Preanger, Soekaboemi, Palaboenratoe, *Koorders 2890* (BO); Bogor, Palace Gardens, *Kostermans s.n.*, Aug. 1953 (A, BO, BRI, K, NY, P, SING).

ECOLOGY. Sandy soil (Kalimantan), 10–150 m. alt. Flowering March, August, and October (flower scented); fruiting March, May, and September.

Calophyllum dasypodum can be recognized by its plump terminal bud; its rather stout twigs with puberulent-subtomentose indumentum; its rather narrow, ovate-elliptic lamina with a deeply undulate margin, a depressed midrib, and a shiny upper surface when dry; its puberulent inflorescence axis; and its spherical, cherry-sized fruits. The epithet *dasypodum* means "hairy foot" and alludes to the conspicuous indumentum on the inflorescence.

The only specimen of *Calophyllum dasypodum* from the Philippine Islands, *Marche 381*, is sterile. It has dried a color similar to that of the other specimens, but its leaf blades are dull, and although the indumentum is subtomentose, the hairs are typical for the species (FIGURE 19, f, g). *Marche 381* may also approach *C. pisiferum*.

Van Gesker s.n. agrees quite well with the description of *Calophyllum lanceolatum* Teijsm. & Binn. and is possibly the specimen on which the original description was based.

The way in which the name *Calophyllum teysmannii* Zoll. ex Planchon & Triana was published makes it, perhaps inadvertently, a new, but superfluous, name for *C. lanceolatum* Teijsm. & Binn. Planchon and Triana placed *C. lanceolatum* in the synonymy of their *C. teysmannii*, and in the discussion after the species noted that it was almost certainly a synonym of *C. teysmannii*. However, both their description and the specimens that they cited are of another taxon, the Javanese form of *C. calaba*. The name *C. teysmannii* Zoll. ex Planchon & Triana was published shortly after *C. teysmannii* Miq.; for further discussion, see *C. teysmannii*.

The confusion between *Calophyllum dasypodum* and the Javanese form of *C. calaba*, which resulted in Backer and Bakhuizen's (*loc. cit.*) inclusion of the two in one species, apparently also occurs in *C. hasskarlii*, a synonym of *C. dasypodum*. In many herbaria *Zollinger 3457*, the type number of *C. hasskarlii*, is a mixed collection, with part being the Javanese form of *C. calaba* (see Vesque, *op. cit.*, p. 582); the two species are not at all closely related.

Calophyllum calaba in Malesia lacks the well-developed indumentum of *C. dasypodum*, its lamina usually has much more dense venation, and its twigs are thinner and are often strongly flattened. The fruits of *C. calaba* are spherical to ellipsoid and are about two thirds the length of those of

C. dasypodum, the thinner outer layer becomes disorganized by air spaces, and the stone walls are about a third as thick.

49. *Calophyllum scriblitifolium* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 326. *pl.* 12. 1956; J. Anderson, Gard. Bull. Singapore **20**: 154. 1963; Smythies, Common Sarawak Trees, 64. 1965; Kochummen, Malayan Forest Rec. ed. 2. **17**: 217. 1965; T. C. Whitmore, Tree Fl. Malaya **2**: 192. 1973; J. Anderson, Trees Peat Swamp Sarawak, 88. *pl.* 27D. 1973. TYPE: Malaya, Perak, Utan Melintang Forest Reserve, 12 Oct. 1949, KEP 69001 coll. Shaari (holotype, KEP).

C. wallichianum auct., non Planchon & Triana; Merr. Bibl. Enum. Bornean Pl. 394. 1921, *pro parte*.

C. revolutum Wyatt-Smith, Malayan Forest Rec. **17**: 43. 1952. *Nomen*.

Tree 24–44 meters tall, d.b.h. to 96 cm.; trunk without buttresses or stilt roots, but knee roots sometimes present (Sarawak); outer bark reddish brown or brown and soft, flaky, to gray, fissured and scaling, to chocolate, the inner surface (bronze) brown; under bark orange-brown; inner bark red to pink; latex white to creamy white, slightly sticky to sticky, turning gray-cream on exposure.

Twigs (slightly) flattened, 3.5–6.5 mm. across, $\pm$ 4- or 8-angled when young, drying blackish to dark brown (rarely grayish), farinose to puberulent at least when young; axillary innovations perhaps with scars within 5 mm. of base; internodes (0.3–)0.7–3 cm. long; uppermost pair of axillary buds subrounded, to 1.5 mm. long, spreading; terminal bud plump, 1.2–2.2(–2.9) cm. long, with grayish to brown, crustaceous to subtomentose indumentum (hairs, FIGURE 20, d, e), underdeveloped internode to 4.5 mm. long. Petiole 1.3–2.8 cm. long, broadly concave above, convex below, $\pm$ persistently puberulent; lamina oblong to elliptic, 7.8–19 by 1.8–7.6 cm., rounded to retuse (mucronate near midrib) at apex, cuneate to acute at base, slightly undulate but strongly and broadly recurved at margin, very coriaceous, drying olivaceous to honey color above and umber-sepia to fulvous below, usually persistently puberulent on midrib on both surfaces, the midrib above abruptly to gradually narrowed at base, depressed at first, becoming $\pm$ raised, 0.3–0.5 mm. wide at midpoint, below strongly raised, rounded to striate, the venation apparent to subobscure on both surfaces, 9 to 16 veins/5 mm., angle of divergence (60–)80–85°. Inflorescences from foliate axils along twigs, with 9 to 11 flowers, unbranched, the axis 3.5–5.5 cm. long, densely puberulent, lowest internode

FIGURE 20. Hairs (from terminal bud, unless otherwise mentioned). a–c, *Calophyllum woodii*: a, Stevens et al. 160; b, SAN 35504; c, bb 34418. d, e, h, *C. scriblitifolium*: d, e, S 16170, from stem (d, from above); h, Native collector 1276. f, g, *C. lowii*: f, Grashoff 709, common hair type of species; g, van Rossum 44. i, *C. glaucescens* (Haviland 2058). j–l, *C. nodosum*: j, k, SAN 52956; l, S 29914. m, *C. depressinervosum* (KEP 98808). n, *C. complanatum* (Stevens et al. 407). o–q, *Calophyllum* sp. 54 (bb 19334), hairs from stem. Scale = 60 μ m. (in p, q, scale = 120 μ m.).

1.8–2.8 cm. long; bracts unknown; pedicels 0.6–1.2 cm. long, densely puberulent. Flower (?) hermaphroditic; tepals 4, the outer pair ovate, 6–7 by 5.5–6 mm., puberulent on back, the inner pair obovate, ca. 12.5 by 6 mm., puberulent in strip down back; stamens ca. 200 plus, the filaments to 6 mm. long, the anthers oblong, 0.9–1.5 mm. long, retuse at apex; ovary ca. 2.5 mm. long, style and stigma unknown. Fruit ellipsoid, ca. 3.4 by 2 cm., rounded at apex, drying blackish, smooth or with inconspicuous longitudinal wrinkles; outer layer detaching cleanly from stone, 1.3–1.5 mm. thick, compact; stone ellipsoid, ca. 2.7 by 1.6 cm., rounded at apex, the walls ca. 0.5 mm. thick, smooth, with faint reticulations but otherwise unmarked; spongy layer unknown.

DISTRIBUTION. Malay Peninsula, Sumatra, and Sarawak (MAP 16).

SELECTED SPECIMENS SEEN. **Malaya.** PERAK: Tanjong Tualang F.R., *KEP 45675* (KEP). SELANGOR: state land between Sungei Bennam and Sungei Tinggi, 1.5 m., *KEP 71563* (KEP). JOHORE: Muar, Bukit Atong, Jalan Yong Peng, *KEP 70211* (KEP, SING); 30th mile Muar–Pant Subag Road, 3 m., *KEP 80558* (KEP, SING). **Sumatra.** UTARA: Laboean batoe, Laboean bilik, 5–10 m., *bb 4950* (BO). **Borneo.** SARAWAK. 1st Division: Setapok F.R., *S 16170* (L, SAR, SING); Gunong Pueh F.R., *S 6419* (SAR); Buntal, *anon.*, March 1912 (SAR). 3rd Division: Loba Kobang South Protected Forest, *S 2740* (KEP, SAR); Naman F.R., Sungei Assan, 6 m., *S 7361/10* (SAR, SING). Sine loco, *native collector 1276* (?) (A, BO, P, UC).

ECOLOGY. Rather large tree of peat swamps, rarely also in kerangas forest in Sarawak; below 10 m. alt. Flowering and fruiting in October.

GERMINATION AND YOUNG PLANT. The radicle probably breaks through the stone to one side of the base. The seedling has but a single pair of leaves. The first flush of growth generally consists of two pairs of leaves: first an internode 5(–10) mm. long, then a pair of scale leaves, then an internode ca. 3 cm. long, and finally a pair of fully expanded leaves (13 of the 15 seedlings seen). Scale leaves are rarely absent (2 of the 15 seedlings seen). The terminal bud is functional, and the young plant is erect (*Stevens et al. 147A*).

Calophyllum scriblitifolium is best recognized by its coriaceous leaf blades with their strongly and broadly revolute margins; its axillary, grayish puberulent inflorescences; its flowers, which have four tepals, the outer pair of which is grayish puberulent on the back; and its ellipsoid, almost smooth-drying fruit that is rounded at the apex and the base. Fresh fruits of *Calophyllum scriblitifolium* are about 5.7 by 2.2 cm., with the outer layer ca. 5 mm. thick, to judge from fallen fruits seen in Sarawak. The leaves, with their strongly recurved margins, seem to have suggested the specific epithet (*scriblitifolium* means “tartlike leaves”).

Calophyllum scriblitifolium is perhaps most closely related to *C. canum*, which at least in Borneo frequently grows in swamps, and which also has white latex, flowers with four tepals, and a similar distribution of indumentum on inflorescence axis and flower. However, the vegetative and fruit characters

given above readily separate the two, and the hairs of the two differ in structure (FIGURE 20, d, e; cf. 19, h-p). *Calophyllum scriblitifolium* is vegetatively similar to *C. coriaceum*, another species with white latex. However, *C. coriaceum* has fruits that are pointed-ellipsoid and dry sharply wrinkled, with stone walls at least 1 mm. thick; the inflorescences are terminal. *Calophyllum coriaceum* is a tree of montane forest, and *C. scriblitifolium* one of peat swamps; the two are not closely related.

More collections of *Calophyllum scriblitifolium* are needed. The variation in hair type in Sarawak is not understood (FIGURE 20, h).

50. ***Calophyllum canum*** Hooker f. Fl. Brit. India 1: 271. 1874; King, Jour. Asiatic Soc. Bengal, II. 59: 177. 1890; Vesque in C. DC. Monogr. Phanerog. 8: 573. 1893; Curtis, Jour. Straits Branch Roy. Asiatic Soc. 25: 78. 1894; Ridley, Fl. Malay Penin. 1: 185. 1922, *pro parte*; I. H. Burkill & M. R. Henderson, Gard. Bull. Straits Settl. 3: 347. 1925; Heyne, Nutt. Pl. Indonesië. ed. 3. 1: 1082. 1950; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 306. 1956; J. Anderson, Gard. Bull. Singapore 20: 153. 1963; Pukol & Ashton, Checklist Brunei Trees, 93. 1964; Smythies, Common Sarawak Trees, 59. 1965; Kochummen, Malayan Forest Rec. ed. 2. 17: 219. 1965; Burkill, Dict. Econ. Prod. Malay Penin. ed. 2. 1: 412. 1966; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 16. 1967, *pro parte*; T. C. Whitmore, Tree Fl. Malaya 2: 176. 1973; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978. TYPE: Malaya, Malacca, 26 March 1865/1866, *Maingay 1645* (Kew dist. 175) (holotype, K).

C. borneense Vesque, Epharmosis 2: tt. 28, 29. 1889, in C. DC. Monogr. Phanerog. 8: 580. 1893; Merr. Bibl. Enum. Born. Pl. 393. 1921; Masamune, Enum. Phanerog. Born. 475. 1942; Keith, N. Borneo Forest Rec. ed. 2. 2: 313. 1952. TYPE: Borneo [Sarawak, Kuching], *Beccari, PB 2101* (holotype, P; isotypes, A (frag.), FI, G, K, M).

C. spectabile auct., non Willd.; Curtis, Jour. Straits Branch Roy. Asiatic Soc. 25: 78. 1894.

C. retusum auct., non Choisy; J. Anderson, Gard. Bull. Singapore 20: 154. 1963, *quoad syn.*

C. lowii auct., non Hooker f.; J. Anderson, Trees Peat Swamp Sarawak, 85. 1973, excl. ill.

Tree 7.5–36 meters tall, d.b.h. to 77 cm.; trunk without buttresses or spurs; outer bark yellowish or light brown to almost black, with rather close lines of lenticels, or finely cracked, scaling or not, hoop marked, the inner surface dirty brown to orange-brown; under bark reddish to orange, or blackish and red mottled; inner bark pale reddish; latex white, not sticky, in Malaya also reported to be clear yellow-brown and sticky, in Borneo opaque to clear yellow, sticky or becoming sticky.

Twigs slightly to strongly flattened, 2–3(–4.5) mm. across, obscurely to strongly 4-angled, drying blackish to dark brown, grayish to brownish farinose-puberulent when young; axillary innovations lacking basal scars; internodes 1–9 cm. long; uppermost pair of axillary buds rounded, to 1 mm. long, spreading

or pointed, ca. 3(–8) mm. long, erect; terminal bud plump to narrowly conical, (0.3–)1–2.2 cm. long, with short, grayish brown to rufous, compact indumentum (hairs, FIGURE 19, h–p), underdeveloped internode 1.5–5(–11) mm. long. Petiole 1–2(–2.5) cm. long, usually broadly concave above, convex to subangled below, drying blackish, glabrescent; lamina ovate or elliptic to suboblong, (3.3–)9–22 by (1.2–)3.5–7.5 cm., acuminate (rarely acute) at apex, rounded to acute at base, strongly to moderately undulate and slightly recurved at margin, coriaceous, drying brown-vinaceous to sabelline above and umber to fulvous below, often nitid, entire lamina subconcave or not, glabrous to transiently farinose to puberulent on midrib above and especially below, the midrib above narrowing gradually from base, depressed, margins raised, becoming $\pm$ raised, or narrowed abruptly near base (Borneo only), depressed at first, soon becoming raised, (0.15–)0.25–0.6 mm. wide at midpoint, below raised, $\pm$ striate, the venation above and below $\pm$ apparent, raised, 10 to 18 (to 21) veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils usually near ends of twigs (rarely terminal—eastern Borneo), with 7 to numerous flowers, usually unbranched (or flowers flabellately arranged, branches to 1 cm. long, with up to 5 flowers), the axis 3–7(–12.5) cm. long, grayish- to rufous-puberulent, lowest internode (0.5–)1–3.5 (–4.8) cm. long; bracts $\pm$ ovate, to 1.2 by 0.6 cm., deciduous; pedicels 0.5–1.5 cm. long, puberulent. Flower (?)hermaphroditic; tepals 4 (rarely 5 to 8), the outer pair elliptic to broadly ovate, (4.5–)5–6.5 by (2.5–)3.5–5 mm., puberulent on back, the inner ones elliptic to ovate, 5.5–8.5 by 3–5(–6) mm., usually puberulent in strip down back (rarely entirely puberulent or puberulent only near base); stamens (180 to) 350 to 600 (to 900 plus), the filaments to 3.5 mm. long, the anthers elliptic to oblong, 0.4–1 mm. long, slightly retuse at apex (very rarely with hairs (Borneo)); ovary 1.2–1.5 mm. long, the style (1.5–)2.8–4.5 mm. long, the stigma peltate, 0.5–0.7 mm. across, 2- to 4-radiate. Fruit spherical to ovoid, 1.5–2.2 by 1.4–1.8 cm., usually stoutly and sharply apiculate, drying brown, rather closely and sharply wrinkled; outer layer not detaching cleanly from stone, 0.6–1.4 mm. thick, compact; stone $\pm$ spherical, 1.2–1.7 by 1.1–1.5 cm., rounded at apex, the walls 0.3–0.4(–0.8) mm. thick, smooth, unmarked; spongy layer (?)thin.

DISTRIBUTION. The typical form in Malaya, Sumatra, and northwestern Borneo; the variant only in Borneo (MAP 19).

SELECTED SPECIMENS SEEN. (Specimens from Borneo that closely match the type specimen of *C. borneense* denoted by “b”; specimens that are $\pm$ typical *C. canum* denoted by “c.”) **Malaya.** KEDAH: Gunong Bounsu F.R., 610 m., *FRI* 6956 (K, KEP, SING); Bukit Enggang F.R., *KEP* 81345 (KEP). PINANG: Government Hill, 305 m., *Curtis* 1543 (K, SING); road to the Spout, 240 m., *Curtis* = 1153 (SING); Waterfall Garden, 30 m., *SFN* 3695 (SING). PERAK: Larut, G. Boobo Range, 240–457 m., *King’s collector* 7704 (G, UC); Larut, less than 30 m., *King’s collector* 5420 (E, FI, P, SING); Batu Gaja, *Wells s.n.*, Feb. 1918 (KEP); Pondok Tanjong F.R., *KEP* 63467 (KEP); Tualang F.R., *KEP* 63269 (KEP). SELANGOR: Weld Hill F.R., 60 m., *KEP* 99519 (A, CANB, K, KEP, LAE, SAN, SAR, SING); F.R.I. [Forest Research Institute], Kepong, *KEP* 99629 (A, KEP, SAN, SAR, SING); Ginting Simpah ridge, 914 m., *KEP* 70994 (KEP).

MAP 19. Distribution of *Calophyllum canum* in Malesia.

NEGRI SEMBILAN: Sungei Menyala F.R., *anon.* (KEP); Senawang F.R., *KEP* 609 (BO, K, KEP, SING). MALACCA: Batang Malaka, *Goodenough* 1791 (SING). KELANTAN: Kemahang F.R., 36 m., *KEP* 92427 (KEP). TRENGGANU: Sungei Kerbat at Jerem Ketch, 335 m., *FRI* 20277 (KEP); Dungun, Jerengau, 30 m., *KEP* 79694 (KEP). PAHANG: Gunong Lesong F.R., *KEP* 10013 (K, KEP); Kuantan, Pekan Road, *KEP* 43188 (KEP); Bukit Setongkol, *KEP* 883 (KEP, SING); Pekan, *Haviland s.n.*, April 1890 (SING); Ulu Peroh, *KEP* 11213 (KEP); Bentong, Kemesul F.R., 45 m., *KEP* 78718 (KEP); Temerloh F.R., *KEP* 5464 (KEP, SING); Balok F.R., *KEP* 97919 (KEP, SING). JOHORE: Sungei Sedili, *SFN* 36891 (A, KEP, SING); Ma' Okil F.R., *KEP* 71284 (KEP); Kluang F.R., *KEP* 78994 (KEP); Renggam F.R., 225 m., *KEP* 71294 (KEP); Banang F.R., 150 m., *KEP* 80557 (KEP). **Sumatra and adjacent islands.** RIAU: Lingga Arch., Pulau Singkep, Koeloe Laboeh, 9 m., *bb* 5370 (BO); Pakanbaru, Tenajan R., low alt., *Soepadmo* 39 (A, BO, C, E, KEP, L, LAE, SING). SELATAN: Rawas, 80 m., *Dumas* 1523 (BO, L); Banjoeasin, Koebroestreken, *Grashoff* 732 (BO, L). BARAT: Pajakombo, Oeloe Air, 1130 m., *bb* 6593 (BO). **Borneo.** SARAWAK. 1st Division: Lundu, *Hewitt* 47 (c) (SAR); Kuching, *Haviland* 27 (c) (SING); Semengoh F.R., 20 m., *Stevens et al.* 290 (c) (A); Sabal Tapang, 105 m., *Stevens et al.* 167 (b) (A); G. Matang, 290 m., *Stevens et al.* 257 (b) (A); G. Santubong, 54 m., *Stevens et al.* 295 (b) (A); Stapok F.R., 5 m., *Stevens et al.* 154 (c) (A). 3rd Division: Lepah P.F., *Anderson* 10/2 (c) (SAR); Batang Igan, Sungei Tutus logging camp, *S* 30255 (c) (SAR). 4th Division: Sungei Kelaput, ca. 5 m. S. of Pulau Bruit, *S* 28 coll. *Anderson*, 13 Nov. 1952 (c) (KEP, SAR); Sambas Road near Poak, *C. Hose s.n.*, 7 Dec. 1911 (c) (BM). BRUNEI: Anduki F.R., *KEP* 32605 (c) (KEP); Temburong, Labu F.R., 15 m., *SAN* 17433 (c) (A, BO, K, KEP, SAN, SAR, SING). SABAH. Sipitang: Sipitang, *KEP* 80046 (c) (KEP). Beaufort: Mesapol F.R., *SAN* 43268 (c) (K, L, SAN);

1.6 km. NE. of Beaufort township, 105 m., *SAN* 15056 (A, BO, BRI, K, KEP, L, SAN, SING); Beaufort Hill, *San* 58588 (SAN). Ranau: Kinabalu Natl. Park, 457 m., *SAN* 54034 (K, L, SAN); Penibukan, 1219 m., *Clemens* 31859 (A, L, NY). Labuk & Sugut: Mile 87½, Telupid Road, Hap Seng logging area, 120 m., *SAN* 83502 (A). Sandakan: Sibuga, Kebun China, *SAN* 37454 (A, K, KEP, L, SAN, SAR, SING); Sepilok F.R., *A* 859 (A, BO, K, KEP, L, SING); Sungei Mayan, 30 m., *Stevens et al.* 375 (A). KALIMANTAN. Timur: E. Kutei, Belajan R. near Long Bleh, 50 m., *Kostermans* 10369 (b) (A, BO, CANB, K, KEP, L, LAE, P, SING); W. Kotei, Long Bleh, 30 m., *bb* 16065 (c) (A, BO, L); Keloempang, *bb* 16927 (BO, L); Boven Mahakam, Liroeng Poedoeng, 50 m., *bb* 20620 (?) (A, BO). Tengah: Koeala Kapeoas, Goehoeng, *bb* 2171 (?c) (BO, L); Sampit, Karoeng, 10 m., *bb* 9924 (BO); Tamoelian, *bb* 2477 (BO).

ECOLOGY. Well-drained mixed dipterocarp forest in Malaya, the variant in Borneo in similar habitats; typical form in Borneo and Sumatra usually in peat swamps; to 1220 m. alt. Flowering April to June, September, and December (advanced bud in January); flower scented. Fruiting May, August, and October (submature fruit December and January); fruit greenish.

YOUNG PLANT. The young plant is erect, and the terminal bud is functional (Bornean form).

LOCAL USES. It is used in tuba fishing (species of *Derris* Lour. probably the poison) in Sarawak. The wood is good for masts and spars (Malaya, Sabah).

The typical form of *Calophyllum canum* can be recognized, even when sterile, by its plump terminal bud and its distinctive leaf blades, which usually dry shiny and brown-vinaceous on the upper surface and have a strongly undulate margin; the midrib is more or less depressed and narrows gradually from the base. The flowers of the typical form usually have four tepals, and there are usually very numerous (350 plus) stamens. The dried fruit is sharply pointed at the apex and has a strongly wrinkled surface. In the Bornean form of *C. canum* (see also below), the leaves do not dry such a dark brown color, the margin of the lamina is less strongly undulate, and the midrib narrows rather quickly near the base. The epithet *canum* means "hoary" or "gray"; it is very appropriate since the indumentum often makes the whole inflorescence look grayish.

The delimitation of *Calophyllum canum* has been somewhat troublesome. The species is most closely related to *C. lowii*; the differences separating the two are discussed under the latter. The typical form of *C. canum* shows relatively little variation, although in Borneo it seems to prefer peat swamps and in Malaya it usually grows in better-drained ground. However, although a number of specimens from Borneo seem referable to *C. canum* on characters of flower and fruit, they differ somewhat vegetatively. These Bornean specimens have a leaf blade that usually dries fulvous above, the margin is not notably undulate, and the midrib narrows abruptly at the base. Fresh leaves of the Bornean form are broadly V-shaped (those of the typical form are (?) always flat), and the inflorescences are sometimes terminal (e.g., *SAN* 37454). More surprising variation occurs in three specimens from western

Sabah that have hairs on the anthers (*SAN 15056* (a few only), *SAN 54034*, *Clemens 31859*). The single flower of *Clemens 31859* examined has ca. 180 stamens, the terminal bud is only ca. 0.3 mm. long, and the hairs are much branched (FIGURE 19, j); the two flowers of *SAN 54034* dissected have 220 and over 450 stamens, respectively, and the hairs are also strongly branched. There is no indication of a relationship between these specimens and *C. molle*, *C. gracillimum*, or *C. rubiginosum*, the other species with hairy anthers.

Collections such as *S 23913*, *23960*, and *25043* growing in colline forest in the 3rd Division of Sarawak have the facies of *C. canum*, but somewhat different hairs (FIGURE 19, h). They are probably to be placed in *C. wallichianum*, the variation of which in Borneo is poorly understood.

The specimen from which *Calophyllum borneense* was described is similar to the Bornean variant of *C. canum*, although its leaf blade has dried very flat, the inflorescence is usually only five-flowered, and the flowers have four to eight tepals. Further collections referable to *C. borneense* sensu stricto were made in Sarawak (see especially *Stevens et al. 257*). In field characters these specimens were very similar to the form of *C. canum* growing near Sandakan, Sabah, and the two have ovoid fruits and similar flowers. However, in *Stevens et al. 257* (*C. borneense*, Gunong Matang, Sarawak) the submature fruits are ca. 1.9 by 1.5 cm., with the outer layer ca. 2.5 mm. thick and the stone walls ca. 0.8 mm. thick. In *Stevens et al. 375* (near Sandakan, Sabah; submature fruits at about the same stage of development) the fruits are ca. 3.2 by 2.3 cm., the outer layer being ca. 5.5 mm. and the stone walls only ca. 0.4 mm. (all measurements from material preserved in alcohol). Although further studies of the whole *C. canum* complex in Borneo are needed, *C. borneense* seems best reduced to synonymy under *C. canum*.

Calophyllum canum is close to *C. lowii* but can be distinguished by the characters given in TABLE 10.

51. ***Calophyllum lowii*** Hooker f. Trans. Linn. Soc. 33: 163. 1860; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 271. 1862 ("C. lowei"); F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868; Vesque in C. DC. Monogr. Phanerog. 8: 604. 1893; Merr., Bibl. Enum. Born. Pl. 393. 1921; Masamune, Enum. Phanerog. Born. 476. 1942. TYPE: in ora septentrionali insulae Borneo [?Sarawak], *Low s.n.* (holotype, κ ; isotypes, κ , ρ (frag.)).

C. palustre Ridley, Kew Bull. 1938: 121. 1938; Masamune, Enum. Phanerog. Born. 476. 1942. TYPE: Dutch SE. Borneo [Kalimantan], Bangarmassing, *Motley 1129* (holotype, κ).

C. wallichianum auct., non Planchon & Triana; Merr. Bibl. Enum. Born. Pl. 394. 1921, *pro parte*; Heyne, Nutt. Pl. Indonesië. ed. 3. 1: 1086. 1950.

Tree to 20 meters tall, d.b.h. to 50 cm.; trunk and bark unknown; latex yellow, clear.

Twigs flattened, 3–5.5 mm. across, $\pm$ 4-angled when young, or with rounded edges, drying blackish, shortly gray-brown-puberulent when young; axillary

TABLE 10. Some differences between *Calophyllum canum* and *C. lowii*.

	<i>C. canum</i>	<i>C. lowii</i>
TWIGS	2-3(-4.5) mm. across	3-5.5 mm. across
LAMINA	Often nitid above, 10 to 18 (to 21) veins/5 mm., margin strongly undulate	Often $\pm$ dull above, 10 to 15 veins/5 mm., margin somewhat undulate
BRACTS	Conspicuous in young inflorescence, to 1.2 cm. long	Inconspicuous
INFLORESCENCES	Rarely branched or flabellate; flowers often rather congested	Usually branched, flabellate; flowers not congested
STAMENS	(180 to) 350 plus, the anthers 0.4-1 mm. long	Fewer than 210 (to 310), the anthers 1-2 mm. long
FRUIT	Apex sharply pointed; surface densely and sharply wrinkled	Apex rounded; surface at most shallowly and distantly striate
STONE WALLS	0.3-0.4(-0.8) mm. thick	Less than 0.2 mm. thick
HAIRS	Apical cells rarely thin-walled	Apical cells thin-walled

innovations lacking basal scars; internodes 2-7.5 cm. long; uppermost pair of axillary buds pointed, to 3 mm. long, spreading; terminal bud plump, (0.8-)1-2.2 cm. long, with grayish brown, crustaceous indumentum (hairs, FIGURE 20, f, g), underdeveloped internode 0.4-1.5 cm. long. Petiole 1.4-3 cm. long, shallowly and broadly concave above, convex below, drying blackish, glabrous when mature; lamina narrowly ovate to elliptic, 11-25 by 1.5-8.5 cm., or ovate, ca. 18 by 7.2 cm., gradually acuminate at apex, acute at base, distantly undulate and narrowly or not recurved at margin, coriaceous, drying olivaceous above and umber to hazel below, puberulent on midrib on both surfaces, or glabrous, the midrib gradually narrowed from base, depressed at first with edges $\pm$ raised, becoming raised at ca. $\frac{1}{3}$ length of leaf, drying blackish, 0.2-0.5 mm. across at midpoint, raised and $\pm$ striate below, the venation on both surfaces $\pm$ apparent (subobscure), raised, 8 to 15 veins/5 mm., angle of divergence 70-80°. Inflorescences from upper foliate axils (very rarely terminal—*bb* 2635), with 11 to numerous flowers, often lowest flowers flabellately arranged, usually with branches up to 5 cm. long and with 7 flowers, the axis 5-15 cm. long, puberulent, lowest internode 1.5-7.5 cm. long; bracts ovate, to 6.5 mm. long, soon deciduous; pedicels 0.9-2.5 mm. long, puberulent, rather slender, incrassate in fruit, to 2.5 mm. across. Flower (?)hermaphroditic; tepals 4 (to 7), the outer two

ovate to broadly elliptic, 6–6.5 by 4.5 mm., puberulent on back, the inner ones suboblong to broadly elliptic, 9.5–10.5 by 4.5–8.5 mm. (rarely suborbicular, ca. 9 mm. long and across), puberulent in strip toward base of back; stamens 130 to 210 (to 310), the filaments to 5 mm. long, the anthers oblong, 1–2 mm. long, retuse at apex; ovary ca. 2 mm. long, the style ca. 3 mm. long, the stigma peltate, ca. 1.2 mm. across, 3-radiate. Fruit spherical to ellipsoid, 2–2.5 by 1.8–2 cm., rounded at apex, or apiculate, drying brown, finely striate; outer layer not detaching cleanly from stone, 0.9–1 mm. thick, compact, rather hard; stone $\pm$ ellipsoid, 1.8–2.3 by 1.6–1.8 cm., rounded at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Sumatra to Borneo (MAP 16).

SELECTED SPECIMENS SEEN. **Sumatra and adjacent islands.** RIAU: Indragirische bovenlanden, Kwala Belilas, 60 m., *bb* 27643 (BO, L), Pagaroembei (Tjenako-Rivier), 8 m., *bb* 26108 (BO, L, SING), Belimbing, 6 m., *bb* 28464 (BO, L, MO), Keritang, 5 m., *bb* 28691 (BO, NY). DJAMBI: Djambi, Gergai, 5 m., *bb* 11328 (BO). SELATAN: Bangoeasin, Koeboestreken, 20 m., *Grashoff* 709 (BO, L); Palembang, *Grashoff* 907A (L). BANGKA: Lobok Besar, 5 m., *bb* 34046 (A, BO, L); Bikang, *bb* 15095 (BO); B[e]linjoe, *Grashoff* 40 (BO, L). BELITUNG: Tandjong Pandan, Banten, 30 m., *bb* 4106 (BO). **Borneo.** SARAWAK. 1st Division: near G. Siol, *Omar* 379 (K, SING); near Kuching, *Haviland & Hose* 3343 (BM, BO, K, L, SAR, UC). KALIMANTAN. Selatan: ond. afd. Pleihari, Pematang Landjar, *bb* 2129 (BO, L). Tengah: Sampit, bij Seramau, *bb* 653 (BO), Mandawei, 10 m., *bb* 2635 (BO); ond. afd. Beneden Djak, Sei. Teroesan, *bb* 2091 (BO, L), P. Kladan, 5 m., *bb* 12251 (BO); Koeala Kapoeas, Sungei Mangkoetoep, *Dachlan* 2197 (BO), P. Telo, *bb* 2174 (BO); Beneden Merlan, Sungei Kemdeinangan, 1 m., *bb* 14417 (BO).

ECOLOGY. Lowland rainforest, frequently periodically inundated, below 60 m. alt. Flowering October to December and March; fruiting in February.

LOCAL USES. The wood is used in house building. The latex boiled with coconut milk is used as a remedy for itching and skin infection (Heyne, *loc. cit.*).

Calophyllum lowii is apparently related to *C. canum*; for the differences distinguishing the two see TABLE 10. *Calophyllum lowii* is larger in all parts (but has fewer stamens) than *C. canum*; its fruit is rounded at the apex, dries almost smooth, and has a thin-walled stone; its pedicel is notably incrassate in fruit; and its leaf does not often dry the brown-vinaceous color common in *C. canum*. The epithet commemorates H. Low, the collector of the type specimen. A number of sterile specimens cited under *C. lowii* (e.g., those from the Indragiri region (Sumatra)) are included here only provisionally.

Planchon and Triana's description of *Calophyllum lowei* (sic) appears to be independent of that of Hooker, published the preceding year. Planchon and Triana cited the specimens that they saw as "Low in herb. Hook. [the holotype of *C. lowii* Hooker f.] et inde in herb. Planch."; fruiting material

that they thought was another species of *Calophyllum* is referable to *C. soulattri*.

The type specimen of *Calophyllum palustre* is a good match with that of *C. lowii*; both have profuse inflorescences and large leaf blades with a rather broad, blackish drying midrib.

52. ***Calophyllum woodii*** P. F. Stevens, sp. nov.

FIGURE 17, 1-n.

C. molle auct., non King; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 15. 1967.

A speciebus aliis *Calophylli* in indumento tomentoso gemmis, ramulis, costis laminarum, axibus inflorescentiarum, pedicellis et tepalis exterioribus praedito, ramulis in siccitate saepe pallide coloratis, lamina elliptica vel oblonga 9–22.5 cm. longa venulis lateralibus (6 ad) 8 ad 16 (ad 20) per 5 mm., et fructu subsphaerico strato exteriori 2.5–3 mm. crasso e putamine haud munde secedenti et putamine parietibus 0.4–0.6(–0.9) mm. crassis, differt.

Tree 21–30 meters tall, d.b.h. to 80 cm.; trunk without buttresses; outer bark yellowish brown to brown, shallowly fissured or with lines of lenticels, becoming strongly fissured, the inner surface orange-red or brown-orange; under bark dark red or greenish straw; inner bark brown-red or pale red; latex brownish, opaque or pellucid, not viscous (rarely yellow (*Kostermans* 6618) or viscous (*Stevens et al.* 160)).

Twigs strongly flattened, 2.3–3.5 mm. across, rounded to $\pm$ 4-angled, drying pale brown or yellowish to grayish, subpersistently brown-tomentose, hairs to 0.8 mm. long, puberulent; axillary innovations lacking basal scars; internodes 1–4 cm. long; uppermost pair of axillary buds rounded, 1–2.5 mm. long, $\pm$ spreading; terminal bud plump to subconical, 0.6–1.2(–1.7) cm. long, with brown, tomentose indumentum (hairs, FIGURE 20, a–c), underdeveloped internode to 3(–6) mm. long. Petiole 1–1.9 cm. long, concave to V-shaped above, convex below, with subpersistent indumentum; lamina elliptic to oblong, 9–22.5 by 3.4–6.3(–8) cm., subrounded to acuminate at apex, broadly cuneate to subrounded (slightly cucullate) at base, broadly undulate and slightly recurved at margin, coriaceous, drying sepia to umber above and below, often shiny, usually tomentose on midrib on both surfaces, the midrib above abruptly to gradually narrowed at base, raised, 0.25–0.35 mm. wide at midpoint, below raised, slightly striate, the venation subobscure to apparent above and apparent below, raised, (6 to) 8 to 16 (to 20) veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils, with 7 to 11 flowers, unbranched, short-tomentose, the axis 2–5.5 cm. long, lowest internode 0.4–1.7 cm. long; bracts ovate, to 5 mm. long, tomentose below, deciduous; pedicels 0.7–2.3 cm. long, slender, short-tomentose. Flower (?) hermaphroditic; tepals 4 (rarely 5), the outer pair ovate, ca. 5.5 by 4.5 mm., tomentose on back, the inner pair subelliptic, ca. 8.5 by 5.5 mm., with strip of tomentum down back; stamens 190 to 270, the filaments to 5.5 mm. long, the anthers elliptic, 0.8–1 mm. long, rounded at apex; ovary ca. 2.5 mm. long, the style ca. 3.5 mm. long, the stigma peltate, ca. 1.4 mm. across, 3-radiate. Fruit

subspherical to ellipsoid, 1.3–2 by 1.2–1.7 cm., rounded at apex, drying brown, wrinkled; outer layer generally detaching cleanly from stone, 2.5–3.3 mm. thick, compact, but with air spaces developing under skin; stone ellipsoid to subspherical, 0.7–1.3 by 0.65–1.1 cm., rounded to mucronulate at apex, the walls 0.4–0.6(–0.9) mm. thick, smooth, unmarked; spongy layer initially thick.

TYPE: North Borneo, Sandakan, mile 8, Labuk road, outside Sibuga F.R., 1 Sept. 1964, *SAN* 42949 coll. *Burgess* (holotype, L; isotypes, K, SAR).

DISTRIBUTION. Borneo, mostly in the eastern part (MAP 17).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: Sabal Tapang, 140 m., *Stevens et al.* 160 (A, SAR); Semengoh F.R., 30 m., *Stevens et al.* 124 (A). 3rd Division: Bukit Raya, Btg. Rejang, *Ashton* 6004 (A). SABAH. Sipitang: Ulu Mendalong, 10 km. SSE. of Malaman, 533 m., *SAN* 16725 (A, BO, BRI, KEP, L); Ulu Moyah, 13 km. SSE. of Malaman, 838 m., *SAN* 16693 (A, BO, KEP, L, SAN, SING). Labuk & Sugut: Mile 42, Labuk Road, *SAN* 71708 (SAN). Sandakan: Mile 8 plantation (tree originating from Sepilok), *SAN* 35504 (K, KEP, L, SAN, SAR, SING); Sepilok F.R., 30 m., *SAN* 19728 (KEP, SAR), *Stevens et al.* 331 (A), 335 (A); Plantation boundary, Gum Gum, mile 17, 12 m., *SAN* 81224 (SAN); Arboretum, mile 14, *SAN* 72843 (SAN), 82500 (A). Tawau: ca. 5 km. from Brantian on Tawau road, 45 m., *Stevens et al.* 434 (A). KALIMANTAN. Timur: Salembat, 100 m., *bb* 11293 (BO). Samarinda: Loa Djanan, W. of Samarinda, *Kostermans* 6618 (A, BO, L, P, SING); Boven Mahakam, Loempobo, 90 m., *bb* 20667 (A, BO, L); mouth of Mahakam R., Tandjong Bangko, 20 m., *Kostermans* 7229 (BO, L); Balikpapan, Sungei Wain, 20 m., *bb* 34418 (BO, L); W. Koetai, Moejoer, 25 m., *bb* 16764 (A, BO), Kahalu, 25 m., *bb* 28354 (BISH, BO, P). Selatan: Pleihari, *bb* 2033 (BO).

ECOLOGY. Well-drained lowland to colline mixed dipterocarp forest, sometimes in swamps; 30–838 m. alt. Flowering April and September (flower smells like syringa (*SAN* 35504)); fruiting June, September, October, and December (fruit greenish to pale cream).

GERMINATION AND YOUNG PLANT. Young plants ca. 30 cm. tall are erect and have functional terminal buds.

Calophyllum woodii can be recognized by the tomentose indumentum on twigs, terminal buds, midrib of the lamina, inflorescence, pedicels, and tepals; the hairs appear to be rough when viewed under high magnification since almost every cell has a small protrusion. The lamina is elliptic to oblong, with fine, moderately dense, and rather widely ascending venation. The inflorescences are axillary and unbranched, and the flowers usually have four tepals. The fruit is generally subspherical and dries wrinkled; the outer layer is 2.5–3.3 mm. thick, and the stone usually has walls less than 0.6 mm. thick. The specific epithet commemorates G. H. S. Wood, who made some of the earliest collections of this species in Sabah.

Calophyllum molle has been confused with *C. woodii*, but in the former the hairs are smooth, the stamens are more numerous, and the anthers,

ovary, and fruit are hairy. *Calophyllum woodii* is closely related to *Calophyllum* sp. 53; the differences between the two are discussed under the latter.

The specimens of *Calophyllum woodii* from Sarawak and adjacent western Sabah have a narrower terminal bud than those from eastern Sabah, and the base of the lamina is not cucullate to slightly so. However, all specimens agree in general facies and in hair type. *Stevens et al.* 160 (Sarawak) had sticky latex, whereas in other specimens seen in both Sarawak and Sabah the latex was free flowing, and the fruits had stone walls about 0.9 mm. thick—somewhat thicker than those of other specimens.

53. *Calophyllum* sp.

FIGURE 17, j.

Tree to 25 meters tall, d.b.h. to 80 cm.; trunk without buttresses or spurs; outer bark yellowish brown, with lines of close-set lenticels, not clearly hoop marked, the inner surface dull yellow-gray or greenish slate and orange-brown mottled; under bark mid-brown or dark reddish; inner bark red; latex clear yellow, sticky, becoming cloudy.

Twigs flattened, 3.3–4 mm. across, obscurely 2- or 4-angled, soon becoming rounded, drying yellowish brown or grayish brown, subsersistently brown-tomentose, hairs to 1 mm. long; axillary innovations lacking basal scars; internodes 1.5–6(–10) cm. long; uppermost pair of axillary buds rounded, 1–2(–3.5) mm. long, $\pm$ spreading; terminal bud obtusely conical, 6.5–9 mm. long, brown-tomentose (hairs, FIGURE 19, q, r), underdeveloped internode absent. Petiole 0.8–1.2 cm. long, broadly and deeply concave above, convex and tomentose below; lamina elliptic to oblong, 12.5–20 by 4.6–6.8 cm., broadly rounded and finally mucronate or slightly retuse at apex, broadly rounded and slightly cucullate at base, slightly and distantly undulate and recurved at margin, coriaceous, drying khaki above and sabelline below, persistently tomentose on midrib below, the midrib above narrowing quickly at or near base, raised, center $\pm$ sulcate, 0.3–0.4 mm. wide at midpoint, below strongly raised, striate, the venation $\pm$ apparent above and apparent below, raised, 11 to 13 veins/5 mm., angle of divergence 75–85°. Inflorescences terminal and from upper foliate axils, with ca. 15 flowers, flabellate, with 3-flowered branches to 1.2 cm. long, the axis 2.8–5.2 cm. long, densely tomentose, basal internode 1.3–2 cm. long; bracts unknown; pedicels 1–1.5 cm. long, tomentose. Flower (?) hermaphroditic; tepals (?) 4, the outer pair ovate-elliptic, ca. 6 by 5 mm., tomentose on back, the inner pair $\pm$ obovate, ca. 10 by 5 mm., with strip of tomentum down back; stamens (?) numerous, the filaments ca. 5 mm. long, the anthers elliptic-obovate, ca. 0.5 mm. long, strongly retuse at apex; ovary ca. 2 mm. long, style and stigma unknown. Immature fruit spherical, ca. 8 mm. long and across, rounded at apex, drying brownish, smooth; outer layer ca. 1.8 mm. thick.

DISTRIBUTION. Northwestern Borneo (MAP 17).

SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: Semengoh Arboretum, *Stevens et al.* 129 (A); Semengoh F.R., 30 m., *Stevens et al.* 289 (A), S 24675 (A, L, SAR, SING).

ECOLOGY. Lowland mixed dipterocarp forest; ca. 30 m. alt.

GERMINATION AND YOUNG PLANT. The seedling has two pairs of leaves separated by an internode less than 7 mm. long. Subsequently produced internodes are longer, the terminal bud is functional, and the plant is erect (*Stevens et al.* 129).

Calophyllum sp. 53 is a distinctive taxon recognizable by its oblong lamina, which is broadly rounded both toward the apex and at the more or less cucullate base, and which dries a khaki color on the upper surface; the venation is fine but distinct. The inflorescence is apparently at least sometimes terminal, and there is tomentose indumentum on the back of the outer pair of tepals. The short branches of the hairs (FIGURE 19, q, r) are visible at a magnification of $\times 30$; the hairs appear rough.

Although the leaves of *Calophyllum* sp. 53 dry in a fashion similar to those of *C. woodii*, and both species have rough hairs, the latter has smaller leaf blades that are more or less acute at the apex, an inflorescence that is not (?ever) terminal, and a plump terminal bud. However, the two taxa are probably more closely related to one another than to other species of *Calophyllum*.

The leaf blades of the young plant are obovate in shape, acuminate at the apex, and narrowly cuneate at the base.

54. *Calophyllum* sp.

FIGURE 17, a.

?Tree; trunk and bark unknown.

Twigs slightly flattened, ca. 5 mm. across, rounded or with 4 raised lines, drying brown to blackish, persistently tomentose; axillary innovations lacking basal scars; internodes 1–4 cm. long; uppermost pair of axillary buds rounded, ca. 0.7 mm. long, spreading, inconspicuous; terminal bud plump, ca. 1.5 cm. long, tomentose (hairs, FIGURE 20, o–q), underdeveloped internode absent. Petiole 1.6–3 cm. long, narrowly concave above, convex below, short-tomentose; lamina subobovate to subelliptic or suboblong, 11.5–19.5 by 4–7 cm., obtuse to short-acuminate at apex, cuneate to subrounded at base, strongly and distantly undulate and slightly recurved at margin, coriaceous, drying greenish olivaceous and shiny above and umber-sabelline below, persistently tomentose on midrib above and on entire lower surface, the midrib above gradually narrowed from base, raised, 0.25–0.35 mm. wide at midpoint, below raised, $\pm$ striate, the venation apparent on both surfaces, raised, 8 to 14 veins/5 mm., angle of divergence 70–75°. Infructescences terminal and from adjacent foliate axils, with scars of ca. 11 flowers, (?)branched, the axis to 6.5 cm. long, short-tomentose, lowest internode ca. 2.2 cm. long; bracts unknown; pedicels 1.5–2 cm. long, tomentose. Flower unknown. Immature fruit ca. 1.2 cm. long, furfuraceous.

DISTRIBUTION. Sumatra (MAP 17).

SPECIMENS SEEN. Sumatra. UTARA: Sibolga, 200 m., *bb* 19334 (A, BO); Provincia di Padang, a Sungei bulu ($\pm$ 0 m.), *Beccari* PS 953 (FI, K, L, MEL).

Calophyllum sp. 54 can be readily recognized by the more or less tomentose indumentum that persists on all parts of the plant except the upper surface of the lamina and the ovary, by its terminal inflorescences, and by its furfuraceous fruits.

Calophyllum sp. 54 is perhaps superficially similar to *C. molle* and *C. rubiginosum*, but both of these species differ in their tomentose ovaries and their leaves that do not dry so bicolored; *C. molle* also has axillary inflorescences. *Calophyllum woodii* and *Calophyllum* sp. 53, two Bornean species with tomentose indumentum, both have hairs with numerous papillae and short branches, and leaves that do not dry bicolored and have denser venation; *C. woodii* has axillary inflorescences.

55. ***Calophyllum cucullatum*** Merr. Philip. Jour. Sci. 17: 288. 1920, Enum. Philip. Fl. Pl. 1: 78. 1923. TYPE: Philippine Islands, Mindanao, Surigao Province, 25 April 1909, BS 34518 coll. Ramos & Pascasio (isotypes, A, BM, BO, K, NY, P, US).

Small tree; trunk and bark unknown.

Twigs slightly flattened, 2.2–2.6 mm. across, with rounded edges, drying black, at first brown-tomentose, hairs to 2 mm. long; axillary innovations lacking basal scars; internodes 8.5–11.5 cm. long; uppermost pair of axillary buds rounded, ca. 1.5 mm. long, suberect; terminal bud 4.5–6.5 mm. long, brown-tomentose, long hairs obscuring shape (hairs, FIGURE 22, a, b), underdeveloped internode absent. Petiole 1–1.5 cm. long, narrowly concave above, convex below, drying black, subpersistently tomentose below; lamina ovate to suboblong, 9.5–20.5 by 4.8–8.8 cm., (short-)acuminate at apex, rounded and cucullate at base, not undulate and slightly recurved at margin, coriaceous, drying umber above and below, with sparse, subpersistent hairs toward base on midrib on both surfaces, the midrib above abruptly narrowed near base, raised, ca. 0.2 mm. wide at midpoint, below raised, rounded, slightly striate, the venation above usually subobscure, below clear, slightly raised, 7 to 10 veins/5 mm., angle of divergence 65–70°. Infructescences from foliate axils, flabellate, with scars of ca. 15 flowers, with 3-flowered branches to 1 cm. long, the axis 3–5.5 cm. long, sparsely tomentose toward base, lowest internode 0.5–3 cm. long; bracts narrowly elliptic, ca. 5.5 mm. long, tomentose beneath, subpersistent; pedicels 1.1–2.3 cm. long, glabrous. Flower unknown. Fruit ellipsoid, ca. 1 by 0.8 cm., apiculate, drying grayish, smooth; outer layer not detaching cleanly from stone, very thin—when pressed less than 0.3 mm. across, with large air spaces developing; stone ellipsoid, ca. 9 by 7 mm., rounded at apex, the walls ca. 0.3 mm. thick, at base fibrous and ca. 0.5 mm. thick, smooth, (?)unmarked; spongy layer thin.

DISTRIBUTION. The Philippine Islands, Mindanao, known only from the type collection (MAP 20).

ECOLOGY. Thickets along streams at an iron deposit (Merrill, 1920, *loc. cit.*); fruiting in April.

Calophyllum cucullatum is a distinctive species that can be recognized

MAP 20. Distribution of *Calophyllum pulcherrimum* (squares), *Calophyllum s* (half-circles), *C. oliganthum* (open stars), *C. cucullatum* (solid star), and *C. pelew*

by its tomentose indumentum; relatively short terminal bud; large, ovate-oblong leaf blades that are cucullate at the base; branched inflorescence; and small, ellipsoid fruits that have a thin outer layer disorganized by air spaces. The epithet alludes to the cucullate (hooded) base of the lamina.

Merrill (1920, *loc. cit.*) compared *Calophyllum cucullatum* with *C. soulattri*, but noted that *C. cucullatum* differed in its cucullate lamina base. *Calophyllum cucullatum* also differs in drying a much darker color, in its short terminal bud, and in its fruits, which have a thin outer layer; the outer layer of the fruit of *C. soulattri* is characteristically at least 1 mm. thick.

56. ***Calophyllum glaucescens*** Ridley, Kew Bull. **1938**: 120. 1938; Masamune, Enum. Phanerog. Born. 475. 1942. TYPE: Sarawak, Kuching, Dec. 1892, *Haviland 2058* (holotype, K; isotypes, L, P (frag.), SING).

Small tree ca. 7 meters tall; outer bark smooth, gray, hoop marked; inner bark light brown, finely laminated; latex yellow.

Twigs slightly flattened, 1.5–2 mm. across, with 4 obscure raised lines, drying yellowish to whitish, glabrous; axillary innovations apparently with basal scars; internodes 2.5–5 cm. long; uppermost pair of axillary buds rounded, less than 0.5 mm. long, inconspicuous; terminal bud rather plump, 1–1.8 mm. long, with brown, puberulent indumentum (hairs, FIGURE 20, i), underdeveloped internode inconspicuous. Petiole 1–1.5 cm. long, broadly concave above, convex below, drying black; lamina elliptic to suboblong, 7–14.6 by 3.3–6.6 cm., acuminate at apex, acute to broadly cuneate at base, not undulate but narrowly recurved at margin, coriaceous, drying umber above and livid-vinaceous below, glabrous, the midrib above narrowing gradually from base, flat, adjacent lamina raised, 0.4–0.7 mm. wide at midpoint, below raised, rounded, the venation on both surfaces subobscure, ca. 25 veins/5 mm., angle of divergence 75–80°. Inflorescences from foliate axils along stem, with ca. 7 flowers, unbranched, the axis 1–1.5 cm. long, glabrous, lowest internode ca. 0.5 mm. long; bracts broadly ovate, ca. 2 mm. long, brown-puberulent beneath, persistent until anthesis; pedicels 6–9 mm. long, glabrous. Flower known only from advanced bud, (?)hermaphroditic; tepals 4, the outer two obovate, ca. 5.5 by 4 mm., subcucullate, the inner two $\pm$ obovate, ca. 6 by 4.5 mm.; stamens 50 to 70, the filaments to 2.7 mm. long, the anthers ellipsoid, 0.5–0.7 mm. long, rounded to subretuse at apex; ovary ca. 1.3 mm. long, the style ca. 2 mm. long, the stigma slightly expanded, 0.3 mm. across. Fruit unknown.

DISTRIBUTION. Borneo (western Sarawak), local (MAP 23).

ADDITIONAL SPECIMEN SEEN. **Borneo.** SARAWAK. 1st Division: Sempadi F.R., 9 m., *S 6012* (SAR).

ECOLOGY. Small tree on dry podzol, 9 m. alt. (*S 6012*). Flowering in December.

Calophyllum glaucescens is a distinctive, albeit poorly known, species recognizable by its very short terminal bud, pale-drying twigs, and lamina with dense venation. The midrib on the upper surface of the lamina is

surrounded by raised blade, and the lower surface of the lamina dries a livid-vinaceous color. The epithet alludes to the rather glaucous underside of the leaf.

Calophyllum glaucescens is somewhat similar to *C. cucullatum*, but the latter species has larger leaf blades at least 9.5 cm. long with a sharply raised midrib on the upper surface, a rounded, cucullate base, less dense venation, and a lower surface that is not pruinose. *Calophyllum cucullatum* also has a longer (4.5–6.4 mm.) terminal bud, tomentose indumentum, and inflorescences up to 5 cm. long. Although better material is needed for confirmation, *C. glaucescens* appears to have scars at the bases of the axillary innovations; such scars are lacking in *C. cucullatum*.

57. ***Calophyllum nodosum*** Vesque, Epharmosis 2: tt. 10, 11. 1889, in C. DC. Monogr. Phanerog. 8: 559. 1893; Merr. Bibl. Enum. Born. Pl. 393. 1921; Masamune, Enum. Phanerog. Born. 476. 1942; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 337. 1956; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 14. 1967; T. C. Whitmore, Tree Fl. Malaya 2: 171. 1972. TYPE: Sarawak [1st Division], Gunong Poe, July 1866, Beccari PB 2440 (holotype, P; isotypes, A (frag.), FI, K).

FIGURE 21, e.

- C. microphyllum* T. Anderson in Hooker f. Fl. Brit. India 1: 272. 1874, non Planchon & Triana (1862) nec Scheffer (1873); King, Jour. Asiatic Soc. Bengal, II. 59: 173. 1890; Ridley, Jour. Straits Branch Roy. Asiatic Soc. 35: 8. 1901; *C. kingianum* Engler in Engler & Prantl, Nat. Pflanzenfam. 3(6): 221. 1893 (7 Nov.), *nomen novum*; *C. parvifolium* Vesque in C. DC. Monogr. Phanerog. 8: 604. 1893 (Dec.), non Choisy (1823), *nomen novum*; Ridley, Fl. Malay Penin. 1: 182. 1922. TYPE: Malaya, Malacca, Mt. Ophir, Aug. 1867–68, Maingay 2576 (Kew dist. 165) (lectotype, K).
- C. depressinervosum* auct., non M. R. Henderson & Wyatt-Smith; Pukol & Ashton, Checklist Brunei Trees, 93. 1964; Smythies, Common Sarawak Trees, 99. 1965.
- C. pulcherrimum* auct., non Wall. ex Choisy & *C. rupicola* auct., non Ridley; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 14. 1967.

Shrub 15 cm. tall to tree to 25(–36) meters tall, d.b.h. to 42 cm.; trunk without spurs or buttresses; outer bark yellowish (brown), with lenticels or boat-shaped fissures, very brittle in old trees, the inner surface black to dull orange-brown; under bark mid to deep red; inner bark reddish; latex clear (rarely cloudy) yellow, sticky.

Twigs slightly flattened, 0.5–1.5 mm. across, 4-angled to 4-alate, drying brown, glabrous or sparsely and transiently puberulent; axillary innovations with (sub)basal pair of scars, nearly always with additional pair within 5 mm. of base; internodes 0.3–2.5 cm. long; uppermost pair of axillary buds rounded, to 0.5 mm. long, inconspicuous; terminal bud rather plump, 0.5–1 mm. long, with short, grayish to brownish, subadpressed indumentum (hairs, FIGURE 20, j–l), often not functional, underdeveloped internode to 3.5 mm. long. Petiole 1–5.5 mm. long, deeply concave above, convex below, glabrous;

FIGURE 21. a, b, *Calophyllum stipitatum* (FRI 3656), fruit, $\times 1.5$: a, from outside; b, longitudinal section. c, *C. complanatum* (SAN 53254), habit, $\times 0.5$. d, *C. pulcherrimum* (Chew 1365), fruit, transverse section, $\times 1$. e, *C. nodosum* (S 19726), fruit, transverse section, $\times 3$. f, *C. depressinervosum* (KEP 104281), fruit, longitudinal section, $\times 3$. g-i, *C. roseocostatum*. g, h, fruit (S 14941), $\times 0.75$: g, longitudinal section; h, from outside. i, terminal bud (S 26299), $\times 6$.

lamina obovate or elliptic to subcuneiform or narrowly elliptic, (0.7-)1.4-6.5 (-10) by (0.15-)0.4-2.5(-3.6) cm., rounded to shortly and bluntly acuminate at apex, narrowly cuneate at base, usually minutely and abruptly rounded at very base, slightly undulate and not recurved at margin, thinly coriaceous, drying umber to near grayish olive above and umber to near sabelline or olive below, glabrous, the midrib above gradually narrowed from base, $\pm$

level to sulcate, surrounding lamina slightly raised, 0.5–1.5(–2) mm. wide at midpoint, often disappearing ca. 2 mm. short of apex, below level to slightly depressed, inconspicuous, striate, the venation subapparent to subobscure above and below, slightly raised (latex canals sometimes clearly impressed), 6 to 13 (to 15) veins/5 mm., angle of divergence 50–70(–75)°. Inflorescences from foliate axils along stem, with 1 to 9 (to 13) flowers, unbranched, the axis to 3.5 cm. long, glabrous (rarely puberulent) at base, lowest internode less than 2 mm. long; bracts ovate, ca. 1.7 mm. long, soon deciduous; pedicels 0.5–2.2 cm. long (–3 cm. long in fruit), glabrous, slender. Flower (?)hermaphroditic; tepals 4 (to 8), the two outer ovate (rarely subtriangular), 3–3.5 by 2.2–3 mm., sometimes puberulent on back at apex, the inner two elliptic to obovate, 3.5–5.5 by 2.3–3.7 mm. (5 by 2.2 mm), any others often much smaller; stamens 27 to 50 (to 60), the filaments to 3 mm. long, the anthers (elliptic-)oblong, 0.5–1 mm. long, slightly retuse at apex; ovary 1.2–1.5 mm. long, the style 2–2.5 mm. long, the stigma peltate, ca. 0.4 mm. across, $\pm$ 3-radiate to infundibular. Fruit spherical, (4–)5.5–10 mm. long and across, rounded to apiculate at apex, drying grayish brown to yellowish brown, smooth or shallowly wrinkled; outer layer not detaching cleanly from stone, ca. 0.3(–0.7) mm. thick, with large air spaces developing; stone ellipsoid to subspherical, (3.5–)5–7.5 by (3–)5–6.5 mm., rounded at apex, the walls less than 0.15 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Malay Peninsula, local; Borneo, widespread in the northwest (MAP 21).

MAP 21. Distribution of *Calophyllum nodosum* (squares; half-circle, reported locality) in Malesia.

SELECTED SPECIMENS SEEN ("f" denotes Bornean specimens with fruits). **Malaya.** JOHORE: G. Mering and G. Ledang, *Ridley* 3222 (BM, SING); G. Ledang (Mt. Ophir), 975 m., *FRI* 12351 (K, KEP). **Borneo.** SARAWAK. 1st Division: Lundu, G. Berumpet, 1463 m., *S* 15099 (A, K, SAN, SAR, SING), Sampadi F.R., *A* 532 coll. *Mashor*, 14 Aug. 1948 (KLU); Bako Natl. Park, Lintang Path, 120 m., *Sinclair & bin Tassim* 10317 (A, B, BM, E, K, M, NY, SAR, SING); Mt. Matang, 1021 m., *Clemens* 22353 (NY); G. Pueh F.R., 30 m., *S* 7530 (SAR); Bungoh Range, Bau, 792 m., *S* 29022 (A, SAR); Sabal Tapang, 190 m., *Stevens et al.* 183 (A). 3rd Division: Ulu Sama, Batang Rajang, *SFN* 36057 (A, K, KEP, L, LAE, SING); Hose Mts., Ulu Temalad, Mujong, 305 m., *S* 17236 (A, K, KEP, SAN, SAR, SING); Bintulu, Merurong Plateau, 853 m., *S* 8714 (SAR); Kapit, Melinau, Bukit Pantu, 732 m., *S* 25720 (KEP, L, SAR, SING); Balingian, Ulu Sungei Arip, Bukit Iju, 180 m., *S* 23786 (A, BO, K, KEP, SAN, SAR, SING); Usun Apau Plateau, R. Julai, 965 m., *S* 3811 (SAR, SING). 4th Division: Baram distr., Kelabit Highland, 1067 m., *S* 35343 (K, SAR); Lambir proposed Natl. Park, Miri, *S* 24064 (A, K, KEP, SAN, SAR). 5th Division: Malignan Range, 1494 m., *S* 33035 (SAR). BRUNEI: Bukit Sagan, 549 m., *BRUN* 3110 (L, SAR); Batu Ketam, Ulu Ingei, 255 m., *BRUN* 5608 (L, SAR); Bukit Patoi, 240 m., *Ashton s.n.*, Aug. 1958 (SAR); Berakas F.R., 15 m., *S* 7822 (BO, BRI, K, L, NY, SAR, SING); Andalau F.R., 21 m., *Sinclair & bin Tassim* 10448 (A, E, K, KEP, SAR, SING); G. Pagon Periok, 1860 m., *BRUN* 2389 (L, SAR); Bados, *KEP* 35589 (KEP); between Danau and Tutong, *van Niel* 3736 (L, MO); Sungei Singap, *KEP* 34570 (KEP); Kuala Belait, *S* 10652 (SAR). SABAH. Sipitang: Menggalong F.R., Sibubu R., *SAN* 21829 (KEP, SAN, SAR); Mesapol, Teck Guan Co., 210 m., *SAN* 50620 (SAN). Beaufort: Bukit Sunngau, Weston, *SAN* 55658 (f) (L, SAN, SAR, SING); Beaufort Hill, *SAN* 35227 (SAN). Kota Belud: Mt. Templer F.R., S. of Sungei Talupit, 610 m., *SAN* 76266 (K, SAN, SAR). Tenom: Kapulu, way to Rendum, 1097 m., *SAN* 72058 (f) (K, SAN); Mandalom F.R., *SAN* 31948 (SAN). Keningau: Mile 9, Kampong Nalayan, *SAN* 58461 (f) (K, L, SAN); Mile 10, Rashna road, Nabawan, 305 m., *SAN* 83839 (f) (A, K). Tambunan: Trusmadi F.R., above Ulu Koingaran R., 1514 m., *SAN* 41779 (K, L). Ranau: Kinabalu Natl. Park, Tohubang near Kampong Kiau, 918 m., *SAN* 51428 (SAN). Labuk & Sugut: Jambongan Is., 3 m., *SAN* 3899 (BO, K); Bukit Gambaran near Telupid, 457 m., *SAN* 51525 (K, SAN, SAR); Bukit Tangkunan, 425 m., *Stevens et al.* 408 (A). Sandakan: Sungei Paitan W.C., *SAN* 23977 (f) (K, KEP, L, SAN, SAR, SING); Mt. Walker F.R., 30–60 m., *SAN* 53171 (K, KEP, L, SAN, SAR, SING); Kiabau Hill, 150 m., *SAN* 43814 (SAN); Sungei Mayan, 40 m., *Stevens et al.* 381 (A). Kinabatangan: Brassey Range, 810 m., *Stevens et al.* 481 (A); Lamag, Bukit Kuamat, *SAN* 70729 (SAN); S. slope of G. Lotung Inarat, 1036 m., *SAN* 83312 (A). Lahad Datu: Pulau Sakar, Look Magulang, 39 m., *SAN* 15524 (f) (K, L, SAN, SAR); Bakapit, Silabukan Falls, 457 m., *SAN* 52956 (K, L, SAN); Mt. Silam, 457 m., *SAN* 22711 (SAN). KALIMANTAN. Timur: Nonoekan, 3 m., *bb* 26213 (?) (BO, L); W. Kutei, Belajan R., Mt. Palimasan near Tabang, *Kostermans* 12913 (f) (BO, CANB, K, L, P, SING); bij L. Petah, 800 m., *Endert* 3209 (f) (BO, L). Barat: between S. & G. Kenepai, *Hallier* 1948 (A, BO, K, L); Bengkajang, G. Bawang, 1400 m., *bb* 9667 (BO); Palo, *Becking* 23 (f) (BO).

ECOLOGY. Common in kerangas forest on acid and often sandy soil, sometimes in waterlogged places; 13–1860 m. alt. Unusually plastic in form: "procumbent shrub 2 ft. tall rooting along branches" (*Purseglove* 5604); "cushion plant" 20–40 cm. tall (*S* 4447); "shrub 6"–1 ft. high" (*Sinclair* 10317)—the last

specimen, at least, is fertile. Near Sandakan, Sabah, to 42 cm. d.b.h.; other individuals nearby somewhat smaller. Flowering February to June; somewhat less frequently July to December. Fruiting January to November (June and December on Malay Peninsula); fruit yellowish to grayish.

GERMINATION AND YOUNG PLANT. The radicle breaks the stone near the base of the seed. The seedling has four to six (or seven) pairs of scale leaves and (one or) two pairs of expanded leaves, all separated by well-developed internodes; the internode between the cotyledons and the first pair of scale leaves is ca. 5(–11) mm. long. The terminal bud is at least initially functional, and young plants ca. 30 cm. tall are erect (*Stevens et al.* 381A).

Calophyllum nodosum is distinguished by its small leaf blades with the midrib above surrounded by raised lamina and below level or slightly depressed; its axillary innovations with basal scars; and its small fruits with a thin outer layer and a thin stone wall. The epithet *nodosum* alludes to the rather closely set nodes, which are especially prominent after the leaves have fallen off.

Calophyllum nodosum is difficult to separate from *C. pulcherrimum* when not in fruit, and it appears also to be related to *C. depressinervosum*; for the differences separating these species see TABLE 11 and the discussion after *C. pulcherrimum*. *Calophyllum nodosum* is also related to *C. complanatum* (q.v.).

Calophyllum nodosum is extremely variable in leaf size, shape, and—to a certain extent—color on drying. Specimens from the 4th Division of Sarawak (Miri: *S* 24064) and from Batu Ketam and Bukit Patoi in Brunei have a narrowly elliptic to obovate lamina 2.5–4.4(–7.5) by 0.15–0.75(–1) cm. and are at first sight different from the other specimens. *S* 24064 is in fruit; the fruits are somewhat smaller (4 mm. long) than normal. In all other features the narrow-leaved specimens agree well with the broader-leaved ones. They appear to represent one extreme of the considerable variation in leaf shape and size shown by *C. nodosum*, and they grow in the same habitat; it does not seem worthwhile to give them formal recognition.

The terminal buds in mature plants of *Calophyllum nodosum* are sometimes functional; those of the young plants seen were functional.

Specimens of *Calophyllum nodosum* from Borneo agree well with those from southern Malaya, despite the considerable distance between the two areas. Ridley (1901, *loc. cit.*; as *C. microphyllum*) suggested that *C. nodosum* may also occur on Gunong Pantii, Johore. The apparent absence of *C. nodosum* from Sumatra is perhaps surprising in view of the abundance and rather wide altitudinal range of the species in Borneo.

Calophyllum microphyllum T. Anderson is lectotypified by *Maingay* 2576 at Kew. Anderson also cited specimens collected by Lobb and Griffith.

58. ***Calophyllum depressinervosum*** M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 335. *pl.* 17. 1956; *C. depressinerve* Wyatt-Smith, Malayan Forest Rec. 17: 113. 1952, *nomen*; Kochummen, Malayan Forest Rec. ed. 2. 17: 220. 1965; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 15. 1967; Corner & Watanabi, Illus. Guide Trop. Pl.

181. *fig.* 1969; T. C. Whitmore, *Tree Fl. Malaya* 2: 179. 1973; Corner, *Gard. Bull. Singapore Suppl.* 1: 104. 1978. TYPE: Malaya, Pinang, Moniot's Road, 1000 feet [305 m.], May 1886, *Curtis* 830 (holotype, SING; isotypes, K, SING). FIGURE 21, f.

Calophyllum sp. near *floribundum* Hooker f.; *Curtis*, *Jour. Straits Branch Roy. Asiatic Soc.* 35: 79. 1894.

Tree 4–36 meters tall, d.b.h. to 86 cm.; trunk without buttresses or spurs; outer bark brown to yellowish, with shallow, rather numerous, short, boat-shaped fissures, not hoop marked, the inner surface (dark) brown (blackish); under bark reddish to red-brown; inner bark dark red to pink; latex yellow, clear, or becoming cloudy, or cloudy, always sticky. Branches $\pm$ pendulous.

Twigs slightly flattened, 1–1.7(–2.5) mm. across, obscurely 4-angled, soon becoming rounded, drying brown, glabrous; axillary innovations with 1 to 3 pairs of scars within 3 mm. of base; internodes (0.5–)1–6 cm. long; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, spreading, not conspicuous; terminal bud plump to conical, 1.5–2.2 mm. long, with short, subadpressed, brownish indumentum (hairs, FIGURE 20, m), usually not functional, underdeveloped internode absent. Petiole 3.5–8 mm. long, (deeply) concave above, convex below, glabrous; lamina ovate to obovate or subelliptic, 3.2–10 by 1.2–4.1 cm., strongly acuminate at apex, acumen ca. 1 cm. long, cuneate to acute at base, slightly and distantly undulate and not recurved to slightly so at margin, thinly coriaceous (rarely coriaceous), drying umber to olivaceous above and cinnamon to sabelline below, glabrous, the midrib above gradually narrowed from base, slightly raised (adjacent leaf raised), 0.1–0.25(–0.35) mm. wide at midpoint, below flat to depressed, striate (rarely somewhat raised), the venation on both surfaces subobscure (subapparent), raised, latex canals frequently (and rarely veins) impressed above, 4 to 10 veins/5 mm., angle of divergence 55–70°. Inflorescences from foliate axils along stem, with 7 to 13 flowers; unbranched, the axis 0.5–5 cm. long, glabrous, lowest internode to 2 mm. long; bracts unknown; pedicels (0.25–)0.4–1.3 cm. long, glabrous, slender; to 1 mm. thick in fruit. Flower (?)hermaphroditic; tepals 4, the outer two broadly ovate, ca. 3 mm. long and across, the inner two obovate, ca. 5.5 by 2.5 mm.; stamens ca. 40, the filaments to 3 mm. long, the anthers subelliptic, 0.4–0.7 mm. long, rounded to retuse at apex; ovary ca. 1.2 mm. long, the style ca. 2 mm. long, the stigma peltate, ca. 0.4 mm. across, (?)lobed. Fruit spherical, 0.8–1.1 cm. long and across, apiculate, drying orange-brown, smooth or broadly wrinkled, wrinkles rounded; outer layer not detaching cleanly from stone, 0.2–0.7 mm. thick, with large air spaces developing; stone ellipsoid, 6–8 by 5–6.5 mm., rounded at apex, the walls less than 0.1 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Cambodia and Thailand to Borneo, excluding Java (MAP 22).

SELECTED SPECIMENS SEEN. **Cambodia:** Pursat, entre Anlong Krauch et Veal Veng, 500 m., *Martin* 1797 (P). **Thailand:** Chantabuli, *anon.*, 13 Aug. 1933 (BKF). **Malaya.** KEDAH: Gunong Jerai F.R., *KEP* 7745 (K, KEP, SING); Bukit Lada Acheh, *KEP* 7570 (KEP); Gunong Inas F.R., *FRI* 4632 (KEP); Perangin

TABLE 11. Differences between *Calophyllum pulcherrimum*, *C. no*

	<i>C. pulcherrimum</i>
LAMINA	
LENGTH (cm.)	(2.7-)4-8(-11)
APEX ACUMINATE	+
VENATION DENSITY (veins/5 mm.)	7 to 13 (to 17)
LATEX CANALS IMPRESSED WHEN DRY	-
VEINS VISIBLE ON LOWER SURFACE	+(and sometimes latex canals)
CINNAMON-SABELLINE BELOW WHEN DRY	-
FRUIT	
LONGER THAN 1.4 CM.	+
OUTER LAYER AT LEAST 1 MM. THICK	+
STONE WALLS AT LEAST 0.3 MM. THICK	+
SEED AT LEAST SOMETIMES POLYEMBRYONIC	-(?)
YOUNG PLANT CA. 20 CM. TALL, ERECT	-

MAP 22. Distribution of *Calophyllum depressinervosum* in Southeast Asia and Malesia.

F.R., 90 m., *KEP* 79284 (KEP); Enggang F.R., 37 m., *KEP* 74991 (KEP). PINANG: Tiger Hill Road, 457 m., *Haniff* 265 (C, UC). PERAK: road from Kampung Ayer to G. Bubu massif, 396 m., *FRI* 13898 (A, K, KEP, SAR, SING); Kirita, K[eledan] Saiong F.R. *KEP* 65947 (KEP); Ulu Kenderong, *KEP* 11038 (KEP). SELANGOR: Kpong, Bukit Lagong F.R., 150 m., *KEP* 98701 (A, K, KEP, SAR, SING); Kuang, *KEP* 22059 (KEP, SING); Bangi F.R., Kajang, *KEP* 14578 (K, KEP, SING); Sungei Buloh F.R., *KEP* 14926 (KEP). NEGRI SEMBILAN: Kuala Pilah, Kepis F.R., *KEP* 62954 (A, BO, K, KEP, SING); Hutan Simpon Paseh, *KEP* 100176 (KEP). KELANTAN: Ulu Temiang F.R., *KEP* 104281 (A, K, KEP, L, SAN, SING); G. Rabong, 366 m., *Soepadmo & Mahmud* 1198 (A, K, KEP, KLU, L, SING); Bukit Hubil, 762 m., *KEP* 98808 (A, BO, KEP, SING); Bukit Lina, 762 m., *KEP* 98801 (KEP); Kemahang F.R., 30 m., *KEP* 93626 (KEP). TRENGGANU: 3 km. N. of Kuala Trengganu, *FRI* 20289 (KEP). PAHANG: Jengka F.R., Temerloh, *KEP* 98594 (K, KEP, SAN, SAR); Mentakab, *KEP* 7922 (KEP); G. Tahan, *Wong & Wyatt-Smith* 49 (KEP). JOHORE: Mawai, *Corner s.n.*, 7 Oct. 1934 (KEP, SING); Kluang F.R., 30 m., *KEP* 69922 (KEP); Mersing, G. Arong F.R., 30 m., *KEP* 84703 (KEP); Labis, Segamat, Mambai F.R., *KEP* 69862 (KEP). **Sumatra and adjacent islands.** RIAU: Lingga, P. Singhap, oetan darat Njakar (Bakong), 150 m., *bb* 2043 (?) (BO, L); Ngina, *Ri/I-8* (BO). BARAT: Loeboek Sikaping, Tandjoeng Boengi, 370 m., *bb* 6502 (BO). UTARA: Sibolga, P. Poene, 10 m., *bb* 3783 (BO); Baroes, Pangkalan Tapoes, 25 m., *bb* 29524 (BO, L); Morsala

Is., Silabua, 10 m., *Kostermans' collector* 13, Jan. 1951 (A, BO, SING). BANGKA: W. Bangka, Penganah, 30 m., *bb* 26138 (BO, SING). BORNEO. SARAWAK. 1st Division: Sadong, Sabal F.R., *S* 13454 (A, BO, K, L, SAN, SAR). 2nd Division: Bukit Ubah Ribu, Ulu Sungei Kaup, 610 m., *S* 33782 (K, KEP, SAN, SAR). BRUNEI. Temburong, mile 1¼ Bangar-Batu Apas road, 9 m., *SAN* 17093 (A, BO, K, KEP, L, SAN, SING). SABAH. Sipitang: Mile 8, Sipitang road, *SAN* 35125 (KEP, L, SAN, SAR, SING); Mesapol F.R., *SAN* 73347 (SAN). Papar: Mandahan Hill, 225 m., *SAN* 78001 (SAN). Sandakan: Sepilok Extension, sea level, *SAN* 24912 (K, KEP, L, SAN, SING). Tawao: Brantian, 30 m., *Stevens et al.* 435 (A); Brassey Range, 660 m., *Stevens*, sight record. KALIMANTAN. Tengah: Midden Doeson, Lemoedajak, 60 m., *bb* 11596 (BO). Barat: Moeara Kajang, 10 m., *bb* 7465 (BO).

ECOLOGY. Mixed dipterocarp forest, on ridges and other well-drained places, sometimes in forest approaching kerangas forest (Sarawak) or swamp forest (Johore—Corner, *loc. cit.*; the single tree I saw in a swamp was on an eminence ca. 1.5 m. above surrounding swamp); to 762 m. alt. In Malaya flowering January, May, November, and December; fruiting January to March and May, November, and December. In Borneo fruiting March, April (most), and June. Ripe fruit yellowish.

GERMINATION AND YOUNG PLANTS. Vigorously growing young plants up to 1.2 meters tall with functional terminal buds have been seen (Sarawak, Sabal Tapang).

Calophyllum depressinervosum can be most readily recognized by its moderate-sized to small leaf blades that are strongly acuminate at the apex, that usually have obscure, rather distant venation when dry, and that often have clearly impressed latex canals. The lower surface of the dried leaf blades is often a yellowish brown, at least in specimens that are not too old. The flowers have four tepals. The fruits are small (about 1 cm. long), and the stone has thin walls. The epithet *depressinervosum* really refers to the latex canals, which are depressed when the leaf is dry (note that the veins are rarely depressed!).

Calophyllum depressinervosum is similar to *C. nodosum* and, to a lesser extent, to *C. pulcherrimum*; some differences between the species are listed in TABLE 11. *Calophyllum depressinervosum* also has less dense venation than does *C. nodosum*: four to ten veins/5 mm. vs. six to thirteen (to fifteen) veins/5 mm. Leaf blades and fruits of specimens of *C. nodosum* from Sarawak (e.g., *S* 17236, 21136, 21243) dry a similar color to those of *C. depressinervosum*, but the species are not otherwise similar.

The above-cited specimens of *Calophyllum depressinervosum* from Cambodia and Thailand are sterile, but there is no doubt as to their identity. The specimens from Kalimantan and some from elsewhere in Borneo (e.g., *SAN* 17093, from Brunei) are robust, with twigs up to 2.5 mm. in thickness, and the leaf blades are rather coriaceous and tend to dry boat shaped. *SAN* 17093 has fruits characteristic of *C. depressinervosum*, albeit borne on rather short pedicels. The specimens from Kalimantan are sterile.

59. *Calophyllum complanatum* P. F. Stevens, sp. nov.

FIGURE 21, c.

A speciebus aliis *Calophylli* in lamina lingulata vel oblonga basi cordata costa supra lamina elevata circumdata infra non nisi vel leviter elevata, et inflorescentia axillari internodio infimo 0–1 mm. longo, differt.

Tree ca. 9 meters tall, d.b.h. ca. 5 cm.; outer bark yellow-green.

Twigs strongly flattened, 1.2–2.6 mm. across, strongly 4-angled, drying brown, glabrous; axillary innovations with pair of basal scars and often another pair within 5 mm. of base; internodes 2–4 cm. long; uppermost pair of axillary buds rounded, less than 0.5 mm. long, inconspicuous; terminal bud plump, 1.5–3 mm. long, with short, brown, tomentose indumentum (hairs, FIGURE 20, n), underdeveloped internode absent. Petiole 1–2 mm. long, shallowly concave above, convex below, glabrous; lamina lingulate to suboblong, 9.5–14.8 by 1.5–4.5 cm., subacuminate to acute at apex, cordate at base, slightly undulate and recurved at margin, thinly coriaceous, drying grayish sepia above and sabelline below, glabrous at maturity, the midrib above abruptly narrowed near base, raised, surrounding lamina also raised, 0.1–0.25 mm. wide at midpoint, below raised, angled to substriate, the edges subdepressed, the venation $\pm$ apparent above, slightly raised, below subobscure, latex canals slightly impressed above and strongly impressed below, 5 to 7 veins/5 mm., angle of divergence ca. 80° . Inflorescences from foliate axils, with ca. 7 flowers, unbranched, the axis 1.2–3 cm. long, glabrous, slender, lowest internode to 1 mm. long; bracts not known; pedicels 0.7–2.2 cm. long, glabrous. Flower (?) hermaphroditic; tepals 4, the outer pair ovate-elliptic, ca. 3.3 by 2 mm., the inner pair $\pm$ obovate, 5–6 by 3–4 mm.; stamens ca. 75, the filaments to 3 mm. long, very slender, the anthers elliptic, 0.4–0.5 mm. long, retuse at apex; ovary ca. 0.7 mm. long, the style ca. 2.7 mm. long, the stigma slightly expanded, ca. 0.3 mm. across. Immature fruit (?) subspherical, ca. 5 mm. long; outer layer ca. 0.2 mm. thick; stone with walls ca. 0.2 mm. thick.

TYPE: Sabah, Kinabatangan, Karamuak, Lamag, east of Sg. [Sungei] Meliau, 45 m., 17 June 1965, *SAN* 53254 coll. *Teorodop* (holotype, K; isotype, SAN).

DISTRIBUTION. Northeastern Borneo (MAP 20).

ADDITIONAL SPECIMEN SEEN. **Borneo.** SABAH. Labuk & Sugut: Mile 86, Bukit Tangkunan, 425 m., *Stevens et al.* 407 (A).

ECOLOGY. On soils derived from ultramafic rock, 45–425 m. alt. Flowering in June.

Calophyllum complanatum can readily be distinguished from the other species of the genus even when sterile: its axillary innovations have basal scars, and its leaf blades are cordate at the base, with the midrib on the upper surface flat and surrounded by raised lamina. The twigs are notably flattened, hence the specific epithet.

Calophyllum complanatum is probably most closely related to *C. nodosum*, which also has innovations with basal scars, the upper surface of the lamina

with the midrib broadly raised, inflorescences with short basal internodes, and flowers with four tepals. *Calophyllum nodosum* differs most obviously from *C. complanatum* in its smaller leaf blades that are never cordate at the base. The two species grow within a few meters of each other on Bukit Tangkunan (for *C. nodosum* see *Stevens et al.* 408); young plants of *C. complanatum* up to 3 meters tall were quite common but showed little variation.

The fruits of *Calophyllum complanatum* are known only from the isotype at Sandakan. These fruits are small and have been distorted during pressing, but they have a well-defined stone wall ca. 0.2 mm. thick. It is therefore likely that the mature fruits of *C. complanatum* are less than 1 cm. long.

60. ***Calophyllum pulcherrimum*** Wall. ex Choisy, Mém. Guttif. Inde, 41. 1849, Mém. Soc. Phys. Hist. Nat. Genève 12: 421. 1851; Wall. Catal. 4848. 1831, *nomen*; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 274. 1862; T. Anderson in Hooker f. Fl. Brit. India 1: 271. 1874, *pro parte*; Kurz, Jour. Asiatic Soc. Bengal, II. 39: 64. 1870; Pierre, Fl. Forest. Cochinch. 1: pl. 104B. 1885, *pro parte*; King, Jour. Asiatic Soc. Bengal, II. 59: 174. 1890, *pro parte*; Vesque in C. DC. Monogr. Phanerog. 8: 570. 1893, *pro parte*; Ridley, Jour. Straits Branch Roy. Asiatic Soc. 33: 47. 1900, Fl. Malay Penin. 1: 182. 1922, *pro parte*; Heyne, Nutt. Pl. Indonesië. ed. 3. 1: 1085. 1950; M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 334. 1956; Gilliland, Common Malay Pl. 37. 1958; Kochummen, Malayan Forest Rec. ed. 2. 17: 220. 1965; Burkill, Dict. Econ. Prod. Malay Penin. ed. 2. 1: 416. 1966; Corner & Watanabi, Illus. Guide Trop. Pl. 183. fig. 1969; T. C. Whitmore, Tree Fl. Malaya 2: 181. 1973; H. Keng, Gard. Bull. Singapore 28: 244. 1976; Corner, Gard. Bull. Singapore Suppl. 1: 104. 1978. TYPE: Singapore, Sept. 1822, Wallich dist. 4848, *pro parte* (holotype, G; isotypes, BM, E, FI, G, K, M, MEL, NY, P, W). FIGURE 21, d.

C. plicipes Miq. Fl. Indiae Batavae Suppl. 1(3): 499. 1861; Kurz, Nat. Tijdschr. Nederl.-Indië 27: 192. 1864; F. Mueller in Walp. Ann. Syst. Bot. 7: 357. 1868. TYPE: Bangka, prope Djeboes, *Teysmann*, HB 3209 (holotype, U; isotypes, BO, L).

C. mesuaefolium Wall. Catal. 4850. 1831; Planchon & Triana, Ann. Sci. Nat. Bot. IV. 15: 293. 1862. *Nomen*.

C. retusum auct., non Choisy; King, Jour. Asiatic Soc. Bengal, II. 59: 176. 1890, *pro minore parte*.

C. pulcherrimum Wall. var. *gracile* (Miq.) Boerl. Catal. Horto Bogor. 2: 82. 1901, *quoad spec. cit.*

C. foetidum Ridley, Jour. Straits Branch Roy. Asiatic Soc. 54: 18. 1910, *pro minore parte*.

Tree 10–23(–30) meters tall, d.b.h. to 40 cm.; trunk rarely with buttresses to 1 meter tall; outer bark yellowish brown, often mottled, with vertical lines of lenticels, or cracked (rarely slightly scaly), or with boat-shaped fissures, the inner surface red-brown to reddish black; under bark green-brown, red, or blackish, outer bark often detaching only with difficulty; inner bark pinkish

to mid-red; latex usually clear yellow (rarely cloudy yellow or brown-yellow), sticky. Branches often pendulous.

Twigs somewhat flattened, 0.7–1.2 mm. across, strongly 4-angled, drying brown or dark brown, glabrous; axillary innovations with 1 (or 2) pair(s) of basal scars; internodes 1–4.5 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, spreading, inconspicuous; terminal bud conical (plump), 0.7–1.3 mm. long, with subadpressed, brownish indumentum (hairs, FIGURE 22, j), usually not functional, underdeveloped internode absent (–3.5 mm. long). Petiole 3–11 mm. long, deeply concave above, convex below, glabrous; lamina elliptic to suboblong (rarely obovate), (2.7–)4–8(–11) by (0.8–)1.6–3.4(–4.2) cm., bluntly acuminate (rarely acute to subrounded) at apex, acute to attenuate toward base, very base minutely rounded, slightly undulate and not recurved at margin, coriaceous, drying umber to sepia above and umber to sabelline below (often with thin, grayish, waxy covering, especially on the upper surface), glabrous, the midrib above gradually narrowed from already narrow base, raised, surrounding leaf raised, 0.15–0.3(–0.55) mm. wide at midpoint, below flat to depressed, striate, the venation subobscure to apparent above and below, slightly raised, 7 to 13 (to 17) veins/5 mm., angle of divergence 65–70(–80)°. Inflorescences from foliate axils along twigs, with 7 to 11 (to 17) flowers, unbranched, the axis 1.5–4.5 cm. long, glabrous, lowest internode less than 2.5 mm. long; bracts ovate to obovate, ca. 2 mm. long, soon deciduous; pedicels 0.4–3 cm. long, glabrous, slender. Flower (?)hermaphroditic; tepals 4 (rarely 8), the two outer ovate to elliptic, 3.5–5.5 by 2.5–4 mm., very rarely with few hairs near apex on back, the inner ones $\pm$ obovate to elliptic, 6–9 by 2.5–3.5 mm., rarely glabrous; stamens (25 to) 65 to 140, the filaments to 5 mm. long, connate for up to 1 mm., the anthers oblong, 0.6–1.2 mm. long, $\pm$ retuse at apex; ovary 1.3–1.5 mm. long, the style 2–3.2 mm. long, the stigma peltate, 0.4–0.8 mm. across, 3-lobed. Fruit ovoid to spherical, 1.5–1.7 by 1.2–1.8 cm., when young ovoid, sharply pointed at apex, smooth, when older apiculate or not, drying brown, prominently wrinkled; outer layer detaching cleanly from stone, 1–2.2 mm. across, compact; stone subspherical, 1–1.3 by 0.95–1.3 cm., rounded at apex, the walls 0.3–0.5 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. Southern Malaya to western Borneo, excluding Java (MAP 20).

FIGURE 22. Hairs (from terminal bud). a, b, *Calophyllum cucullatum* (BS 34518). c, d, *C. oliganthum* (BS 34520). e, f, *C. andersonii*: e, *S* 24679; f, *Haviland* = 1812. g, h, *C. pelewense* (Kanehira 386). i, *Calophyllum* sp. 61 (*S* 4732). j, *C. pulcherrimum* (Shah & Shukor 2395). k, *C. roseocostatum* (*S* 26299). l, *C. stipitatum* (FRI 3656). m, *C. confertum* (SAN 17146). n–p, *C. praetermissum* (Haviland & Hose 3342), papillae in only one plane (o, p, apex and base of hair ca. 500 μ m. long). q, *C. flavo-ramulum* (FRI 7521). r–t, *C. celebicum* (Cel./II-213), the few thin-walled apical cells fall off, leaving flat tops. Scale = 60 μ m.

SELECTED SPECIMENS SEEN ("f" denotes Bornean specimens with fruits). **Malaya.** NEGRİ SEMBILAN: Pengkalen Kempas, *KEP* 4213 (K, SING); Pasir Panjang, *KEP* 4202 (K, SING); Port Dickson, Cape Rachado, 120 m., *KEP* 71340 (KEP); Sungei Menyala F.R., 45 m., *KEP* 64091 (KEP). MALACCA: Pulu Besar, *Maingay* 1065 (*Kew dist.* 169, *pro parte*) (K); Sungei Udang, *Goodenough* 1738 (SING, w); Merlimau, *Derry* 156 (SING); Bukit Sabukor, *Derry* 104 (BM). PAHANG: Sungei Rompin, Bukit Leuting, *KEP* 3230 (K, SING); E. edge of Chini F.R., 150 m., *FRI* 14560 (A, K, KEP, SING); Baloh F.R., *KEP* 6842 (K); Lesong F.R., ridge N. of Sungei Jekatih, 180 m., *FRI* 20006 (KEP, SAR); Menchali F.R., *KEP* 29655 (KEP); Temerloh, 64³/₄ miles Maran Road, 180 m., *KEP* 77964 (KEP). JOHORE: Sungei Kayu, *SFN* 31990 (K, KEP, SING); G. Ledang (Mt. Ophir), Ulu Sungei Belemang, *FRI* 12327 (A, K, KEP, SING); Banang F.R., 270 m., *FRI* 2122 (A, K, KEP, SAN, SING); 10th mile Mersing-Endau Road, *FRI* 2783 (K, KEP, SING); Tg. Penawar, Johore Coast, 15 m., *FRI* 7624 (K, KEP, SING); Pulau Tinggi, *KEP* 70936 (KEP); Batu Pahat, Soga F.R., *KEP* 79519 (KEP); G. Arong F.R., *KEP* 94884 (KEP, SING); G. Pulau F.R., 455 m., *FRI* 17553 (KEP); G. Lambak microwave station, Renggam F.R., *FRI* 17755 (K, KEP, SAR, SING); Panchor, Tg. Sewat Rogei, *KEP* 62814 (KEP); Kota Tinggi, 115 chains in from E. coast, 60 m., *KEP* 118195 (A, K, KEP, SING). **Singapore:** Seletar Reservoir, Mandai Road, *Shah & Shukor* 2370 (A, BRI, C, KEP, KLU, SING); Tanjong Gul, *Sinclair* 10762 (E, FI, G, K, SING); Fairy Point, Changi, *Hullett* 801 (K, SING); Pulau Damar Laut, *Sinclair* 5299 (E); Chan Chu Krang, *Ridley s.n.*, Nov. 1894 (SING); MacRitchie Reservoir, *SFN* 39477 (B, K, M, NY, SING); Bukit Timah F.R., *SFN* 34440 (A, BO, K, LAE, SING); Tampenis, *Ridley* 4639A (FI, SING); Garden Jungle, *Ridley* 13305 (BM, K, SING); Keranji, *Ridley* 260 (BM, SING). **Sumatra and adjacent islands.** RIAU: Riouw, Tandjong Pinang, Kelong, P. Ngalm Besar, 12 m., *bb* 11444 (BO); Lingga, P. Singkep, Tandjong Batang, 15 m., *bb* 4019 (BO); Marok Toewa bij Soengei Air Tawar, *bb* 1687 (BO). DJAMBI: Djambi, Sei Oeron, 43 m., *bb* 12277 (BO). SELATAN: Banjoeasin en Koeboestrecken, 15 m., *134 E 1 P* 1036 (BO, L); Koemering Oeloe, 80 m., *Grashoff* 565 (BO); Kaju Agung, *Kostermans* 14089 (L). BANGKA: Lobok Besar, G. Pading, 20 m., *Kostermans & Anta* 964 (A, BO, K, KEP, LAE, NY, SING); G. Mangkol, 50 m., *Kostermans & Anta* 716 (A, BO, K, LAE, NY, P, SING); prope Djeboes, *Teysmann, HB* 3214, *pro parte* (BO); G. Maras, 20 m., *Kostermans & Anta* 1241 (A, BO, CANB, K, KEP, LAE, P, SING); Belinjoe, 28 m., *Grashoff* 72 (BO, L); Muntoh, Majang, *bb* 7302 (BO); Soengei Liat, *Teysmann, HB* 7565 (C, FI, MEL), G. Rebo, 295 m., *Bünnemeijer* 1886 (BO, L); Plangas, *Teysmann, HB* 3251 (BO); S. Bangka, Mindik, 25 m., *bb* 10689 (BO), Toboali, *bb* 1941 (BO, L). BELITUNG: Tandjong Padan, Bantan, 30 m., *bb* 7377 (BO); N. von Manggor, *Ham* 18 (BO). **Borneo and adjacent islands.** SARAWAK. 1st Division: Mt. Santubong, *S* 21510 (f) (A, BO, K, KEP, P, SAN, SAR, SING); Matang, *Beccari PB* 1647 (f) (FI); Bako Natl. Park, summit of Bukit Gondol, 270 m., *S* 20924 (A, K, SAN, SAR, SING); Serian, G. Penrissen, *S* 16306 (f) (A, BO, K, SAN, SAR, SING); G. Buri, 490 m., *S* 36950 (f) (SAR). KALIMANTAN. Timur: Nunukan, 100 m., *Kostermans* 9024 (A, BO, CANB, K, L, SING); W. Koetai, near M. Moentai, 15 m., *Endert* 2009 (A, BO, K), Mt. Maranga on Tandjung Plateau, 200 m., *Kostermans* 12542 (BO, K, L, P, SING); E. Koetai, Godong Lengah (Bengalon), 15 m., *bb* 7952 (BO); Loa Djanan, W. of Samarinda, *Kostermans* 9868 (A, BO, K, KEP, L, P, SING); Sg. Tiram complex, SW. of Samarinda, *Kostermans* 6056 (A, BO, K, L). Selatan: Bangarmassing, *Motley* 561 (K, P); Kintap, Pleihari, *Dachlan* 2049 (BO, L); Martapoera, Kaläan, 400 m., *bb* 12040 (BO), G. Melati, *Dachlan* 2156 (BO); G. Pamatton,

Korthals s.n. (f) (L). Tengah: Karrau R., *S. Müller s.n.* (L); Poeroek Tjahoe, M[oear]a Djaan, 100 m., *bb 10485* (BO), M[oear]a Laoeng, 80 m., *bb 10099* Kelapeh, 200 m., *bb 1033* (BO). Barat: Karimata Arch., Poelau Seroetoe, *Mondi[h]* 170 (f) (BO, K, L, NY, SING, U); Pontianak, *Dedi 865* (BO); Melawi Tjatit, B. Gontoeck, 180 m., *bb 27014* (f) (A, BISH, BO, K, NY, P, SING); B. Tengkoarjoeng, 450 m., *bb 25115* (BO, L, MO); Afd. Beneden Matan, S. Kendawangan, 10 m., *bb 14428* (BO, L). Java. BARAT: cult. in hort. Bogor. (seed from Bangka) sub *VI C 47* (BO, BRI, G, K, LAE, MO, NY, P, SING, US).

ECOLOGY. Mixed dipterocarp forest, to 300(–590) m. alt. Sometimes on sandy soil; on beach; on dry land with patches of low scrub; in swamp forest. Flowering all year, mostly June to September (flower scented, sometimes foetid (*Ridley 13305*)); fruiting October to June (fruit dull green). Fruit eaten by fruit bat (*Pteropus edulis*) in Malaya (*Ridley, 1930*); however, this report may properly refer to fruits of *C. tetrapterum*.

Anthony (1974) reported several galls on *Calophyllum pulcherrimum* in Singapore. A psyllid made the leaf revolute with undulations and crisped edges; the midrib became abaxially curved, and the petiole twisted. A possibly undescribed species of the midge genus *Bruggmanniella* caused fleshy spheroid galls, which were often attached to the midrib on the abaxial surface of the leaf; another midge gall caused swellings of the stem, petiole, and midrib. A moth larva formed an elongated swelling of the lamina roughly parallel to the midrib.

GERMINATION AND YOUNG PLANT. The radicle emerges after the stone wall to one side of the base has been broken. The seedling has usually three, but sometimes up to five, pairs of scale leaves and two pairs of normal leaves, all separated by well-developed internodes; the first pair of scale leaves is borne 0.5–1.8 cm. from the cotyledonary node. The terminal bud may produce the first flush of leaves; scale leaves are not produced at the beginning of this flush. However, in the forest even the first flush is often produced by an axillary bud (the terminal bud being damaged?), subsequent flushes seem always to be produced by axillary buds, and there are scale leaves at the bases of the innovations. The young plant is strongly arched, but as the plant gets older the lower part of the stem straightens. (*Stevens et al. 47*; seedlings from *Stevens et al. 333* grown at Kuching but unfortunately later eaten by a dog. Details of the young plant sent by P. J. Martin.)

LOCAL USES. The wood is good for poles, fishing stakes, masts, and similar objects, and is also used in construction and for ships' knees. The fruit is sour but edible.

Specimens of *Calophyllum pulcherrimum* can be recognized by their usually nonfunctional terminal buds, axillary innovations with basal scars, and leaf blades with the midrib flat to depressed below and broadly raised and continuous with the leaf surface above. The fruit is ovoid, at least 1.5 cm. long, and strongly wrinkled when dry; the outer layer of the fruit is 1–2.2 mm. thick, and the stone walls are 0.3–0.5 mm. thick. The epithet *pulcherrimum* means "most beautiful," a not inappropriate name for the often very floriferous specimens of this species.

Sterile or flowering specimens of *Calophyllum pulcherrimum* are very difficult to distinguish from *C. nodosum*, and some of the specimens of *C. pulcherrimum* from Kalimantan cited above may be wrongly identified. *Calophyllum nodosum* in turn is very similar in both flower and fruit to *C. depressinervosum* (FIGURE 21), although vegetatively the two can be distinguished fairly easily. The differences between the three species are summarized in TABLE 11, but work is needed to confirm the possible differences in seedling and in the growth of the young plant. All three species were found growing by a logging road at Sabal Tapang (Sarawak), and in undisturbed forest there trees of *C. pulcherrimum* and *C. depressinervosum* were growing within 30 meters of each other on a ridge.

Calophyllum pulcherrimum has often been confused with *C. floribundum* (= *C. tetrapterum* var. *tetrapterum*), and although Henderson and Wyatt-Smith (*loc. cit.*) clearly separated the two, the confusion still seems to persist, to judge by determinations on specimens. The two species can be separated very easily, even in the absence of flowers and fruits. *Calophyllum tetrapterum* has a functional terminal bud, its axillary innovations usually lack basal scars, and the midrib on the lower (and usually also on the upper) surface of the lamina is clearly raised (FIGURE 7, c). The fruits of *C. tetrapterum* are usually less than 1.3 cm. long and lack the relatively thick outer layer and stone walls of those of *C. pulcherrimum*. Although the leaf margin of *C. tetrapterum* is often markedly paler than the rest of the blade when dry, this is not always the case, and the margin of the blade may be a similarly pale color in some specimens of *C. pulcherrimum*.

The confusion between the two species is of long standing. There are specimens of *Calophyllum floribundum* sensu stricto in some herbaria mounted with the label of Wallich dist. 4848, the type number of *C. pulcherrimum*. One of the three numbers collected by Maingay and cited as *C. floribundum* in the original description of that species is a specimen of *C. pulcherrimum* (see the discussion after *C. tetrapterum*). Some synonyms of *C. tetrapterum* have been cited under *C. pulcherrimum*, and Boerlage (*loc. cit.*) reduced *C. gracile*, a synonym of *C. tetrapterum* and a good match with the lectotype of *C. floribundum*, to varietal rank under *C. pulcherrimum*. Specimens of *C. pulcherrimum* with the name *C. pulcherrimum* var. *gracile* were widely distributed (cult. Hort. Bogor. sub VI C 47). Finally, on one sheet of Pierre 3645 at Paris (*C. tetrapterum* var. *tetrapterum*, collected in Cambodia), there are some small pieces of fruiting *C. pulcherrimum*. I have not seen any other material of *C. pulcherrimum* from north of Malaya, and the fragments of this species on Pierre 3645 probably came from Maingay's specimen that Pierre (*loc. cit.*) used to illustrate the fruits of his *C. pulcherrimum* (properly *C. tetrapterum* var. *tetrapterum*).

61. *Calophyllum* sp.

Tree ca. 4.5 meters tall; trunk and bark unknown.

Twigs slightly flattened, 1.2–1.8 mm. across, rounded to obscurely 4-angled, drying brown, sparsely puberulent when very young; axillary innovations with basal scars; internodes 0.8–3.2 cm. long, first-developed internode often

twice as long as others; uppermost pair of axillary buds rounded, ca. 0.6 mm. long, suberect, sometimes subglabrous; terminal bud plump, 1–1.5 mm. long, with subadpressed, brown indumentum (hairs, FIGURE 22, i), underdeveloped internode to 1 mm. long. Petiole 3–4 mm. long, concave above and convex below, puberulent at edge when very young; lamina obovate, 2–3.7 by 0.9–2.3 cm., rounded to shallowly retuse at apex, cuneate at base, slightly undulate and not recurved at margin, coriaceous, drying umber above and umber or sepia below, glabrous even when young, the midrib above abruptly narrowed at base, flat at first, becoming slightly raised, 0.15–0.25 mm. wide at midpoint, below slightly raised, striate, inconspicuous, the venation apparent above and below, raised, 5 to 7 veins/5 mm., angle of divergence 45–55°. Inflorescences from foliate axils, with 7 to 11 flowers, unbranched, the axis 4–6 cm. long, glabrous, lowest internode and first pair of flowers not developed, next internode 1.8–3.5 cm. long, others 0.8–1.5 cm. long; bracts foliaceous, to 2.6 by 2 cm., persistent; pedicels ca. 8 mm. long, glabrous. Flower (?)hermaphroditic, known only in bud; tepals 8; stamens ca. 120, the anthers elliptic, ca. 0.3 mm. long; stigma peltate. Fruit unknown.

DISTRIBUTION. Known only from one collection made in the 4th Division, Sarawak (MAP 20).

SPECIMEN SEEN. **Sarawak:** Baram, G. Api, 1219 m., 12 July 1961, S 4732 coll. *Anderson* (K, SAR).

ECOLOGY. Exposed submontane forest on limestone hill, 1219 m. alt.

Calophyllum sp. 61 is a distinctive taxon. It has a small terminal bud, axillary (?and terminal) innovations with basal scars, and small leaf blades in which the midrib is flat on the upper surface and more or less raised on the lower. The axillary inflorescences, with their basal scars, foliaceous, persistent bracts, and long, first fully developed internodes are striking. However, until the fruits are known, it seems premature to name this taxon.

62. *Calophyllum pelewense* P. F. Stevens in Fosberg & Sachet, *Smithson. Contr. Bot.* **45**: 12. 1980. TYPE: Pelew Islands, July–Aug. 1929, *Kanehira* 386 (holotype, A; isotypes, BISH, NY). FIGURE 24, f.

C. cholobtaches auct., non Lauterb.; *Kanehira*, *Bot. Mag. Tokyo* **45**: 329. 1931, *Fl. Micronesica*, 233. *fig. 105*. 1933, *Jour. Dept. Agr. Kyushu Imp. Univ.* **4**: 370. 1935.

Tree; trunk and bark not known.

Twigs flattened, 1.5–2 mm. across, strongly 4-angled to subalate, drying brown, glabrous; axillary innovations with basal scars; internodes (0.5–)1–3 (–5.5) cm. long; uppermost pair of axillary buds rounded, ca. 0.5 mm. long, spreading; terminal bud plump, 1–2.5 mm. long, with short, gray, adpressed indumentum (hairs, FIGURE 22, g, h), underdeveloped internode 1–2.5 mm. long. Petiole 0.9–1.5 cm. long, shallowly and narrowly to broadly concave above, convex below, glabrous; lamina elliptic to ovate (rarely obovate), 3.5–10.2 by 2.1–4.9 cm., acuminate (rarely ± rounded) at apex, acute to

attenuate at base, undulate and slightly recurved at margin, coriaceous, drying umber on both surfaces, glabrous, the midrib above gradually narrowed from base, not depressed or slightly so, the edges not raised or slightly so, 0.35–0.6 mm. wide at midpoint, below raised, $\pm$ striate, the venation subapparent on both surfaces, raised, 5 to 10 veins/5 mm., angle of divergence 55–70°. Inflorescences from foliate axils (rarely terminal), with 9 to 17 flowers, unbranched, the axis 1.3–8 cm. long, puberulent at base, lowest internode to 2 mm. long; bracts subobovate, ca. 3.5 mm. long, soon deciduous; pedicels 1–2.5 cm. long, glabrous. Flower (?)hermaphroditic; tepals 8 to 11, the outer pair broadly ovate, ca. 4 mm. long and across, the inner ones obovate, 5.5–6 by 3.5–4.5 mm., glabrous; stamens 125 to 230, the filaments ca. 3 mm. long, the anthers suboblong, 0.8–1 mm. long, retuse at apex; ovary ca. 2 mm. long, the style ca. 2.2 mm. long, the stigma peltate, 0.7–1.2 mm. across, $\pm$ 3-radiate. Fruit probably ellipsoid, ca. 1.5 by 1 cm., rounded at apex, drying vinaceous-brown, wrinkled; outer layer (?)not detaching cleanly from stone, ca. 0.5 mm. thick, with air spaces developing; stone with walls ca. 0.2 mm. thick; spongy layer unknown.

DISTRIBUTION. The Caroline Islands, Palau group (MAP 20).

ADDITIONAL SPECIMENS SEEN. **Caroline Islands:** KOROR, *Raymondus* 334 (?) (WRSL); Palau, Garusamao, *Takamatsu* 1556 (BISH, US); Amiliki [Aimiriik], *Hosokawa* 7216 (BISH); Aimiriik, *Kanehira* 1984 (K, P, NY, US); Almatan [Armitin], 8 m., *Takamatsu* 1525 (BISH); Airai, *Kanehira* 2380 (NY); Ngerikill R., *Fisher* 25 (US), 55 (US); sine loco, *Ledermann* 14489 (K).

ECOLOGY. River banks at landward edge of mangroves. Flowering in March (flower scented); submature fruit in March, young fruit July and August.

Calophyllum pelewense can be recognized by its very short terminal bud; axillary innovations with basal scars; axillary inflorescences with a short basal internode; usually elliptic to ovate leaf blades with rather prominent, distant venation, flowers with eight to eleven tepals; and fruits of moderate size (ca. 1.5 cm. long). The epithet *pelewense* is derived from Pelew (Palau) Islands, where this species grows.

Specimens of *Calophyllum pelewense* have been labeled *C. cholobtaches* (= *C. soulattri*), but the two species are not at all close. *Calophyllum soulattri* has a longer terminal bud, a greenish-drying lamina, a branched inflorescence, flowers with four tepals, and a spherical fruit with a thick, compact outer layer.

63. *Calophyllum pyriforme* P. F. Stevens, sp. nov.

FIGURE 23, a–c.

A speciebus aliis Calophylli quibus fructibus stipitatis habent in lamina longiore magnis tenuiter coriacea apice longe acuminata pagina infra indumento subpersistenti praedita et fructu apice rotundato, non acuto, differt.

Tree 4.5–7.5 meters tall, d.b.h. to 9 cm.; trunk without buttresses; outer bark brown, yellowish, or gray-black, sometimes with shallow fissures, exfoliating in thin scales; inner bark red-brown or yellowish white; latex yellow.

FIGURE 23. a-c, *Calophyllum pyriforme*: a, habit (SAN 64779), $\times 0.5$; b, terminal bud (SAN 21748), $\times 0.75$; c, fruit (SAN 19092), longitudinal section, $\times 1$. d-f, *Calophyllum* sp. 65 (S 23854). d, e, fruit, $\times 1.25$: d, from outside; e, longitudinal section. f, terminal bud, $\times 6$.

Twigs slightly flattened, 2-2.5 mm. across, slightly 4-angled, drying brown, at first tomentose, glabrescent; axillary innovations with basal scars, or scars up to 1.8 cm. from base; internodes (1-)1.5-7(-8) cm. long; uppermost pair of axillary buds rounded, to 2 mm. long, $\pm$ spreading, not conspicuous; terminal bud conical, 4.5-11 mm. long, with short, tomentose, brown indumentum (hairs, FIGURE 27, c), underdeveloped internode absent. Petiole 1-1.7 cm. long, narrowly channeled above, convex below, subsersistently tomentose; lamina elliptic to suboblong, 11.5-23 by (3.7-)5-8.8 cm., abruptly acuminate at apex, acumen to 1.5 cm. long, acute at base, undulate and sharply but

narrowly recurved at margin, thinly coriaceous, drying umber to olivaceous above and honey to pale olivaceous below, tomentose on midrib above and over entire lower surface, the midrib above abruptly narrowed near base, raised, sulcate at first, 0.1–0.2 mm. wide at midpoint, below raised, substrate, the venation apparent to subobscure on both surfaces, raised, 6 to 9 (to 11) veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils (very rarely terminal), with 5 to 9 flowers, unbranched, the axis 1.2–3.5 (–7.5 in fruit) cm. long, subpersistently tomentose, lowest internode (absent to) 3–8 mm. long; bracts narrowly ovate, ca. 4 mm. long, deciduous; pedicels 0.8–1.2 (–2.2) cm. long, subpersistently tomentose. Flower (?) hermaphroditic; tepals 8, the outer pair broadly ovate to elliptic, 5–6 by 4–4.5 mm., short-tomentose on back, the next pair elliptic, 8.5–9.5 by 4–6 mm., the inner ones narrowly elliptic, 8–10 by ca. 3 mm. (rarely ca. 7.5 by 4 mm.); stamens 190 to 265, the filaments to 5.7 mm. long, connate for up to 2 mm., the anthers elliptic-oblong, 0.5–0.8 mm. long, shallowly retuse at apex; ovary ca. 2 mm. long, the style 4–5 mm. long, the stigma peltate, ca. 0.6 mm. across, 4-radiate. Fruit obovoid, 1.7–3 by 1.3–1.6 cm., apiculate, stipe fibrous and 6–10 by 5–7 mm., drying dark brown, sharply wrinkled; outer layer not detaching cleanly from stone, 0.6–1 mm. thick, compact, fibrous; stone ellipsoid, 1.6–1.75 by 1.1–1.3 cm., rounded at apex, the walls less than 0.1 mm. thick, smooth, (?)unmarked; spongy layer thin.

TYPE: North Borneo [Sabah], Bettotan, near Sandakan, 10 Aug. 1927, *SFN 19092* coll. *Boden Kloss* (holotype, L; isotypes, K, LAE, NY, SING, UC).

DISTRIBUTION. Eastern Borneo (MAP 23).

MAP 23. Distribution of *Calophyllum flavo-ramulum* (erect triangles), *C. stipitatum* (stars in solid circles), *C. glaucescens* (half-circles), *Calophyllum* sp. 65 (solid stars), and *C. pyriforme* (inverted triangles) in Malesia. Inset: *C. elegans* (solid circles), *C. roseocostatum* (open circle).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SABAH. Labuk & Sugut: Mile 80 Labuk Road, 150 m., *SAN* 38780 (SAN). Kinabatangan: timber camp at Daramakud, *SAN* 16863 (A, BO, KEP, L, SING); Brassey Range, 620 m., *Stevens et al.* 475A (A); G. Rara F.R., ca. 32 km. NW. of Luasong camp, 366 m., *SAN* 75782 (K, L, SAN, SING); ca. 48 km. NW. of Luasong camp, 488 m., *SAN* 75654 (A, L, SAN, SING); Old Road, Luasong, 27 m., *SAN* 64779 (K, L, SAN). Lahad Datu: Mostyn, Tingkayu area, 90 m., *SAN* 54523 (SAN); N. of Camp 3, Ulu Sg. Danum, *SAN* 85237 (A, KLU). Tawau: Mile 33, main road Kalabakan, *SAN* 65829 (K, L, SAN). **KALIMANTAN.** Timur: Berau, near Telukbajur, *Koster-mans* 21748 (BO, CANB, G, L, P, SAR, SING).

ECOLOGY. Along river banks or in periodically inundated forest, also hilly country, sometimes on sandy soil; to 620 m. alt. Flowering March and April; fruiting August and September (fruit pale green).

Calophyllum pyriforme is perhaps the most distinctive species in the group of taxa that have stipitate fruits with a fibrous outer layer and a thin-walled stone; these species all have scars at or near the bases of the axillary innovations (see TABLE 12). It can be recognized by its rather large leaf blades that are long-acuminate at the apex and that have subpersistent, tomentose indumentum on the lower surface; by the tomentose indumentum on the inflorescence axis, pedicels, and the backs of the outer tepals; and by its fruits, which are rounded at the apex. The hairs are distinctive, with the thickening of the walls so poorly developed that the cross walls are invisible (FIGURE 27, b). The pear-shaped fruits suggested the specific epithet.

Calophyllum pyriforme has been confused with *C. rubiginosum*; however, the two species are only superficially similar and are not closely related. *Calophyllum pyriforme* has twigs that dry brown, not yellow; inflorescences that are nearly always axillary, rather than terminal; and anthers that are glabrous, not hairy. The pyriform fruits of *C. pyriforme* are not furfuraceous, while the ellipsoid fruits of *C. rubiginosum* are.

Some specimens appear to have rather regular variation in internode length along the main stem. Internodes are periodically shorter; the leaves at the nodes above these short internodes are soon deciduous. These shorter internodes are probably the first of the flush. The presence of scars at the start of axillary innovations is not as constant as it is in other members of this group.

64. *Calophyllum roseocostatum* P. F. Stevens, sp. nov.

FIGURE 21, g-i.

A speciebus aliis Calophylli quibus fructibus stipitatis habent in ramulis tenuis 1.3–2.2 mm. in transversis, internodio terminali innovationis aliis subaequant, lamina in siccitate nitida costa (rubro-)brunnea cetera paginae olivacea, et fructu apice saepe rotundato, differt.

Tree 14–27 meters tall, d.b.h. to 70 cm.; trunk without buttresses (spurred); outer bark yellow-brown to grayish, with deep, distant, boat-shaped fissures, the inner surface orange-red or blackish; under bark dark red to chestnut; inner bark dark red; latex yellow, opaque, not viscous.

Twigs somewhat flattened, 1.3–2.2 mm. across, 4-angled, drying brown, glabrous (farinose when young); axillary innovations usually with pair of scars within 5 mm. of base; internodes 1–5 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, subspreading; terminal bud narrowly conical to $\pm$ plump, 2.5–4 mm. long, with compact, brown indumentum (hairs, FIGURE 22, k; cf. 22, l), underdeveloped internode to 3 mm. long. Petiole 1–1.6 cm. long, slender, concave above and convex below, glabrous; lamina elliptic to oblong, 5.7–11.1 by 2.3–3.1 cm., acuminate at apex, narrowly cuneate to acute at base, undulate and slightly recurved at margin, coriaceous, drying olivaceous and shiny above, greenish olivaceous-buff below, glabrous, the midrib gradually narrowed from base, slightly raised, center $\pm$ sulcate, 0.25–0.4 mm. wide at midpoint, below raised, striate, the venation apparent on both surfaces, raised, 11 to 15 veins/5 mm., angle of divergence 65–75°. Infructescences from foliate axils, with scars of 5 to 7 flowers, not branched, the axis 0.7–2 cm. long, puberulent, lowest internode to 2 mm. long; bracts not known; pedicels 1–1.5 cm. long, puberulent (glabrous toward apex). Flowers not known; tepals (from scars) 8. Fruit obovoid, 2.6–4.2 by 1.7–2 cm., rounded to obtuse at apex, stipe fibrous and 0.6–1.2 cm. by ca. 6 mm., drying brown, wrinkled; outer layer not detaching cleanly from stone, ca. 1.5 mm. thick, compact, but air spaces developing under skin; stone ellipsoid, ca. 2 by 1.3 cm., rounded at apex, the walls less than 0.1 mm. thick, smooth, unmarked; spongy layer becoming thin.

TYPE: Sarawak, Kuching, Semengoh F.R., 90 m., Sept. 1961, *S 14941* coll. *Galau* (holotype, k; isotypes, l, SAR).

DISTRIBUTION. Northwestern Borneo, known only near Kuching (MAP 23).

ADDITIONAL SPECIMENS SEEN. **Borneo.** SARAWAK. 1st Division: 12th Mile, Penrissen Road, Semengoh F.R., *S 26299* (A, K, L, SAN, SAR, SING), *S 25388* (K, L, SAR, SING), 60 m., *S 14760* (K, SAR); outside Arboretum, *S 33541* (A, SAN, SAR), *Stevens et al. 136* (A).

ECOLOGY. Well-drained mixed dipterocarp forest, ca. 60 m. alt. Fruiting April, September, and October.

Calophyllum roseocostatum can be recognized by its slender twigs, the scars of the bases of the axillary innovations, its short terminal buds, and its medium-sized, elliptic to oblong lamina with the midrib on the upper surface drying reddish brown and almost level. The fruits are stipitate. The epithet alludes to the color of the midrib on the upper surface of the dried lamina.

Calophyllum roseocostatum is a member of the group of taxa centered around *C. pyriforme*; the differences separating the taxa in the group are given in TABLE 12. Further collections may change the rank of the taxa recognized here; it is perhaps a little surprising that *C. roseocostatum* is at least locally quite common around Kuching, but has not yet been found elsewhere.

TABLE 12. Differences between *Calophyllum pyriforme*

	<i>C. pyriforme</i>	<i>C. stipitatum</i>	<i>C. roseocostatum</i>
HAIRS BRANCHED, ALL CELLS UNTHICKENED	+	—	—
GENERAL INTERNODE LENGTH (cm.)	1.5–7	1.2–3.5	1–5
TERMINAL INTERNODE LENGTH (cm.)	1.5–7	0.2–0.6	1–5
TWIG THICKNESS (mm.)	2–2.5	2–2.5	1.3–2.2
TOMENTUM SUBPERSISTENT ON STEM AND LOWER SURFACE OF LEAF BLADE	+	—	—
LEAF BLADE LENGTH (cm.)	11.5–23	5.4–10.5	5.7–11.5
MIDRIB NARROWING GRADUALLY FROM BASE	—	+	+
MIDRIB SHARPLY RAISED	—	—	—
VENATION LESS PROMINENT ON LOWER THAN ON UPPER SURFACE	—	—	—
TEXTURE	Thinly coriaceous	Coriaceous	Coriaceous
APEX	Long- acuminate	Acuminate	Acuminate
FRUIT ROUNDED AT APEX	+	+	+(—)
GEOGRAPHIC DISTRIBUTION	E. Sabah E. Kalimantan	Malaya (?)Brunei	SW. Sarawak

65. *Calophyllum* sp.

FIGURE 23, d-f.

Tree ca. 21 meters tall, d.b.h. ca. 48 cm.; trunk and bark unknown.

Twigs slightly flattened, 2–2.5 mm. across, strongly 4-angled, drying brown, glabrous when mature; axillary innovations with basal scars; internodes 1–3.5 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, $\pm$ spreading; terminal bud plump, 2–3 mm. long, with brown, subadpressed indumentum (hairs, cf. FIGURE 22, k), underdeveloped internode ca. 2 mm. long. Petiole 6–10 mm. long, deeply concave above, convex below, glabrous; lamina obovate to elliptic, 6–11 by 2.4–4 cm., acuminate at apex, cuneate to acute at base, strongly undulate but only slightly recurved at margin, coriaceous, drying with $\pm$ persistent, grayish, waxy covering, olivaceous above and sabelline below, midrib and margin fulvous on both surfaces, glabrous at maturity, the midrib above narrowing gradually from base, raised, 0.2–0.3 mm. wide at midpoint, below raised, striate, the venation subapparent, clearer above than below, raised, 12 to 15 veins/5 mm., angle of divergence ca. 70°. Infructescences from foliate axils, with scars of 5 to 9 flowers, unbranched, the axis 2.3–4 cm. long, glabrous, lowest internode to 0.5 mm. long; bracts unknown; pedicels 1.6–2 cm. long, glabrous. Flower unknown. Fruit obovoid-ellipsoid, 2.6–3.5 by 0.7–1.3 cm., sharply pointed at apex, stipe 1–1.3 cm. by ca. 8 mm., drying tawny, wrinkled; outer layer not detaching from stone, ca. 1 mm. thick, compact, fibrous; stone ca. 1.15 by ca. 1 cm., rounded at apex, the walls ca. 0.2 mm. thick, smooth, unmarked; spongy layer initially thick.

DISTRIBUTION. Known only from Sarawak (MAP 23).

REPRESENTATIVE SPECIMENS SEEN. **Borneo.** SARAWAK. 3rd Division: Bukit Raya, Kapit, Sibul, 180 m., S 23854 (A, BO, K, KEP, L, SAN, SAR, SING). 4th Division: Bukit Mersing, Ashton 6005 (A).

ECOLOGY. Ridge forest, 180 m. alt. Submature fruit in October.

Calophyllum sp. 65 can be recognized by its axillary innovations with basal scars, its small terminal bud and relatively long underdeveloped internode, and its lamina, which has a grayish covering, a fulvous midrib, and venation that tends to be more prominent on the upper than on the lower surface. The fruits are stipitate and have a fibrous outer layer and a thin-walled stone.

Calophyllum sp. 65 is closely related to such species as *C. stipitatum* and *C. pyriforme*; the differences distinguishing it from these taxa are given in TABLE 12.

66. *Calophyllum stipitatum* P. F. Stevens, sp. nov.

FIGURE 21, a, b.

A speciebus aliis *Calophylli* quibus fructibus stipitatis et innovationibus axillaribus cicatricibus basalibus habent in lamina mediocra in siccitate infra olivacea costa supra plus minusve depressa, et fructu apice rotundato, differt.

Tree ca. 18 meters tall, d.b.h. to 38 cm.; trunk probably without buttresses; outer bark $\pm$ smooth, with broad, shallow, distant, boat-shaped fissures; latex yellow, clear, greenish near cambium.

Twigs flattened, 2–2.5 mm. across, 4-angled or not, drying blackish, at maturity smooth, glabrous; axillary innovations with one or two pairs of basal scars; internodes 1.2–3.5 cm. long, terminal internode 2–6 mm. long; uppermost pair of axillary buds rounded, to 1 mm. long, spreading; terminal bud broadly conical, 2.3–3 mm. long, with short, tomentose, brown indumentum (hairs, FIGURE 22, 1), underdeveloped internode to 2 mm. long. Petiole 0.7–1.5 cm. long, broadly concave above and convex below, glabrous; lamina elliptic to obovate, 5.4–10.5 by 2.3–4 cm., acuminate at apex, narrowly acute to long-attenuate at base, margin rather distantly undulate and slightly recurved, coriaceous, drying with grayish covering, sepia above and olivaceous below, the margins pale, glabrous at maturity, the midrib above gradually narrowed from base, $\pm$ depressed, edges slightly raised, 0.2–0.35 mm. wide at midpoint, below raised, striate, the venation subobscure to apparent on both surfaces, raised, latex canals on lower surface subraised to clearly impressed, 7 to 10 veins/5 mm., angle of divergence 65–70°. Infructescences arising from foliate axils, with scars of 9 to 13 flowers, unbranched, the axis 2.7–4 cm. long, sometimes puberulent at base, lowest internode less than 1 mm. long; bracts not known; pedicels 0.8–1.4 cm. long, glabrous. Flower not known. Fruit (submature) obovoid, ca. 1.8 by 0.9 cm., subpersistently apiculate, stipe fibrous and ca. 8 by 4 mm., drying dark brown with apical part smooth and stipe closely wrinkled; outer layer not detaching cleanly from stone, ca. 0.5 mm. thick, compact, fibrous; stone ellipsoid, ca. 9 by 7.5 mm., rounded at apex, the walls ca. 0.1 mm. thick, smooth, (?)unmarked; spongy layer thick in young fruit.

TYPE: Malaya, Pahang (southeast), Aur forest, reserve at Sungei Aur, flood plain Sungei Aur, 11 May 1967, *FRI 3656* coll. *Whitmore* (holotype, κ ; isotypes, A, KEP, L, SAR, SING).

DISTRIBUTION. The Malay Peninsula, probably also northwestern Borneo, local (MAP 23).

ADDITIONAL SPECIMENS SEEN: **Borneo.** BRUNEI: Andalau, *Ashton s.n.* (SAR); Kuala Belait, *S 10681* (SAR).

ECOLOGY. Lowland rainforest. Submature fruit in May.

Calophyllum stipitatum is clearly related to the other species from Borneo that have stipitate fruits, scars at the bases of the axillary innovations, and inflorescences with very short basal internodes (*C. elegans*, *C. pyriforme*, *C. roseocostatum*, *Calophyllum* sp. 65). The main differences between these species are listed in TABLE 12. The epithet *stipitatum* alludes to the stipitate fruits.

Although the specimens from Brunei cited above as *Calophyllum stipitatum* have several pairs of scars at the bases of the axillary innovations, they agree with that species, rather than with *Calophyllum* sp. 65, in vegetative

characters. However, the identity of these specimens can be confirmed only by the collection of fruiting material.

67. *Calophyllum elegans* Ridley, Kew Bull. **1938**: 118. 1938; Masamune, Enum. Phanerog. Born. 475. 1941; Smythies, Common Sarawak Trees, 59. 1965. TYPE: Sarawak, near Kuching, 8 Jan. 1892, *Haviland* 968 coll. *Garai* (holotype, K; isotypes, BM, L, P, SAR).

Tree 6–22 meters tall, d.b.h. to 20 cm.; trunk without buttresses; outer bark brown to yellowish brown, with broad, shallow, boat-shaped fissures, not hoop marked, the inner surface deep red to reddish brown; under bark deep red to chestnut brown; inner bark pale red; latex opaque to clear yellow, sticky.

Twigs slightly flattened, 1.6–2.5 mm. across, $\pm$ 4-angled when young, later with $6 \pm$ raised lines, drying brown to blackish, sparsely puberulent when young; axillary innovations with pair of (sub)basal scars, terminal innovations with ca. 3 pairs of near basal scars; internodes 1.5–3 cm. long; uppermost internode of innovation usually (0.3–)0.5–1 cm. long; uppermost pair of axillary buds rounded, to 1.5 mm. long, spreading; terminal bud plump, 3–3.5 mm. long, abruptly narrowed at apex, with short, subadpressed, brown indumentum (hairs, FIGURE 25, c, d), underdeveloped internode to 2 mm. long. Petiole (0.4–)0.8–1.5 cm. long, deeply concave above, convex below; lamina elliptic to oblong or subobovate, (3–)4.6–8.5 by (1.3–)2.7–4.7 cm., retuse to obtuse (subacuminate) at apex, cuneate to acute at base, slightly undulate and recurved at margin, coriaceous, drying umber to olivaceous above and umber to near sabelline below, glabrous when mature, the midrib above gradually narrowed from base, sharply raised, 0.2–0.45 mm. wide at midpoint, sulcate, below raised, rounded toward apex, striate toward base, the venation rather apparent above, apparent to subobscure below, raised, 6 to 11 veins/5 mm., angle of divergence 70–80°. Inflorescences from foliate axils, with 9 to 11 flowers, unbranched, the axis 1.2–3 cm. long, glabrous, lowest internode lacking; basal bracts broadly ovate, ca. 1.7 mm. long, coriaceous, persistent, upper bracts ovate-elliptic, to 3 mm. long, chartaceous, subpersistent; pedicels 7–9 mm. long, glabrous. Flower (?) hermaphroditic; tepals 8, glabrous, the outer pair ovate to elliptic, 3–3.5 by 2.2–3 mm., $\pm$ keeled, the next pair subobovate, ca. 5 by 2.2 mm., the innermost ones oblong-elliptic, to 3.5 by 1.4 mm.; stamens ca. 95, the filaments to 3.5 mm. long, the anthers elliptic-oblong, 0.6–1 mm. long, retuse at apex; ovary ca. 1.8 mm. long, the style ca. 1.8 mm. long, the stigma infundibular, ca. 0.3 mm. across. Immature fruit ellipsoid-obovoid, shape distorted by drying, ca. 2.2 by 0.8 cm., sharply apiculate, stipe ca. 8 mm. long.

DISTRIBUTION. Western Sarawak, local (MAP 23).

SELECTED SPECIMENS SEEN. **Borneo. SARAWAK.** 1st Division: Semengoh Arboretum, 15 m., *S* 5383 (A, BO, K, KEP, L, P, SAN, SAR, SING); G. Matang, 580 m., *Stevens et al.* 274 (A); Sempadi F.R., 15 m., *S* 6095 (SAR); Sabal Tapang, 190 m., *Stevens et al.* 185 (A); Stapok F.R., 10 m., *Stevens et al.* 153 (A).

ECOLOGY. Edge of swamp forest, mixed dipterocarp forest on sandy clay soil, and kerangas forest; 10–580 m. alt. Flowering January and February (flower scented).

Calophyllum elegans is characterized by its rather small, thinly coriaceous lamina that has a variously shaped apex, a sharply raised midrib on the upper surface, and apparent venation. The bracts toward the apex of the inflorescence are thinner and less persistent than the coriaceous, persistent basal bracts. The innovations have (sub)basal scars, and the uppermost internode of each innovation is nearly always markedly shorter than the others, the terminal pair of leaves being smaller than the rest (figures in parentheses in the description above). Although only immature fruits are known, they are clearly of the stipitate type. The specific epithet *elegans* (“elegant,” “fine”) is appropriate for the neat-looking specimens of this species.

Calophyllum elegans is related to the groups of species centered on *C. pyriforme*. For the differences separating it from other taxa in this group, see TABLE 12.

Although *Calophyllum elegans* is superficially similar to some of the forms of *C. tetrapterum*, the two species are not at all close. The internodes of *C. tetrapterum* are usually about the same length, and its innovations usually lack basal scars; the terminal bud is not acutely pointed; the lowest internode of the inflorescence is more or less well developed, and if the inflorescence bracts are subpersistent, they are never small and coriaceous; the fruit is subspherical and lacks a stipe.

68. ***Calophyllum oliganthum*** Merr. Philip. Jour. Sci. 17: 289. 1920, Enum. Philip. Fl. Pl. 3: 80. 1923. TYPE: Philippine Islands, Mindanao, Surigao del Norte Province, Bucas Grande Island, 10 June 1919, BS 35110 coll. Ramos & Pascasio (isotypes, A, BM, BO, K, P, US).

Tree 1–5 meters tall, d.b.h. to 10 cm.; trunk and bark unknown; branches pendulous.

Twigs slightly flattened, 0.6–1.3 mm. across, not angled, drying blackish when young (grayish when older), glabrous or $\pm$ transiently puberulent; axillary innovations (?) always lacking basal scars; internodes 1.5–7 cm. long; uppermost pair of axillary buds rounded, 0.5–1 mm. long, suberect, not conspicuous; terminal bud conical, (1.5–)2–3 mm. long, with adpressed indumentum (hairs, FIGURE 22, c, d), underdeveloped internode absent (to 2 mm. long). Petiole (0.4–)0.6–1.1 cm. long, shallowly concave above, convex below, usually becoming glabrous; lamina elliptic to ovate (rarely obovate), (2–)3–8 by (0.7–)1.2–3.5 cm., acuminate at apex, (narrowly) cuneate at base, not undulate to slightly so and recurved at margin, coriaceous, drying sepia to sabelline-sepia above, umber to fulvous below, glabrous or with few hairs on midrib below when very young, the midrib above narrowing gradually from base, flat, obscure, surrounding lamina $\pm$ raised, 0.2–0.3 mm. wide at midpoint, below slightly raised to raised, rounded, the venation subobscure above, $\pm$ apparent

and raised below, 8 to 15 veins/5 mm., angle of divergence 60–70°. Inflorescences from foliate axils along stem, with 3 to 5 (to 7) flowers, unbranched, the axis 1–2.5(–3.7) cm. long, sometimes sparsely and transiently subtomentose, at least toward base, lowest internode 0.3–1(–1.7) cm. long; bracts ovate, ca. 1.5 mm. long, caducous; pedicels (0.6–)1–1.8 cm. long, glabrous. Flower (?)hermaphroditic; tepals 4 to 8, the outer two suborbicular, ca. 4 mm. long and across, the next two broadly elliptic, ca. 6 by 4–4.5 mm., others, if present, probably much smaller; stamens 45 to 80, the filaments to 3.5 mm. long, the anthers suboblong, 0.5–1 mm. long, retuse at apex; ovary ca. 1 mm. long, the style ca. 4.5 mm. long, very slender, the stigma ca. 0.4 mm. across, 2- or 3-radiate. Fruit ellipsoid, 1–1.3 by ca. 0.8 cm., rounded at apex, drying dark brown, $\pm$ smooth; outer layer not detaching cleanly from stone, less than 0.5 mm. thick, air spaces developing; stone ellipsoid, 8–11 by 5–7 mm., rounded at apex, the walls 0.15–0.3 mm. thick, smooth, unmarked; spongy layer thin.

DISTRIBUTION. The Philippine Islands, Mindanao (MAP 20).

SELECTED SPECIMENS SEEN. **Philippine Islands.** MINDANAO. Surigao del Norte: Dinagat Is., BS 83812 (NY); sine loco, BS 34520 (A, K, P, US).

ECOLOGY. Small tree, low alt. On Dinagat Island growing on iron deposit. Flowering in June; fruiting April and June.

Calophyllum oliganthum can be recognized by its small, probably nonfunctional terminal buds, its lamina with the midrib on the upper surface flat and the adjacent blade slightly raised, and its axillary inflorescences with a well-developed basal internode. The ellipsoid fruit has a thin outer layer and a thin-walled stone. The epithet *oliganthum* ("few flowers") was coined because the inflorescences have few flowers.

Calophyllum oliganthum is superficially similar to *C. nodosum* and *C. depressinervosum*. All three species have more or less profuse branching due to a weak or nonfunctional terminal bud, leaves with a rather similar midrib on the upper surface, flowers with usually four tepals and few, small stamens, and fruits of similar structure. However, in *C. oliganthum* the axillary innovations lack basal scars, the midrib on the lower surface of the lamina is raised, rather than depressed, the inflorescence is only three to five flowered and lacks flowers close to the base, and the fruit is ellipsoid, rather than spherical; polyembryony has not been observed. Venation density and prominence are more like those of *C. nodosum*, but the lamina is larger and dries darker, and the internodes are much longer.

69. ***Calophyllum garcinioides*** P. F. Stevens, sp. nov.

FIGURE 24, a–e.

C. cuneatum auct., non M. R. Henderson & Wyatt-Smith; Meijer, Bot. Bull. Herb. Forest Dept. Sabah 7: 15. 1967.

A speciebus aliis *Calophylli* in lamina coriacea canalibus laticibus venulis lateralibus oblique transgressentibus, innovationibus axillaribus cicatricibus basalibus ornatis, floribus cum 12 ad 16 tepalis, et fructu subsphaerico 1.6–2 cm. longo putamine parietibus minoribus 0.2 mm. crassis, differt.

FIGURE 24. a-e, *Calophyllum garcinioides*. a, b, habit, $\times 0.5$: a, SAN 71859; b, SAN 31788. c, d, fruit (SAN 62033), $\times 0.75$: c, longitudinal section; d, from outside. e, terminal bud (SAN 26052), $\times 3$. f, *C. pelewense* (Kanehira 386), terminal bud and axillary inflorescence with basal scar (arrow), $\times 6$.

Tree (1.8-)9-25(-39) meters tall, d.b.h. to 63 cm.; trunk without buttresses; outer bark usually yellowish brown (brown or gray), fissured, the inner surface brown to greenish brown; under bark red to reddish brown; inner bark red; latex yellow, transparent, sticky (rarely white).

Twigs flattened, 1.5-3.9 mm. across, at first slightly 2-, 4-, or 6-angled, soon becoming rounded, drying blackish brown, glabrous or sparsely farinose-puberulent; axillary innovations with scars 1.5-7 mm. from base; internodes 0.5-3 cm. long; uppermost pair of axillary buds rounded, ca. 1 mm. long, spreading; terminal bud plump, 2.5-6 mm. long, with adpressed, brown to grayish indumentum (hairs, FIGURE 25, e, f; cf. 22, k), underdeveloped internode to 3(-6) mm. long. Petiole 3.5-7 mm. long, broadly and shallowly concave above and convex below, glabrous; lamina obovate or trapeziform to elliptic

(rarely ovate), 2.5–9.3 by 1.4–5 cm., usually subacuminate to acute (rarely retuse) at apex, narrowly cuneate to rounded at base, distantly and shallowly recurved and at most slightly recurved at margin, coriaceous, drying umber or sabelline above and umber to sepia below, glabrous, the midrib above narrowing gradually or abruptly at base, usually subdepressed ($\pm$ raised), 0.2–0.5(–0.7) mm. wide at midpoint, below raised, obscurely angled to striate, the venation apparent to obscure on both surfaces, raised, beneath usually with latex canals ascending obliquely over veins, 7 to 15 veins/5 mm., angle of divergence 50–75°. Inflorescences terminal and from adjacent foliate axils, with 7 to 17 flowers, branched when terminal (rarely so when axillary), the axis 3–9.5 cm. long, glabrous or puberulent toward base, lowest internode to 3(–11) mm. long; bracts usually soon deciduous (very rarely foliaceous, to 3 cm. long, persistent—*Clemens* 32480); pedicels 0.7–2 cm. long, glabrous. Flower (?)hermaphroditic; tepals 12 to 16, the outer pair broadly ovate to elliptic, 9.5–10.5 by 5.5–9 mm., the inner ones obovate to elliptic, 11–13 by 5–10 mm.; stamens 240 to 330, the filaments to 6 mm. long, connate for up to 0.6 mm., the anthers oblong, 1.1–1.5 mm. long, rounded to slightly retuse at apex; ovary 2–3 mm. long, the style ca. 4 mm. long, the stigma peltate, 1.1–1.4 mm. across, 3- or 4-lobed. Fruit subspherical, 1.6–2 by 1.1–1.4 cm., rounded to strongly apiculate at apex, drying brown, sharply wrinkled; outer layer detaching cleanly from stone, ca. 1 mm. thick, compact; stone subspherical, 1.5–1.9 by 1–1.3 cm., rounded at apex, the walls less than 0.2 mm. thick, smooth, unmarked; spongy layer thin.

TYPE: North Borneo [Sabah], Ranau, above Mosilau Camp, 15 Aug. 1963, *SAN* 36197 coll. *Mikil* (holotype, *SAN*; isotypes, *A*, *K*, *KEP*, *L*, *SAR*, *SING*).

DISTRIBUTION. Northeastern Borneo (MAP 24).

SELECTED SPECIMENS SEEN (“w”—white latex; “y”—yellow latex). **Borneo and adjacent islands.** SARAWAK. 4th Division: Baram, G. Mulu, 1554 m., *Anderson & Keng K 3* (*A*, *BO*, *K*, *L*, *SAN*, *SAR*, *SING*), 1696 m., *S 4259* (*K*, *L*, *SAN*, *SAR*, *SING*), 1524 m., *Chew 383* (*A*, *L*, *SING*), 1600–2200 m., *Hotta 14731* (*L*). 5th Division: Lawas, G. Murut, Ba Kelalan, 2149 m., *S 26502* (*L*, *SAR*, *SING*), 1829 m., *S 26372* (*L*, *SAN*, *SAR*). BRUNEI: G. Pagon Periok, 1859 m., *BRUN 2386* (*K*, *L*, *SAR*). SABAH. Tambunan: Trusmadi, 2134 m., *SAN 31788* (*K*, *L*, *SAN*). Ranau: Kinabalu Natl. Park & vicinity, 2438 m., *KEP 71640*

FIGURE 25. Hairs (from terminal bud, unless otherwise mentioned). a, b, *Calophyllum parkeri* (Parker 2313), from outside of basal scale on inflorescence. c, d, *C. elegans* (*S 5383*). e, f, *C. garcinioides* (*Clemens 34390*, from axillary bud). g–i, *C. sclerophyllum*: g, *Kostermans 8020*; h, *5 E-1 P-649*; i, *A 398*, from above. j, *C. havilandii* (Haviland & Hose = 3345). k, t, *C. cordato-oblongum* (*CP 3823*) (t, base of hair ca. 450 μ m. long); l–o, *C. teysmannii* var. *inophylloide*: l, *Kostermans 12792*, hair ca. 600 μ m. long; m, *FRI 5873*; n, *Kostermans 12734*; o, *bb 31797*. p, q, *C. hosei* (Native collector 889) (q, an uncommon type). r, *C. grandiflorum* (*Kostermans 23822*). s, *C. calcicola* (*Kostermans 13837*). Scale = 60 μ m. (in l, m, scale = 120 μ m.; in r = 30 μ m.).

MAP 24. Distribution of *Calophyllum parkeri* (triangle), *C. fraseri* (circles), *C. enervosum* (half-circles), *C. praetermissum* (solid stars), *C. confertum* (open stars), and *C. garcinioides* (squares) in Southeast Asia and Malesia. Inset: *Calophyllum* sp. 73.

(KEP), 1219 m., *SAN* 16232 (BO, BRI, KEP, L, SING), 1829 m., 37989 (K, KEP, SAN, SAR, SING), 1219 m., 38068 (?) (Y) (A, KEP, SAN, SAR), 2438 m., 38325 (Y) (K, L, SAN), 71849 (Y) (K, L, SAN, SING), 1524 m., *RSNB* 4308 (W) (K, L, SAN, SING), 1829 m., 4731 (W) (CANB, K, L, SAN, SING), *Clemens* 32442 (A, B, BO, G, K, L, M, NY, UC), 1676 m., 33992 (A, BO, G, L, NY, UC), Marai Parai, 1524 m., *Clemens* 32480 (probable) (A, BO, L, M, NY, UC), 1524 m., 33194 (probable) (A, BO, NY). Kinabatangan: Lamag, Karamuak, Mt. Tavai, 990 m., *SAN* 51744 (SAN, *pro parte*).

ECOLOGY. Locally common in lower montane and montane forest, sometimes in soil derived from ultramafic rock; 990–2438 m. alt. Flowering March (Sarawak) and July to September (Sabah); fruiting February to April and June to August (fruit greenish).

GERMINATION AND YOUNG PLANT. The young plant is erect, and the terminal bud is functional. Young plants about 0.5 meters tall have axillary innovations with basal scars.

Although *Calophyllum garcinoides* is at first sight like other small- and coriaceous-leaved species of *Calophyllum* found on mountains, it can readily be distinguished from these other species by the scars at the bases of the axillary innovations, the obliquely ascending latex canals on the lower surface of the lamina, the axillary and terminal inflorescences that usually both have a very short basal internode, the flowers with 12 to 16 tepals, and the subspherical fruit with a thin-walled stone. The characteristic latex canals on the underside of the lamina are not always readily visible on dried specimens; however, they have been observed on specimens from all mountains where it grows. They look like the latex canals of *Garcinia* L.; hence, the specific epithet.

Similar inflorescences, leaves, and axillary innovations occur in some specimens of the poorly known *Calophyllum fraseri*, from Malaya (q.v.). However, that species always has axillary inflorescences, flowers with at most eight tepals, and fruits about twice as large with stone walls ca. 1 mm. thick.

There is considerable variation in leaf shape within *Calophyllum garcinoides*, but the extremes are connected by intermediates. Specimens taken from trees reported to have white latex (all collected by the expedition of the Royal Society, London) tend to have thicker leaf blades that are more obtuse at the apex, while specimens from trees reported to have yellow latex have thinner leaf blades that are more acute at the apex. However, *SAN 29128*, with yellow latex, has a lamina that is rounded at the apex.

Specimens from Mt. Kinabalu that are cited above with a question mark have relatively small, thin leaf blades that are more or less acuminate at the apex and axillary innovations that lack basal scars. *SAN 60644*, which has larger leaf blades that are subacuminate at the apex and scars ca. 7 mm. from the base of the axillary innovations, is intermediate between these and more normal specimens. Further variation is shown by the specimens collected by the Clemenses from Marai Parai, which have leaf blades that are strongly retuse at the apex and rounded at the base, while the specimen of *Clemens 32480* at A has persistent, foliaceous bracts.

The single specimen seen from Mt. Tavai, in Kinabatangan, is sterile.

70. *Calophyllum fraseri* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 344. pls. 24, 25. 1956; T. C. Whitmore, Tree Fl. Malaya **2**: 182. 1973, *pro parte*. TYPE: Malaya, Pahang-Selangor border, Fraser's Hill, 28 Sept. 1923, *SFN 11282* coll. Nur (holotype, SING; isotype, KEP).

C. ?praineum auct., non King; King, Jour. Fed. Malay States Mus. **7**: 39. 1916.

C. canum auct., non Hooker f.; Henderson, Gard. Bull. Straits Settl. **4**: 93. 1927.

C. symingtonianum M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 338. 1956, *pro minore parte*; T. C. Whitmore, Tree Fl. Malaya **2**: 192. 1973, *pro parte*.

Tree 15–36 meters tall, d.b.h. to 58 cm.; trunk without buttresses or stilt roots; outer bark dirty deep gray to yellow-brown, dimpled or with shallow fissures at wide intervals; inner bark pale yellow-cream to pink; latex milky (Maxwell's Hill) or clear yellow, resinous (G. Mengkuang, Kelantan); wood yellow.

Twigs rather strongly flattened, 1.8–2.5 mm. across, not 4-angled to slightly so, soon becoming rounded, drying blackish to dark brown, puberulent when young; axillary innovations with or apparently lacking basal scars; internodes 1.5–3(–4.5) cm. long; uppermost pair of axillary buds rounded to subacute, to 1.5 mm. long, adpressed to terminal bud or not; terminal bud plump, 4.5–7 mm. long, with short, subadpressed, ferrugineous indumentum (hairs, cf. FIGURE 20, m), underdeveloped internode to 2.5 mm. long. Petiole 0.7–1.2 cm. long, usually shallowly concave above, convex below, glabrous when mature; lamina ovate to elliptic, 5–12.8 by 1.8–4.8 cm., $\pm$ acuminate at apex, acute to cuneate at base, broadly undulate but not recurved or slightly so at margin, coriaceous, drying cinnamon-drab above and sabelline below, glabrous when mature, the midrib above narrowing rather gradually from base, at least margins raised, 0.2–0.6 mm. wide at midpoint, below strongly raised, striate, the venation above and below $\pm$ apparent, raised, at least sometimes crossed by obliquely ascending latex canals, (7 to) 9 to 14 veins/5 mm., angle of divergence 60–70(–80)°. Inflorescences from foliate axils, sometimes two per axil, with up to 11 flowers, unbranched, the axis 1–4 cm. long, puberulent, especially toward base, or glabrous, lowest internode to 2.5 mm. long; bracts unknown; pedicels 0.5–1.8 cm. long, glabrous, to 2.5 mm. thick in fruit. Flower (?)hermaphroditic; tepals 4 or 8, the outer pair ovate, 4–7 by 3.5–5 mm., the next pair ovate to suboblong, 5–8 by 3–4.5 mm., inner ones, where present, suboblong, ca. 9 by 4 mm.; stamens (?)numerous, the filaments to 3.5 mm. long, the anthers oblong, ca. 1.6 mm. long, retuse at apex; ovary ca. 1.5 mm. long, the style ca. 3.5 mm. long, the stigma peltate, 0.8–1.4 mm. across, (?)3-radiate. Fruit ellipsoid, 2.6–3.3 by 2.3–5.2 cm., apiculate or not, drying vinaceous-brown, deeply reticulate or shallowly corrugate; outer layer detaching $\pm$ cleanly from stone, 1.5–2.5 mm. across, compact; stone ellipsoid, 2.1–3 by 1.6–2.15 cm., rounded at apex, the walls 0.8–1.1 mm. thick, to 3 mm. thick at base, smooth, unmarked; spongy layer initially thick.

DISTRIBUTION. Malaya (MAP 24).

SELECTED SPECIMENS SEEN. **Malaya.** KEDAH: Kedah Peak, 914 m., *Robinson & Boden Kloss* 6039 (SING); Gunong Inas F.R., 914 m., *FRI* 9262 (KEP). PAHANG: Fraser's Hill, 1219 m., *F.M.S. Mus.* 11576 (BO, KEP), path to Pine Tree Hill from Weld Hill, *KEP* 28955 (KEP); Bentong, ridge above Sungei Tanglin to G. Mengkuang, 1067 m., *KEP* 79614 (KEP); Gunong Berumbun, *Ridley* 13910 (prob.) (K, SING); Sungei Ikan, *KEP* 27634 (prob.) (SING); Bukit Percival, *KEP* 35944 (KEP); Maxwell's Hill, bend 57, 762 m., *KEP* 76333 (K, KEP); ridge to G. Tapis, 914 m., *FRI* 10974 (A, K, KEP, SAR). KELANTAN: G. Rabong, 1295 m., *FRI* 20685 (KEP, SAN). TRENGGANU: G. Padang, 1219 m., *SFN* 31878 (KEP, SING); Ulu Brang, camp 3, *FRI* 1755 (KEP).

ECOLOGY. Colline or montane rainforest, 760–1295 m. alt. Flowering March and September; submature fruit September and October.

Bilabiate, purselike galls probably caused by coccids (see *Calophyllum teysmannii*) occur fairly commonly (KEP 27634, 35944, 66601; Robinson & Boden Kloss 6126; Ridley 13910).

Calophyllum fraseri is characterized by its elliptic leaf blades that are more or less acute at the base and acuminate at the apex and that have rather clear venation on both surfaces, and by its relatively large (ca. 3 cm. long) fruit that has a compact outer layer and a stone with walls ca. 1 mm. thick. The specific epithet commemorates L. J. Fraser, a trader and mule train operator, who disappeared in 1916 on what was subsequently called Fraser's Hill.

Calophyllum fraseri is perhaps related to *C. garcinioides*, from northeastern Borneo. Leaves of the two species dry similarly and have latex canals ascending obliquely to the venation; both species also have axillary innovations with scars at the bottom (but see below). However, *C. garcinioides* has a smaller (less than 2 cm. long) fruit with a thin-walled (less than 0.2 mm.) stone and larger flowers with 12 to 16 tepals. The base of the lamina in *C. garcinioides* is usually more or less rounded or cuneate; in *C. fraseri* it is acute. *Calophyllum fraseri* is perhaps also close to the poorly known *C. parkeri* (q.v.).

Despite recent collections made from Kelantan and Trengganu, *Calophyllum fraseri* is a very poorly known species, and its variation is not yet understood. Specimens from Fraser's Hill (the type locality) have a small (less than 1.2 cm. long) inflorescence axis that is puberulent toward the base and has a clear basal internode; the flowers have four tepals. Only one specimen with flowers has been collected elsewhere; this specimen (FRI 20685, from Kelantan) has an inflorescence axis at least 2 cm. long that lacks a clear basal internode, and flowers with eight tepals. Axillary innovations with basal scars have been seen only in specimens from Kedah Peak, Kelantan, Trengganu, and perhaps from Cameron's Highlands; much of the material is too poor for confirmation of the presence or absence of these scars, although they appear to be absent on material from Fraser's Hill. Specimens with these scars have more coriaceous leaf blades than the other specimens, and obliquely ascending latex canals are visible on the lower surface. Fruits are known only from Trengganu (G. Padang), and Pahang (Maxwell's Hill and G. Tapis) (i.e., not from the type locality).

Despite this confusing situation, the following points may be noted. First, the specimens of *Calophyllum fraseri* that are most similar to *C. garcinioides* in vegetative characters can be clearly distinguished from that species by characters of both flower and fruit. Second, because fruits are not known from the type locality of *C. fraseri*, it remains to be established whether or not *C. fraseri* from Fraser's Hill is conspecific with the other material cited. Henderson and Wyatt-Smith (*op. cit.*) thought that their *C. cuneatum* was close to *C. fraseri*; *C. cuneatum* (= *C. calaba* var. *cuneatum*) also has flowers with four tepals, but differs most obviously in its very much shorter petioles. Third, the specimens cited that have bilabiate coccid galls are mostly

sterile; I do not know of specimens with both galls and scars at the bases of the axillary innovations. Some specimens determined as *C. fraseri* by T. C. Whitmore have been removed to *C. teysmannii* var. *inophylloide* (q.v.), which has similar galls. The latter taxon is quite variable, and it is possible that some specimens still included in *C. fraseri* will also have to be removed to *C. teysmannii*.

71. ***Calophyllum parkeri*** Fischer, Kew Bull. 1926: 455. 1926. TYPE: Burma, Tavoy, Nwalabo, 1050 m., 2 Dec. 1924, *Parker 2313* (holotype, K; isotype, A).

Small tree; outer bark cracked into irregular plates, otherwise unknown.

Twigs slightly flattened, 2.5–3.2 mm. across, rounded, drying blackish, glabrous; axillary innovations unknown; internodes 0.5–2.5 cm. long; uppermost pair of axillary buds and terminal buds unknown (hairs, FIGURE 25, a, b). Petiole 5–8 mm. long, broadly and shallowly concave above, convex below, glabrous; lamina elliptic, 5.2–8.5 by 1.6–3.4 cm., cuneate at apex, rounded to subcuneate at base, slightly undulate and somewhat recurved at margin, coriaceous, drying umber above and below, glabrous, the midrib above gradually narrowed from base, flat or slightly raised, 0.3–0.6 mm. wide at midpoint, below raised, striate to subangled, the venation subapparent on both surfaces, slightly raised, 6 to 10 veins/5 mm., angle of divergence 50–60°. Inflorescences axillary and terminal, with up to 13 flowers, unbranched (terminal inflorescences sometimes branched), the axis 3–4 cm. long, glabrous, lowest internode to 1 mm. long; bracts unknown; pedicels to 1.3 cm. long, glabrous. Flower (?)hermaphroditic; tepals 12 (rarely 13), the outer pair orbicular, 3–3.5 mm. long and across, the next pair suborbicular, 6.5–7 by 5.5–6.5 mm., the inner ones elliptic to obovate, 9–12 by 4.5–7.5 mm.; stamens ca. 310, the filaments to 7.5 mm. long, connate for up to 1 mm., the anthers oblong, 1–1.2 mm. long, retuse to rounded at apex; ovary 2–2.5 mm. long, the style ca. 5.5 mm. long, the stigma peltate-infundibular, ca. 1.5 mm. across, not radiate. Fruit unknown.

DISTRIBUTION. Burma (MAP 24); known only from the type specimen.

Calophyllum parkeri is an imperfectly known species that can be recognized by its rounded twigs; moderate-sized, elliptic leaf blades that are cuneate at the apex and subrounded at the base and have a more or less flat midrib on the upper surface; axillary and terminal inflorescences (the former, at least, have a very short or nonexistent basal internode); and 12-tepaled flowers. It is quite possible that the axillary innovations have basal scars. The epithet commemorates the collector, R. N. Parker.

If the axillary inflorescences and axillary innovations of *Calophyllum parkeri* have basal scars, it may be related to the specimens of *C. fraseri*, from the eastern part of Malaya, and to *C. garcinoides*, from Borneo. *Calophyllum fraseri* apparently has four- to eight-tepaled flowers and axillary inflorescences. Although *C. garcinoides* has both axillary and terminal inflorescences and flowers with at least twelve tepals, the tepals of the outermost pair are

about three times the size of those of *C. parkeri*; it also has obliquely ascending latex canals on the lower surface of the lamina.

72. ***Calophyllum flavo-ramulum*** M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore **15**: 310. *pls. IC*, 6. 1956; Kochummen, Malayan Forest Rec. ed. 2. **17**: 219. 1965; T. C. Whitmore, Tree Fl. Malaya **2**: 181. 1973. TYPE: Malaya, Trengganu, Kemaman, Bukit Kajang, 500 feet [150 m.], 8 Nov. 1935, *SFN 30321* coll. *Corner* (holotype, SING; isotypes, A, BO, K, KEP, LAE).

Tree 30–38 meters tall, d.b.h. to 88 cm.; trunk without buttresses; outer bark yellowish to greenish brown, strongly fissured, flaking, ca. 8 mm. thick, in transverse section with orange lines demarcating brown islands; the under surface $\pm$ bright orange; under bark pale straw; inner bark reddish; latex clear yellow, sticky.

Twigs $\pm$ flattened, 2–3 mm. across, rounded or obscurely 4-angled, drying dark to blackish brown when young, yellowish when older, subpersistently reddish brown–puberulent or not; axillary innovations with basal scars; internodes 1.5–4.5 cm. long; uppermost pair of axillary buds rounded, up to 1.5 mm. long; terminal bud plump, 2.5–6 mm. long, with reddish brown–tomentose to grayish puberulent indumentum (hairs, FIGURE 22, q), underdeveloped internode absent. Petiole 0.6–1.4 cm. long, shallowly (deeply) concave above, convex below, subpersistently puberulent or not; lamina oblong (elliptic), 7.5–16 by 1.7–4.8 cm., $\pm$ gradually to abruptly acuminate at apex, cuneate to attenuate at base, undulate and slightly recurved at margin, entire lamina $\pm$ concave, coriaceous, drying brown-vinaceous to umber above and umber to fulvous below, often persistently puberulent on midrib above and especially below, the midrib above usually narrowing gradually from rather narrow base, raised, usually sulcate at first, 0.15–0.35 mm. wide at midpoint, below raised, striate, the venation $\pm$ apparent above and below, raised, 10 to 19 veins/5 mm., angle of divergence 70–80°. Inflorescences terminal and from adjacent foliate axils, with 7 to 15 (axillary inflorescences) to many (terminal inflorescences) flowers, unbranched (flabellate), or with 3-flowered branches to 1 cm. long, the axis 2.4–7 cm. long, reddish puberulo-tomentose (rarely subglabrous except at base), lowest internode of axillary inflorescences to 3 mm. long; bracts not seen, early deciduous; pedicels 0.5–1.5(–2.2) cm. long, puberulent (rarely glabrous), slender at first, in fruit to 3 mm. thick. Flower (?)hermaphroditic; tepals 8, the outer two broadly ovate, ca. 5 by 3.5–4.5 mm., $\pm$ puberulent on back, the next pair obovate, 6.5–10 by 3.5–7 mm., sometimes puberulent on back near base, the inner ones obovate, 7.5–11 by 3–5 mm., stamens 100 to 135, the filaments to 3 mm. long, the anthers oblong-elliptic, 0.5–0.7 mm. long, rounded at apex; ovary ca. 1.5 mm. long, the style ca. 3 mm. long, the stigma peltate, ca. 0.5 mm. across, $\pm$ 3-lobed. Fruit ellipsoid to subspherical, 2.5–3.5 by 2–2.6 cm., rounded to sharply pointed at apex, drying vinaceous-brown, with shallow, fairly dense, rounded wrinkles, or almost smooth (Sumatra); outer layer detaching $\pm$ cleanly from stone, 1.5–2.3 mm. thick, compact; stone ellipsoid, 2–2.6 by 1.75–2.2 cm.,

rounded at apex, the walls 0.9–1.2 mm. thick, thinner to one side of base, smooth, unmarked, perhaps with basal plug ca. 5 mm. across; spongy layer thin.

DISTRIBUTION. The eastern part of the Malay Peninsula, the Lingga Archipelago, perhaps in northeastern Sumatra (MAP 23).

SELECTED SPECIMENS SEEN. **Malaya.** TRENGGANU: Kuala Trengganu, 45 m., *KEP* 76064 (KEP); Dungun, Karteh Ulu Chukai F.R., 150 m., *KEP* 93882 (KEP); Jerengau State Land, *KEP* 76661 (KEP); Bukit Bauk F.R., 150 m., *KEP* 93973 (KEP); Kemaman, Bukit Kajang, 150 m., *SFN* 30565 (KEP, SING). PAHANG: Kuantan, Bukit Goh F.R., *KEP* 77978 (K, KEP); G. Tahan, *Wong & Wyatt-Smith* 34 (?) (KEP); Sungei Kelui, G. Tapis, *FRI* 10083 (?) (KEP); Baloh F.R., *KEP* 40216 (KEP). JOHORE: Kluang F.R., 90 m., *FRI* 7521 (A, KEP, SING); Mersing F.R., 15 m., *KEP* 77944 (KEP); Jemaluang F.R., *KEP* 73552 (KEP); Panti F.R., 366 m., *KEP* 99237 (KEP); Lenggong F.R., 35 m., *Stevens et al.* 57 (A). **Sumatra and adjacent islands.** RIAU: Lingga, P. Singkep, Marok Toewa bij Soengei Soelit, *bb* 1708 (= *Amat* 22) (BO, L), S. Poelak, 25 m., *bb* 4031 (= *Amat* 6) (BO). UTARA: Laboehan Batoe, Rattosan, Basau, 50 m., *bb* 8978 (?) (BO).

ECOLOGY. Lowland or colline mixed dipterocarp forest, 15–427 m. alt. Flowering January, April, July, and August; fruiting February, May, and July (fruit mauvish black—*KEP* 77978).

Some inflorescences of *SFN* 30321 are galled, having been converted into cauliflowerlike structures ca. 1 cm. across.

Calophyllum flavo-ramulum can be distinguished from the other large-leaved species of *Calophyllum* by its short terminal bud, axillary innovations with basal scars, leaf blades that dry boat shaped, and terminal inflorescences. (Although *C. flavo-ramulum* was described as having axillary inflorescences, some inflorescences, even on the type specimen, are terminal.) The older twigs of *C. flavo-ramulum* dry a yellowish color, hence the specific epithet.

Calophyllum flavo-ramulum has been confused with *C. dasypodum*, but the two species are not close. The terminal bud of *C. dasypodum* is longer, its older twigs do not dry yellow, its leaves do not dry boat shaped, its inflorescences are axillary, and its flowers usually have four tepals.

The specimens cited from the Lingga Archipelago are very similar to those from the Malay Peninsula, although they have somewhat smaller flowers and ellipsoid fruits that dry almost completely smooth, with only faint striations. The fruits of the Malayan specimens are variable in shape, but dry wrinkled. In the ellipsoid fruits of *KEP* 99237, the outer layer is much thickened (7 mm.) at the base.

73. *Calophyllum* sp.

Tree ca. 20 meters tall, d.b.h. to 32 cm.; trunk without buttresses; outer bark pale gray to yellow, smooth except for diamond-shaped fissures; latex golden, clear, very sticky.

Twigs slightly flattened, ca. 2 mm. across, not angled, drying pale brownish,

shiny, glabrous; axillary innovations with several pairs of basal scars; internodes 2–3.5 cm. long, uppermost pair of axillary buds rounded, ca. 0.7 mm. long, inconspicuous; terminal bud plump, 2–5 mm. long, consisting of several pairs of glabrous, imbricate scales up to 2.5 by 4 mm., underdeveloped internode absent. Petiole 0.7–1.3 cm. long, shallowly concave above, convex below, drying blackish, glabrous; lamina elliptic to suboblong, 7–13.5 by 3.4–5 cm., acuminate at apex, acute at base, slightly recurved and undulate at margin, entire lamina ± concave, coriaceous, drying ± vinaceous-brown above and subchestnut-brown below, glabrous, the midrib above gradually narrowed from base, raised, 0.25–0.5 mm. across at midpoint, below rather narrow, raised, rounded, the venation on both surfaces apparent, raised, 9 to 14 veins/5 mm., angle of divergence 75–80°. Inflorescences, flowers, and fruits not known.

DISTRIBUTION. The Malay Peninsula, Trengganu (MAP 24).

SPECIMENS SEEN. **Malaya.** TRENGGANU: Dungun, Bukit Bauk F.R., 30 m., KEP 53353 (KEP), 77983 (KEP).

Calophyllum sp. 73 is a remarkable taxon that is easily recognized, even when sterile, by its terminal buds, which are composed of a number of decussate, glabrous, imbricate perulae. Such buds are unique in the genus, and fertile material of this taxon is much needed.

KEP 53353 was cited as *Calophyllum ?flavoramulum* by Henderson and Wyatt-Smith (1956), but in that species a pair of indumentum-covered perulae completely enclose the rest of the bud.

74. *Calophyllum enervosum* M. R. Henderson & Wyatt-Smith, Gard. Bull. Singapore 15: 352. pl. 32. 1956; Kochummen, Malayan Forest Rec. ed. 2. 17: 221. 1965; T. C. Whitmore, Tree Fl. Malaya 2: 180. 1973. TYPE: Malaya, Johore, Mersing, Jemaluang F.R., 30 m., 20 April 1954, KEP 71894 coll. Wyatt-Smith (holotype, KEP; isotypes, BO, K, SING).

Tree 24–33 meters tall, d.b.h. to 50 cm.; trunk without buttresses; outer bark greenish olive to yellowish, smooth to rough and cracking very finely, hoop marked, the inner surface dull brownish orange; under bark dull reddish; inner bark reddish, laminated; latex clear yellow, very sticky, reported to turn cloudy (Henderson & Wyatt-Smith, *loc. cit.*).

Twigs slightly flattened, 2–2.7 mm. across, (obscurely) 4-angled, soon becoming rounded, drying blackish when young, later whitish to brown, ± brown-tomentose when young; axillary innovations with pair of scars 2–5 mm. from base; internodes 1–3 cm. long; uppermost pair of axillary buds rounded, less than 1 mm. long, inconspicuous; terminal bud plump, 2–4 mm. long, with ferrugineous, puberulo-tomentose indumentum (hairs, FIGURE 27, a), underdeveloped internode absent. Petiole (0.3–)0.5–1 cm. long, flat to broadly and shallowly concave above, convex below, glabrous; lamina elliptic to obovate, 3–9 by 1.4–4.8 cm., rounded to shortly and rather obscurely acuminate at apex, narrowly cuneate to attenuate and finally decurrent at base, not or broadly and rather distantly undulate and not or slightly recurved

Stevens, P F. 1980. "A revision of the Old World species of *Calophyllum* (Guttiferae)." *Journal of the Arnold Arboretum* 61(2), 117–424.

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