

## REVISION OF THE GENERA ALEURITES, REUTEALIS AND VERNICIA (EUPHORBIACEAE)

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### SUMMARY

The three closely related genera *Aleurites* J.R. Forst. & G. Forst., *Reutealis* Airy Shaw and *Vernicia* Lour., together constituting the subtribe Aleuritinae of the tribe Aleuritideae (Euphorbiaceae subfamily Crotonoideae), are revised. Originally included in *Aleurites*, *Reutealis* and *Vernicia* are considered generically distinct on account of differences in the indumentum, leaf base, inflorescences, number of stamens and fruit type. This distinction has also been confirmed by a recent phylogenetic analysis. *Aleurites* (2 species) differs from *Reutealis* and *Vernicia* by the more numerous stamens arranged in 4 rather than in 2 whorls, and the indehiscent fruits. The monotypic genus *Reutealis* can easily be distinguished from *Aleurites* and *Vernicia* by its five-angular or five-ribbed rather than terete twigs, the presence of rather persistent, hooded bracts, and spatulately flattened rather than terete stigmas. *Vernicia* (3 species) differs from the other two genera by its large and showy flowers arranged in corymbiform rather than in pyramidal thyrses and the lack of stellate hairs. Moreover, in *Vernicia* lobed leaves show conspicuous glands at the nadir of each sinus while in *Aleurites* these glands are absent (leaves of *Reutealis* are never lobed).

**Key words:** *Aleurites*, *Reutealis*, *Vernicia*, Malesia, systematics, taxonomy.

### INTRODUCTION

The group Aleuritinae was first established as a tribe by Hurusawa (1954), after which Webster (1975) reduced it to its present rank. According to the most recent classifications of Euphorbiaceae by Webster (1975, 1994) the subtribe Aleuritinae represents one of five subtribes of the tribe Aleuritideae in the subfamily Crotonoideae. The Aleuritinae comprise the genera *Aleurites*, *Reutealis* and *Vernicia*. These three genera are characterized by palmately veined, often lobed leaves (apart from *Reutealis*, in which the leaves are never lobed, in the other genera both simple and lobed leaves usually occur within the same individual), two conspicuous glands at the apex of the petiole, petaliferous flowers with fused sepals and connate filaments, and large, oil-containing seeds. Palynologically, subtribe Aleuritinae is characterized by inaperturate, spheroidal pollen grains with the sexine showing the *Croton* pattern, the latter being typical of the whole subfamily Crotonoideae (Erdtman, 1952; Punt, 1962; Chen & Shen, 1990; Nowicke, 1994). However, the pollen of *Reutealis trisperma* and *Vernicia cordata* has not been studied so far.

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The genus *Aleurites* was originally monotypic including the single species *A. triloba* J.R. Forst. & G. Forst. [= *A. moluccana* (L.) Willd.], the so-called 'candle nut' or 'kemiri nut', which is widespread in Malesia and Melanesia including Australia (North Queensland) and often cultivated for its valuable seed oil in other tropical areas. *Aleurites* was expanded by Müller (1866) to include the monotypic genera *Vernicia* Lour. and *Dryandra* Thunb., establishing for these the section *Dryandra* (Thunb.) Müll. Arg. In addition, he retained *Aleurites trisperma* Blanco, but under the new section *Reutiales* Müll. Arg. This treatment was accepted by succeeding workers, including Pax (1910) and Pax & Hoffmann (1931), until Airy Shaw's segregation of the group in 1967, following the discovery of the (as he claimed) related genera *Deutzianthus* Gagnep. (incl. *Loerzingia* Airy Shaw, see Webster, 1994) and *Tapoides* Airy Shaw.

Airy Shaw (1967) found broadly equivalent distinctions among these three (at that time) new genera and *Vernicia* and *Dryandra*. Rather than reducing the newer genera to sections of *Aleurites*, he restored *Vernicia* and raised *Reutiales* (anagram of *Aleurites*) to generic rank, changing the latter into *Reutealis* which sounded more like a generic name.

*Aleurites trisperma* Blanco, originally endemic to the Philippines and nowadays naturalized in West Java, *A. cordata* (Thunb.) Blume from Japan, *A. montana* (Lour.) Wils., and *A. fordii* Hemsl. both occurring in SE Asia (China, Burma, Vietnam, Thailand) were thus changed into *Reutealis trisperma* (Blanco) Airy Shaw, *Vernicia cordata* (Thunb.) Airy Shaw, *V. montana* and *V. fordii* (Hemsl.) Airy Shaw, respectively (Airy Shaw, 1967).

Some authors (e.g., Wagner et al., 1990) did not recognize these new combinations. However, in most other recent accounts (e.g., Backer & Bakhuizen van den Brink f., 1968; Radcliffe-Smith, 1987) *Reutealis* and *Vernicia* are accepted as separate genera. In his recent classification of Euphorbiaceae Webster (1994) only provisionally accepted the two segregates, for he considered *Reutealis* occupying an intermediate position showing the small flowers and stellate indumentum of *Aleurites* on the one hand, and the dehiscent fruits of *Vernicia* on the other hand.

Until recently *Aleurites* was considered to be monotypic, with *Aleurites moluccana* as its single species (Airy Shaw, 1981), or as comprising not more than two species (Radcliffe-Smith, 1987; Webster, 1994). *Aleurites moluccana* is a polymorphic species with exceedingly variable leaves often within the same individual. As a consequence, several separate species and varieties have been described based on this variation, especially from Hawaii. Yet, as pointed out by Wagner et al. (1990), none of these varieties endemic to Hawaii (Sherff, 1951; Stone, 1967; Degener & Degener, 1971) have a geographical or ecological basis and are therefore generally not recognized. Moreover, *Aleurites erratica* O. Deg., I. Deg. & K. Hummel which was named solely on the basis of drift seed collected at Canton Atoll in the Pacific (Degener et al., 1978) has most probably to be treated as a synonym of *A. moluccana* (see also Forster, 1996). Only two varieties described so far deserve further attention, namely *Aleurites moluccana* var. *rockinghamensis* Baill. endemic to Australia (Baillon, 1866) and *A. moluccana* var. *floccosa* Airy Shaw endemic to New Guinea (Airy Shaw, 1966). Although with a question mark, in his last contribution on the genus Airy Shaw (1981) placed *Aleurites moluccana* var. *floccosa* from New Guinea into the synonymy of *A. moluccana* var.

*rockinghamensis* distinguishing the latter from *A. moluccana* var. *moluccana* on account of differences in the indumentum, leaf shape, and number of carpels.

Based on a number of arguments including the differences outlined by Airy Shaw (1981), largely allopatric distribution, lack of intermediate forms, as well as additional discontinuities in floral and seedling morphology, Forster (1996) recently elevated *A. moluccana* var. *rockinghamensis* to species level. In the present paper this view is accepted. However, some of the characters Forster used to support his species concept deserve some qualification, possibly partly due to the fact that the author – as he admits himself – restricted the geographical coverage of his study to populations of *Aleurites* that occur naturally in Australia and New Guinea.

#### DISCUSSION AND TAXONOMY

Upon comparison with specimens of *Aleurites*, it was found that *Reutealis* and *Vernicia* share some characteristics with and also differ quite significantly from this genus. The genus *Aleurites* mostly has a cuneate or truncate leaf base, a 2- or 3-locular ovary, drupaceous fruits and 17–32 stamens. *Reutealis* and *Vernicia* have leaves that are truncate to cordate but never cuneate at base, 3–5-locular ovaries, dehiscent fruits and 7–14 stamens. Evidence from cytology (Graner, 1935; Stockar, 1946) has shown that *Aleurites moluccana* is tetraploid, with  $2n = 44$ , while *Reutealis* and the three *Vernicia* species are all diploids with  $2n = 22$ . Because of these differences the authors consider *Reutealis* and *Vernicia* generically distinct from *Aleurites*.

*Reutealis* and *Vernicia* are similar in leaf characters such as shape, venation and glands. However, upon close examination, differences in both vegetative and floral characters were found. *Reutealis* has distinctly stellate hairs on the underside of the leaf and 5-angular twigs while *Vernicia* has a simple or bifurcate indumentum and terete twigs. The most obvious difference is found in the inflorescences: *Reutealis* has a woolly pyramidal thyrse bearing numerous flowers of up to 13 mm in diameter whilst *Vernicia* is characterized by a tomentose corymbiform thyrse with flowers of at least 14 mm (up to 35 mm) in diameter, the petals of which are (in contrast to those of *Aleurites* and *Reutealis*) distinctly veined. The anthers in *Reutealis* are extrorse while those of *Vernicia* open introrse. In both genera, three bifid (in *Reutealis* also occasionally trifid) styles are present but these are spatulately flattened in *Reutealis* and terete in *Vernicia*. Moreover, the seeds of *Vernicia* are obovoid to subglobose and pointed at the micropylar end while those of *Reutealis* are thick-discoid to subglobose and obtuse at both the micropylar and the chalazal end.

Within *Vernicia*, three species can be distinguished, *V. cordata*, the Japanese wood oil tree, *V. fordii*, the T'ung oil or Chinese wood oil tree, and *V. montana*, also called Mu-yu tree. *Vernicia fordii* is the only deciduous species of the genus and adapted to the more temperate regions of Central and South China and also South Burma and North Vietnam. The three *Vernicia* species can readily be distinguished by the structure of the glands at the apex of the petiole (i.e., at the junction between petiole and lamina). In *V. fordii* there are two small, sessile, discoid glands whereas in *V. cordata* and *V. montana* the glands are stalked. What distinguishes the latter two species is that in *V. cordata* the glands are slenderly stalked and swollen at the apex and in *V. montana* they are club-shaped. In addition to these basal glands, all species show a gland at the

nadir of each sinus in lobed leaves. Moreover, the inflorescences are unisexual and many-flowered in *V. cordata* and *V. montana* and usually bisexual and few-flowered in *V. fordii* where one terminal pistillate flower is surrounded by several 3–7-flowered staminate cymules. In *V. cordata* the styles are structurally clearly separable from the usually 3-locular ovary, whereas in *V. montana* (also with a usually 3-locular ovary) and *V. fordii* (in which the ovary is usually 4-locular) the ovary is gradually narrowing into the styles. Apart from these characters, the three species differ slightly in the structure of their fruits and seeds (for details see descriptions below).

The differences between *Aleurites*, *Reutealis* and *Vernicia* described above corroborate Airy Shaw's (1967) generic concept and overcome Webster's (1967, 1994) doubt about whether the latter two segregates need to be recognized. This conclusion finds major support in the results of a phylogenetic analysis of the group (Van Welzen & Stuppy, ms.) showing that the members of Aleuritinae form a monophyletic group with the monotypic genus *Reutealis* basal to *Aleurites* and *Vernicia*, both also being monophyletic.

#### DIFFERENCES BETWEEN *ALEURITES MOLUCCANA* AND *A. ROCKINGHAMENSIS*

As already indicated above, some of the characters used by Forster (1996) to support his elevation of *Aleurites moluccana* var. *rockinghamensis* to species level deserve re-evaluation after investigation of *Aleurites* specimens from outside the geographical area covered by Forster's investigations. Most of the characters mentioned by Forster (1996) in which *A. moluccana* and *A. rockinghamensis* differ from each other can be confirmed and even some others can be added:

#### **Colour and density of the indumentum**

According to Forster (1996) the indumentum is silver in *Aleurites moluccana* and ferruginous-silver in *A. rockinghamensis*. However, our own observations have shown that the colour of the trichomes varies tremendously even within the same individual from greyish- or fulvous-silver to various shades of ferruginous-silver. It can only be said that in *A. rockinghamensis* the indumentum generally tends to be darker and distinctly more ferruginous than in *A. moluccana*, which usually displays greyish- or fulvous-silver hairs. Forster's (1996) distinction between whether the lower leaf surface is "glabrous or with scattered trichomes" (as it is supposed to be in *A. moluccana*) or with "sparse to dense, generally velutinous trichomes" (as it is supposed to be in *A. rockinghamensis*) is hardly acceptable. E.g., there are a number of specimens of *A. moluccana* present in the Leiden Herbarium, especially from New Guinea (!), which were erroneously determined as *A. moluccana* var. *floccosa* (= *A. rockinghamensis*) on account of their dense, floccose and dark ferruginous indumentum on young leaves and shoots. Moreover, the hairs on the petals of the two species are not simple as claimed by Forster (1996) but in fact conspicuously stellate.

#### **Leaf shape**

As stated by Airy Shaw (1981) and later supported by Forster (1996) the leaves in *Aleurites moluccana* are "relatively narrow, not or rarely cordate" whilst those of *A. rockinghamensis* should be "broader, mostly cordate". However, our own observa-

tions have shown that in *A. rockinghamensis* the leaf base is mostly cuneate or truncate and only sometimes cordate. With respect to the shape of the leaf lamina, measurements showed that the length/width ratio of the leaf blade ranges from 1–1.8 in *A. rockinghamensis* but from 1–4 in *A. moluccana*. Since there is an overlap in the proportion of length/width of the leaf lamina, an absolute distinction between the two species cannot be drawn, but there is in fact a clear tendency towards (relatively) broader leaves in *A. rockinghamensis*.

### **Inflorescence size**

Although one of the most striking characters to distinguish *A. moluccana* and *A. rockinghamensis*, Forster (1996) did not particularly emphasize the difference in the size of the inflorescence. In *A. moluccana* the size of the inflorescence varies within 6–25 by 6–23 cm and in *A. rockinghamensis* within 8–25 by 7.5–30 cm. Of course, there is a large degree of overlap in inflorescence size; however, in *A. moluccana* the inflorescence is always much more delicate than in *A. rockinghamensis*. Although, it seems to be difficult to express the delicacy of such a variable structure by numbers, the basal diameter of the peduncle, i.e., the main axis of the inflorescence, can well be used as a measure of delicacy and there is even hardly any overlap in dimension between the two species. The basal diameter of the peduncle ranges from 2 to 4.5(–5) mm in *A. moluccana* and from 5 to 9 mm in *A. rockinghamensis*. Moreover, although variable, the colour of the indumentum of the inflorescence is mostly darker in *A. rockinghamensis* than in *A. moluccana*.

### **Flower size**

According to Forster (1996) the flowers of *A. moluccana* are significantly smaller than those of *A. rockinghamensis*. In average this is true, but occasionally the flowers of *A. moluccana* are larger in diameter than those of some (particularly small flowering specimens) of *A. rockinghamensis*. However, in flowers of *A. moluccana* the calyx is generally smaller in diameter (most probably as a consequence of the generally larger androecium, see below) so that in direct comparison they look more delicate than the flowers of *A. rockinghamensis*.

### **Number of stamens**

Forster (1996) pointed out that the number of stamens is variable in both *A. moluccana* and *A. rockinghamensis* and there is a degree of overlap. However, for *A. rockinghamensis* Forster gave the range as 24–32, whereas our own observations have shown that also numbers of 20 can occur. In *A. moluccana* the number of stamens varies between (17–)18–26, quite as stated by Forster.

### **Style length and indumentum**

Forster (1996) omitted to point out, that the styles in *A. moluccana* are mostly glabrous (rarely with a few scattered stellate hairs on the outside) whilst those in *A. rockinghamensis* are conspicuously stellate-pubescent on the outside. Moreover, in *A. rockinghamensis* the styles are usually not only longer than in *A. moluccana* but also much less deeply divided (only up to half of their length rather than almost to the base). However, the discontinuity in style length between *A. moluccana* and *A. rockinghamensis* as given by Forster (1996) cannot be fully confirmed. In *A. moluccana* style

length varies from 0.5 to 2.6 mm (Forster: 0.5–2 mm) and in *A. rockinghamensis* from 2.6 to 3.2 mm (Forster: 2.8–3 mm).

### Ovary, fruit and seed

Besides the structure of the inflorescence (see below) the most reliable character to distinguish *A. moluccana* and *A. rockinghamensis* is the number of carpels/locules per ovary. In *A. moluccana* the ovary is almost strictly 2-locular (rarely 3-locular), in the second the ovary is – with very rare exceptions – strictly 3-locular (rarely even 4-locular). Only of limited use but still worth to be mentioned is that the fruits are generally larger in *A. rockinghamensis* [4–6.5 by 5.5–8 cm] than in *A. moluccana* [4–4.5 by 4–6(–7) cm].

The seeds finally seem to provide another good character to distinguish the two species. *Aleurites moluccana* is characterized by seeds which are broadly obovoid, dorsiventrally compressed, cordate in dorsal view, truncate or rarely minutely tipped at the micropylar end and always tapering towards the obtusely acuminate chalazal end, while the seeds of *A. rockinghamensis* are subglobose to obovoid, truncate at the micropylar and obtuse at the chalazal end (however, only one seed seen).

The differences in characters of seedlings at third leaf stage mentioned by Forster (1996) have not been re-examined due to the lack of adequate herbarium as well as viable seed material. According to the author in this respect *A. rockinghamensis* differs from *A. moluccana* mainly in the larger cotyledons, weaker primary venation, more obvious glands at the junction of the petiole with the blade, and shape of the primary and later leaves.

### KEY TO THE GENERA IN SUBTRIBE ALEURITINAE

- 1a. Indumentum distinctly stellate, silver to ferruginous-silver. Leaf base cuneate, rounded, truncate, or (especially if the leaves are lobed) shallowly to moderately cordate or reniform; lobed leaves without a gland at the nadir of each sinus. Stamens 17–32; anthers introrse. Ovary 2- or 3(–4)-locular. Fruits drupaceous . . . . . **1. *Aleurites***
- b. Indumentum stellate, bifurcate or simple, whitish to light beige or fulvous to ferruginous. Leaf base truncate or shallowly to deeply cordate or reniform, never cuneate; lobed leaves always with a gland at the nadir of each sinus. Stamens 7–12(–14); anthers introrse or extrorse. Ovary 3–5-locular. Fruits capsular . . . . . **2**
- 2a. Twigs 5-angular. Indumentum of both simple and stellate hairs. Leaves never lobed. Inflorescence a woolly panicle; bracts conspicuously hooded after anthesis. Flowers small, less than 1 cm diam.; petals not veined, densely covered with simple hairs on the outside; anthers extrorse; styles 2- or 3-lobed with spatulately flattened stigmas . . . . . **2. *Reutealis***
- b. Twigs terete. Indumentum of bifurcate or simple but never stellate hairs. Leaves often lobed. Inflorescence a corymbiform thyrses, only shortly puberulous or tomentose; bracts inconspicuous, not hooded. Flowers large, 2–4 cm diam., petals distinctly veined, outside glabrous or sparingly pubescent in the lower half; anthers introrse; styles bifid, distal ends terete . . . . . **3. *Vernicia***

## 1. ALEURITES

- Aleurites* J.R. Forst. & G. Forst., Char. Gen. Pl. (1776) 56; Müll.Arg. in DC., Prodr. 15, 2 (1866) 722; Hook.f., Fl. Brit. India 5 (1887) 384; Pax in Engl., Pflanzenr. IV.147 (1910) 128; J.J. Sm., Meded. Dept. Landb. Ned.-Indië 10 (1910) 550; Backer & Bakh.f., Fl. Java 1 (1963) 477; Airy Shaw, Kew Bull. 20 (1967) 393; Kew Bull. 26 (1972) 213; Kew Bull. Add. Ser. 4 (1975) 29; E. Walker, Fl. Okinawa S. Ryukyo Is. (1976) 644; Airy Shaw, Kew Bull. Add. Ser. 8 (1980) 25; Muellera 4 (1980) 230; Kew Bull. 36 (1981) 252; Alph. Enum. Euphorb. Philipp. Is. (1983) 4; W.L. Wagner, D.R. Herbst & Sohmer, Man. Fl. Pl. Hawai'i 1 (1990) 597; G.L. Webster, Ann. Missouri Bot. Gard. 81 (1994) 114; P.I. Forst., Muellera 9 (1996) 6. — *Aleurites* J.R. Forst. & G. Forst. section *Camirium* (Rumph. ex Gaertn.) Müll.Arg. in DC., Prodr. 15, 2 (1966) 723, nom. inval.; Pax in Engl., Pflanzenr. IV.147 (1910) 129. — Type species: *Aleurites triloba* J.R. Forst. & G. Forst. [= *Aleurites moluccana* (L.) Willd.]
- Camirium* Rumph. ex Gaertn., Fruct. Sem. Pl. 2 (1791) 194. — Type species: *Camirium cordifolium* Gaertn. [= *Aleurites moluccana* (L.) Willd.]

Trees, monoecious, evergreen. *Indumentum* of greyish or fulvous-silver to ferruginous-silver stellate, multicellular hairs, glandular or stinging hairs absent. Young twigs terete, scurfily stellate pubescent. *Stipules* minute, cylindrical, stellate-pubescent, early caducous, leaving two small circular scars. *Petiole* terete, slightly ribbed or striate, evenly scurfily or shortly stellate-pubescent or puberulous, with two (rarely three) sessile, discoid, shining glands adaxially at junction with blade, the glands exuding a sweet sap. *Leaves* alternate, simple, ovate to ovate-lanceolate or ovate-trullate, not or shallowly 3- or 5-palmately lobed, without glands in marginal sinuses between lobes, densely stellate-pubescent above and beneath when young, glabrescent; lobes triangular-deltoid; base cuneate, rounded, truncate, or (especially if the leaves are lobed) shallowly to moderately cordate or reniform; margin entire; apex and lobes acute to acuminate; basally palmately 3- or 5-veined, pinnate along the midrib with 4–8 major lateral veins per side. *Inflorescences* terminal, solitary, many-flowered pyramidal thyrses, conical, branching from the base, bisexual or rarely unisexual with the flowers in bracteate clusters, protogynous with a solitary pistillate flower terminating each major axis, lateral cymes staminate, axes densely stellate-pubescent; bracts trigonous-subulate, convex, acute, early caducous, densely stellate-tomentose. *Flowers* unisexual, actinomorphic, fragrant, white to cream; buds ovoid or ovoid-ellipsoid, apex obtuse; calyx valvate, closed in bud, later rupturing to the base into 2 or 3 (4) often unequal, lanceolate to ovate lobes, stellate-tomentose outside, subglabrous or with scattered stellate hairs inside; petals 5 (6), free, imbricate, oblanceolate-spathulate, rounded at the apex, drying dark brown to black, veins not distinct, outside glabrous or with loose to dense stellate hairs in a longitudinal band in the middle, inside simple-pubescent at the base; disc 5-lobed, lobes free, flattened, inconspicuous. *Staminate flowers*: pedicel slender, filiform, mostly longer and always significantly thinner than in the pistillate flowers; disc lobes thick, somewhat convolute, glabrous; stamens 17–32, in 4 whorls, the outer ones free, the inner ones united into a column; filaments pubescent, with loose to dense, colourless to brown stellate hairs; anthers basifixed to dorsibasifixed, opening introrsely with 2 longitudinal slits, glabrous or with scattered stellate hairs; pistillode absent. *Pistillate flowers*: usually somewhat larger than the staminate ones; pedicel short, stout, stellate-pubescent; disc lobes deltoid to semicircular, stellate pubescent, especially at the apex; ovary superior, 2- or 3(–4)-locular, with 1 ovule per locule, densely stellate-tomentose; styles fused at base, thick, bifid, entirely glabrous

or stellate-pubescent on the outside. *Fruits* large, drupaceous, varying in shape according to number of locules developed, evenly to sparingly stellate-pubescent, with fleshy exocarp and thin, woody endocarp. *Seeds* ecarunculate, subglobose to ovoid, dorsiventrally compressed or not, surface gibberulous; hilum large. *Embryo* straight, embedded in copious endosperm; cotyledons broad, flat.

Distribution — The genus *Aleurites* comprises two species. One (*A. moluccana*) is very widespread (tropical Asia, Oceania from India to China and Polynesia, Australia and New Zealand) and also widely cultivated throughout the tropics, the other (*Aleurites rockinghamensis*) has only a very limited distribution in Papua New Guinea and Australia.

Note — The name of the genus is derived from the Greek for 'wheaten flour', referring to the mealy appearance of the lower leaf surface.

#### KEY TO THE SPECIES

- a. Inflorescence delicate, base of peduncle 2–4.5(–5) mm diam. Stamens 17–26. Styles (0.5–)1–2.6 mm long, glabrous or rarely with a few scattered stellate hairs on the outside, bifid almost to the base; ovary 1 or 2(–3)-locular. Seeds cordate in dorsal view, dorsiventrally compressed, truncate or rarely minutely tipped at the micropylar end, always tapering towards and pointed at the chalazal end . . . . . **1. *A. moluccana***
- b. Inflorescence robust, base of peduncle 5–9 mm diam. Stamens 20–32. Styles 2.6–3.2 mm long, conspicuously stellate-pubescent on the outside, bifid up to half of their length; ovary 3- or 4-locular. Seeds oval to almost elliptic in dorsal view, not dorsiventrally compressed, truncate at the micropylar end, attenuate and obtuse at the chalazal end . . . . . **2. *A. rockinghamensis***

#### 1. *Aleurites moluccana* (L.) Willd. — Fig. 1j–m

*Aleurites moluccana* (L.) Willd., Sp. Pl. 4 (1804) 590; Müll.Arg. in DC., Prodr. 15, 2 (1866) 723; Scheff., Ann. Mus. Bot. Lugd.-Bat. 4 (1868) 120; Hook. f., Fl. Brit. India 5 (1887) 384; Pax in Engl., Pflanzenr. IV.147 (1910) 129, f. 45; J.J. Sm., Meded. Dept. Landb. Ned.-Indië 10 (1910) 551; Merr., Interpr. Herb. Amboin. (1917) 318; Sp. Blancoan. (1918) 228; J. Straits Branch Roy. Asiat. Soc., special number (1921) 344; Enum. Philipp. Flow. Pl. 2 (1923) 448; Gagnep. in Lecomte, Fl. Indo-Chine 5 (1925) 291; Merr., Trans. Amer. Philos. Soc. new ser., 24 (1935) 239; Backer & Bakh.f., Fl. Java 1 (1963) 478; B.C. Stone, Pacific Sc. 21 (1967) 551; Airy Shaw, Kew Bull. 20 (1967) 393; Kew Bull. 26 (1972) 213; Whitmore, Tree Fl. Malaya 2 (1973) 54; Airy Shaw, Kew Bull. Add. Ser. 4 (1975) 29; E. Walker, Fl. Okinawa S. Ryukyo Is. (1976) 644; Airy Shaw, Kew Bull. Add. Ser. 8 (1980) 26; Muellera 4 (1980) 230; Kew Bull. 36 (1981) 252; Kew Bull. 37 (1982) 5; Alph. Enum. Euphorb. Philipp. Is. (1983) 4; W.L. Wagner, D.R. Herbst & Sohmer, Man. Fl. Pl. Hawai'i 1 (1990) 598, pl. 80 upper left; P.I. Forst., Muellera 9 (1996) 7. — *Jatropha moluccana* L., Sp. Pl. (1753) 1006. — *Aleurites moluccana* (L.) Willd. var. *moluccana*: Airy Shaw, Muellera 4 (1980) 230. — (Lecto)type (selected here): *Hb. Linnaeus 1141/5* (LINN, n.v.; IDC microfiche). See note 1.

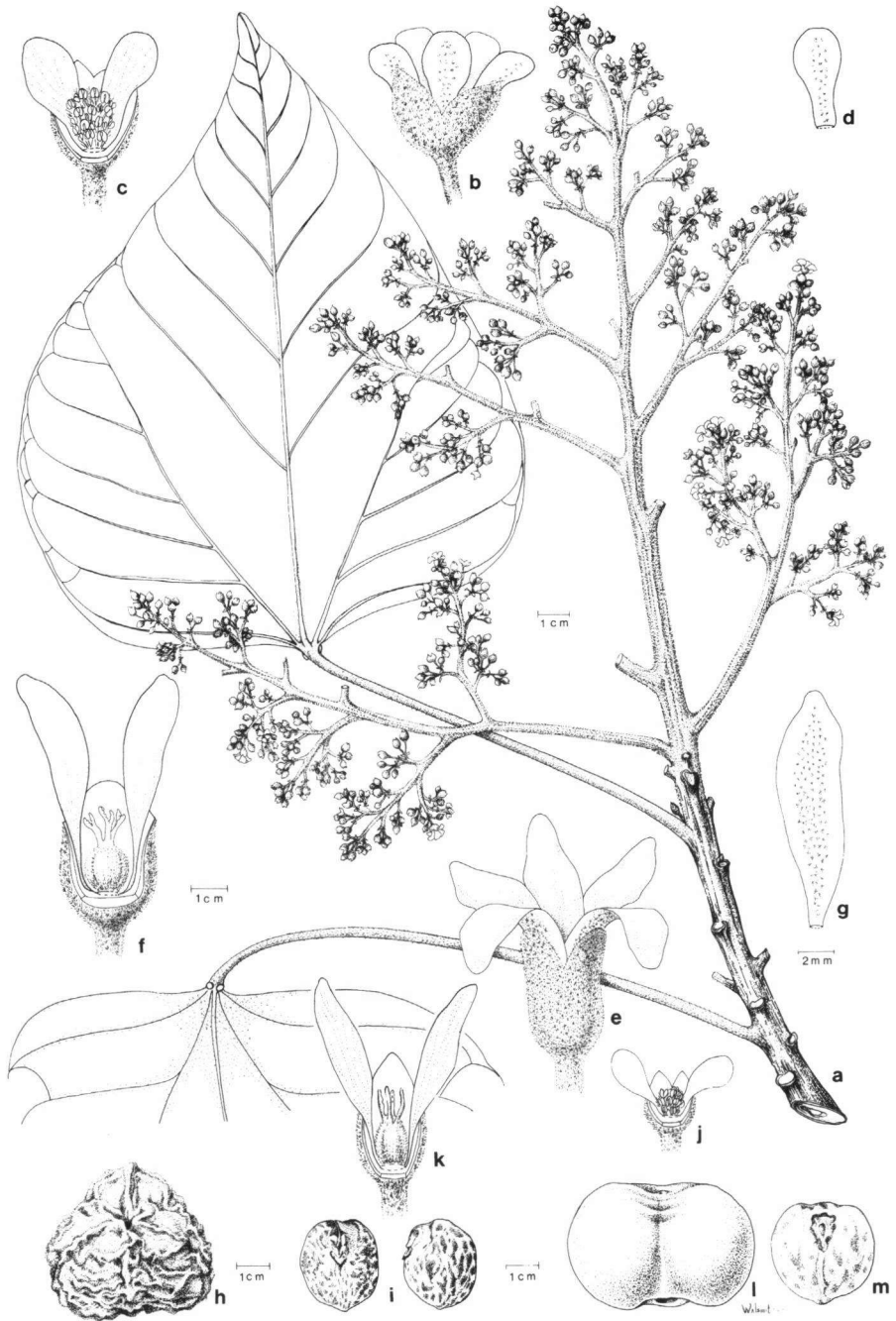
*Aleurites triloba* J.R. Forst. & G. Forst., Char. Gen. Pl. (1776) 56, t. 56.; Boerl., Handl. Fl. Ned. Indië 3, 1 (1900) 282; Hemsl., Bull. Misc. Inform. (1906) 121. — Type: J.R. Forst. & G. Forst., Char. Gen. Pl. (1776) t. 56.

*Juglans camirium* Lour., Fl. Cochinch. 1 (1790) 573. — *Camirium cordifolium* Gaertn., Fruct. Sem. Pl. 2 (1791) 195, t. 125, f. 2. — *Aleurites cordifolia* Steud., Nomencl. Bot. ed. 2, 1 (1840) 49; nom. superfl. — Type: Rumphius, Herb. Amboin. 2 (1741) t. 58.



- Aleurites commutata* Geiseler, Croton Monogr. (Mar. 1807) 82. — Type: *Vahl* (holo C, n.v.).
- Aleurites ambinux* Pers., Syn. Pl. 2 (Sep. 1807) 587. — Lectotype (selected here): *Anonymous s.n.* (P).
- [*Camirium oleosum* Reinw. ex Blume, Catalogus (1823) 104; nom. nud.]
- Aleurites lobata* Blanco, Fl. Filip. (1837) 756. — Neotype (selected here): *Merrill Species Blancoanae 127* (holo L; iso NY, W), Philippines, Luzon, Cavite Province, Maragondong.
- Aleurites lanceolata* Blanco, Fl. Filip. (1837) 757. — Type lost (for synonymy see Fern.-Vill., Nov. App., 1880, 191).
- [*Aleurites pentaphylla* Wall., Numer. List (1847) no. 7959; nom. nud. pro *Wallich 7959* (K, n.v.), India, Calcutta Botanical Garden.]
- [*Aleurites integrifolia* Vieill., Ann. Sci. Nat. (Paris) 16 (1862) 59, name in synonymy; Guillaumin, Ann. Inst. Mus. Colon. Marseille, ser. 2, 9 (1911) 225.]
- Aleurites angustifolia* Vieill., Ann. Sci. Nat. (Paris) 16 (1862) 60; Guillaumin, Ann. Inst. Mus. Colon. Marseille, ser. 2, 9 (1911) 225. — Syntypes: *Vieillard s.n.* (P?, n.v.), New Caledonia, Croît à Puébo; *Vieillard 1149* (P), New Caledonia, Balade.
- Aleurites javanica* Gand., Bull. Soc. Bot. France 29 (1913) 27. — Type: *Treub s.n.* (P?, n.v.), Indonesia, Java, cultivated in Bogor Botanical Garden.
- Aleurites remyi* Sherff, Field Mus. Nat. Hist., Bot. Ser. 17 (1939) 558; Airy Shaw, Kew Bull. 20 (1967) 393. — *Aleurites moluccana* (L.) Willd. var. *remyi* (Sherff) B.C. Stone, Pacific Sc. 21 (1967) 553. — Type: *Remy 600*, p.p. (P, 3 sheets), Hawaii.
- Aleurites moluccana* (L.) Willd. var. *serotina* O. Deg. & Sherff in Sherff, Amer. J. Bot. 38 (1951) 57. — Type: *Degener, Clay & Bertram 19329* (holo F, n.v.; iso A, B, BISH, CM, G, LA, MO, NY, P, PHIL), USA, Hawaii, Maui, near Kamole Gulch.
- Aleurites moluccana* (L.) Willd. var. *katoi* O. Deg., I. Deg. & B.C. Stone [in B.C. Stone, Pacific Sc. 21 (1967) 551; nom. nud.] in O. Deg. & I. Deg., Phytologia 21 (1971) 315. — Type: *Stone 3427* (holo BISH; iso BISH), USA, Hawaii, Kauai High School in Lihue.
- Aleurites moluccana* (L.) Willd. var. *aulanii* O. Deg. & I. Deg., Phytologia 21 (1971) 316. — Type: *O. Degener & I. Degener (Stanley & Aulani Loo) 32481* (holo NY; iso L), USA, Hawaii, Kukuiahaele.
- Aleurites erratica* O. Deg., I. Deg. & K. Hummel, Phytologia 38 (1978) 361. — Type: *O. Degener & I. Degener 24627* (holo TUB, ?, n.v.; iso BISH), Phoenix Islands, Canton Atoll.
- Croton moluccana* auct. non L.: L., Sp. Pl. (1753) 1005 (only reference to Burman). See note 2.

Large tree with spreading pendulous and ascending branches, up to 15–25(–40) m tall. *Bark* smooth, red-brown, with deep fissures, blaze pink to red. *Indumentum* greyish- or fulvous-silver to mostly pale, rarely dark ferruginous-silver. *Stipules* c. 1 mm long. *Petiole* 3.5–16(–40) cm by 1.5–6 mm; glands at the apex 0.5–2 mm diam. *Leaf blade* in some extreme, mostly cultivated forms narrowly lanceolate, orbicular or deeply lobed with narrow lobes (see note 3), (6–)12–30 by 3–15(–28) cm, ratio 1–4. *Inflorescences* delicate, 4–27 by 4–32 cm, axes densely fulvous- (to ferruginous-silver) pubescent; base of peduncle 2–4.5(–5) mm diam.; bracts 2–4 by 0.5–2 mm. *Staminate flowers*: 5–9 by 5–10 mm; pedicel 4–12 by 0.3–0.5 mm, stellate-pubescent; buds 2–3 by 2–2.5 mm; calyx lobes 2.5–3 by 1.5–3 mm; petals (3.5–)5–7(–9.5) by 1.2–3 mm; stamens 17–26, outermost filaments 0.5–1 mm long, the innermost ones 2–3.5 mm long; anthers 0.6–0.8 by 0.3–0.6 mm. *Pistillate flowers*: 6–11 by 7–10 mm; pedicel stout, 2–3.5(–6) by 1–2.5 mm, stellate-pubescent; buds 4–5.5 by 2–2.5 mm; calyx lobes 3–6 by 2–5 mm; petals 6–11 by 1.6–3 mm; ovary subglobose, laterally compressed (rarely trigonous), 2- (or 3-)locular, 1.5–3 by 2–3.5 mm, densely fulvous to rarely ferruginous stellate-tomentose; styles deeply bifid (almost up to the base), (0.5–)1–2.6 mm long, mostly glabrous, rarely with very few colourless, stellate hairs on the outside. *Fruits* laterally compressed, broadly ovoid-subglobose or transversely



ovoid with 4 (6) low longitudinal ridges, very slightly acuminate at the apex, 4–4.5 by 4–6(–7) cm. *Seeds* broadly obovoid, cordate in dorsal view, dorsiventrally compressed, truncate or rarely minutely tipped at the micropylar end, always tapering towards the obtusely acuminate chalazal end, (20–)23–32 by 20–32 by (15–)18–24 mm, greyish, mottled brownish.

**Distribution** — Native of tropical Asia and Oceania, from India and China to Polynesia and New Zealand, and widely cultivated in the tropics generally. According to Forster (1996) in Australia *A. moluccana* is restricted to North Queensland. About the area of origin of *A. moluccana*, A. C. Smith (1981) writes: “Indigenous in Malasia, although the precise area of its nativity is probably impossible to establish because of its early aboriginal introduction to neighboring areas, doubtless including India and Ceylon as well as Melanesia and Polynesia.”

**Ecology & Habitat** — Occurring throughout the tropics, wild and cultivated, from sea-level up to at least 1000 m altitude on a variety of substrates, both on red loam and stony clay ground, on sand and limestone, sometimes in periodically rather dry areas (Smith, 1910). Young plants are common as pioneers in disturbed gaps or margins of the vineforest (Forster, 1996).

**Uses** — Wood is used for the production of tea boxes and canoes but not for construction. The seeds are eaten raw or after roasting in fire together with rice or used as purgative. Wrapped in leaves or strung to palm leaf midribs they are also used as torches. The latex is chewed as chewing gum in the Pacific and is also used medicinally and as glue. In Hawaii juice from the husk is used as a black dye, and similarly from the bark of the root, the latter is used to paint canoes. Also in Hawaii, the roasted seeds mixed with salt and seaweed make a condiment called ‘inamona’. Chinese in Hawaii let the wood of felled trees rot to grow a fungus [*Auricularia cornea* (Ehrenb. ex Fr.) Ehrenb. ex Endl.] for local consumption and for export to China. The tree is also used as an ornamental.

The seeds contain a high amount of oil (60%) which is used as fuel, lubricant or as part in varnish, paint or soap. The oil is also used as rubbing oil for rheumatism (Pax, 1910; Smith, 1910; Wagner et al., 1990).

**Vernacular names** — English: Candle nut, Indian walnut. Indonesia: Kemiri (Malay); moentjang (Sundanese). Philippines: Biau (Bagobo, Cebu Bisaya,); kalumban, kapili, lumbang, lumbang-bato (Tagalog); kami (Sulu); rumbang (Bisaya) (Merrill, 1923). Papua New Guinea: Mboal. Tahiti: Tahii-tairi. Samoa: Lama. Hawaii: Kukui; aulani kukui, small-seeded kukui (former var. *alulanii*); kato kukui, mango-leaved kukui (former var. *katoi*); kona kukui (former var. *remyi*) (Degener & Degener, 1971). Brazil: Noz da India (Pax, 1910).

Fig. 1. *Aleurites rockinghamensis* (Baill.) P.I. Forst. a. Habit; b. staminate flower; c. staminate flower showing androecium (calyx and petals partly removed); d. petal of staminate flower in dorsal view; e. pistillate flower; f. pistillate flower showing gynoecium (calyx and petals partly removed); g. petal of pistillate flower in dorsal view; h. fruit (the strong wrinkles are an artifact due to drying out); i. seed in ventral (hilum up) and side view. — *A. moluccana* (L.) Willd. j. Staminate flower showing androecium (calyx and petals partly removed); k. pistillate flower showing gynoecium (calyx and petals partly removed); l. fruit; m. seed in ventral view (hilum up) [all L.; a: Hyland 8014; b–d: NGF (Streimann & Kairo) 44575; e–g: NGF (Floyd) 7463; h & i: Veldkamp & Stevens 5918; j–m: Van Royen 3828].

Notes — 1. Linnaeus in his description refers to his own Ceylon flora and the one made by Hermann. Both refer to the fact that the plant is Moluccan. The specimen in LINN has the reference ‘Comm. Rumphius’ and is one of the Moluccan plants sent by Rumphius (via Hermann?) and may, therefore, be selected as the type.

2. The name *Croton moluccana* L. is based on two references. The first one (‘Fl. Zeyl. 346’; must be page 146) is *Givotia rottleriformis* Griff. (Euphorbiaceae); the other one (‘*Nux juglans moluccana bifida* Burm., Fl. Zeyl. 170’) is *Aleurites moluccana* (L.) Willd. (the latter is based on *Jatropha moluccana* L., by coincidence the same epithet). The best thing to do is to lectotypify Linnaeus’s name with one of the Hermann specimens (*Givotia rottleriformis*), because this is the only indirect reference (via L., Fl. Zeyl.) to specimens; the other reference only mentions the description in Burman’s Thesaurus Zeylanica (= *Aleurites moluccana*) (Merrill, 1917; Trimen, 1898). The specimen in LINN (no. 1140/20) in London is *Melanolepis multiglandulosa*, but this is not the type of the species. Müller Argoviensis regarded this specimen as the type and, therefore, erroneously made the necessary combination in *Mallotus* (and subsequent authors in *Rottlera* and *Melanolepis*).

3. As already mentioned in the introduction, *Aleurites moluccana* shows a strong variation in leaf shape, which has led to the description of several separate species or varieties which are, however, not recognized here. On account of its very narrow, unlobed, lanceolate leaves one New Caledonian form was described as separate species (*A. angustifolia*) already last century (Vieillard, 1862). Later two extreme forms from Hawaii – according to Stone (1967) probably of aboriginal Hawaiian selection – have been described as separate species or variety respectively, but are not accepted here. One is *A. remyi* (later assigned to varietal status) bearing relatively lengthened, simple, lanceolate leaves (with or without obscure lobes) or deeply lobed leaves with the lateral lobes very narrow and the terminal lobe much elongated. The second is *A. moluccana* var. *katoi* (‘Mango-leaved Kukui’) bearing narrow, (only?) lanceolate leaves with the lateral lobes obscure or absent (for references see above). Besides that, of the material seen by the authors, one (cultivated) specimen from New Caledonia (*Balansa* 3443, P) shows perfectly orbicular leaves.

Another dubious variety, *A. moluccana* var. *aulanii* (‘small-seeded Kukui’), was described by Degener & Degener (1971) solely on the basis of smaller seeds.

## 2. *Aleurites rockinghamensis* (Baill.) P.I. Forst. — Fig. 1a–i

*Aleurites rockinghamensis* (Baill.) P.I. Forst., Muelleria 9 (1996) 8. — *Aleurites moluccana* (L.) Willd. var. *rockinghamensis* Baill., Adansonia 6 (1866) 297; Airy Shaw, Muelleria 4 (1980) 230. — Lectotype (Forster, 1996): *Dallachy s.n. MEL 232486* (holo MEL; iso MEL), Australia, Queensland, Cook District, Rockingham’s Bay.

*Aleurites moluccana* (L.) Willd. var. *floccosa* Airy Shaw, Kew Bull. 20 (1966) 26. — Type: *NGF (Havel) 9169* (holo K, n.v.; iso L, LAE), Papua New Guinea, Morobe District, Wau, Anderson’s Logging Area.

Large tree with spreading pendulous and ascending branches, up to 30 m tall. *Bark* smooth, grey, nondescript, blaze brown speckled to cream. *Indumentum* sometimes greyish- or fulvous-silver, mostly pale to dark ferruginous-silver. *Stipules* c. 1 mm long. *Petiole* 3–21 cm by 2–6 mm; glands at the apex 0.5–2 mm diam. *Leaf blade* 11–40 by 7–30 cm, ratio 1–1.8. *Inflorescences* robust, 7.5–38 by 7.5–30 cm, axes

densely fulvous- to ferruginous-silver stellate-pubescent; base of peduncle (5–)6 mm diam.; bracts 3–5 by 0.8–2 mm. *Staminate flowers*: 5–12 by 6–12 mm; pedicel 5–15 by 0.3–0.6 mm, stellate-pubescent; buds 3.5–5 by 3–4 mm; calyx lobes 3–5.8 by 2.5–5 mm; petals 4.5–10 by 2–4 mm; stamens 20–32, outermost filaments 0.5–1 mm long, the innermost ones 2–3.8 mm long; anthers 0.6–0.9 by 0.3–0.7 mm. *Pistillate flowers*: 8–12 by 8–12 mm; pedicel stout, 2–5.5 by 2–3 mm, stellate-pubescent; buds 4.5–6 by 3–3.5 mm; calyx lobes 4–7 by 3–6 mm; petals 9–13.5 by 2.5–4 mm; ovary subglobose, trigonous (or rarely tetragonous) in cross section, 3- (or 4-)locular, 2–3 by 2.5–3.5 mm, densely fulvous to ferruginous stellate-tomentose; styles bifid up to half of their length, 2.6–3.2 mm long, densely colourless to ferruginous stellate-pubescent without, glabrous within. *Fruits* broadly ovoid-subglobose with 6 (8) low longitudinal ridges, very slightly acuminate at the apex, 4–6.5 by 5.5–8 cm. *Seeds* subglobose to obovoid, oval to almost elliptic in dorsal view, not dorsiventrally compressed, truncate at the micropylar end, attenuate and obtuse at the chalazal end, 20–27 by 20–25 by 20–25 mm, white to cream, conspicuously mottled brown.

Distribution — Australia (Queensland with a disjunct southerly occurrence near Ingham; Forster, 1996) and Papua New Guinea.

Ecology & Habitat — Rather common tree in rain forest, also occurring in the margins of the forests and as a pioneer in disturbed places, thriving on a variety of substrates usually of volcanic origin, up to at least 1190 m altitude.

Vernacular names — English: Candle nut. New Guinea: Tsikúreh (Managalase), Towai (Daga, Bonenau).

Note — Endosperm edible after cooking or roasting.

## 2. REUTEALIS

*Reutealis* Airy Shaw, Kew Bull. 20 (1967) 394; G.L. Webster, Ann. Missouri Bot. Gard. 81 (1994) 114. — *Aleurites* J.R. Forst. & G. Forst. section *Reutealis* Müll. Arg. in DC., Prodr. 15, 2 (1866) 724. — Type species: *Aleurites trisperma* Blanco [= *Reutealis trisperma* (Blanco) Airy Shaw].

Trees, monoecious, evergreen. *Indumentum* simple on developing shoots, stipules, leaves and petioles, stellate on lower surface of developed leaves, both simple and stellate on inflorescences, bracts, pedicels and buds, all parts glabrescent, greyish-white to light beige or rarely fulvous to ferruginous. Young *twigs* distinctly 5-ribbed, soon glabrescent. *Stipules* small, triangular, acuminate, the tip recurved, early caducous, leaving fairly prominent scars. *Petiole* terete, slightly ribbed or striate, usually displaying a conspicuous adaxial groove, with two sessile, discoid, concave (cup-shaped) glands at the apex exuding a sweet sap, black in dry leaves. *Leaves* alternate, simple, never lobed, ovate to broadly ovate; base truncate or shallowly to deeply cordate or reniform; margin entire; apex acuminate to cuspidate with a sessile, discoid gland at the top (c. 1 mm diam.); basally palmately 3–7-veined, pinnate along the midrib with 4–9 major lateral veins per side. *Inflorescences* terminal or rarely subterminal, solitary, many-flowered pyramidal thyrses, bisexual or rarely unisexual, with the flowers in bracteate clusters, protogynous with a solitary pistillate flower terminating each major axis, lateral cymules staminate; bracts oblong-triangular, acuminate, conspicuously hooded after anthesis. *Flowers* unisexual, actinomorphic, white; buds ovoid, apex acuminate; calyx bell-shaped, valvately rupturing for half to two thirds its length into

2 or 3, equal or unequal lobes, densely pubescent outside, glabrous inside; petals 5, free, imbricate, narrowly obovate-spathulate, rounded at the apex, drying dark brown to black, veins not distinct, clawed, glabrous on the inside except for the claw, the latter with few simple, downwards pointing, white hairs, sericeous outside, the petals of the staminate flowers basally adnate to the staminal column; disc 5-lobed, lobes free, apically with a conspicuous tuft of upwardly directed hairs. *Staminate flowers*: pedicel short, stouter than in the pistillate flowers, densely puberulous; disc glands erect, alternipetalous, adnate to the staminal column, basally glabrous or subglabrous; stamens (7) 8(–10), in 2 whorls (5+2–5), united into a column, the 5 outer free for about half their length, slightly shorter than the 2–5 inner, the latter united for almost their entire length; filaments glabrous in their free parts, the staminal column sericeous; anthers basifixed, opening extrorsely with 2 longitudinal slits, glabrous; pistillode absent. *Pistillate flowers*: pedicel stout, densely puberulous; disc glands represented by minute triangular protuberances, much smaller than in the staminate flowers, tapering towards the apex; ovary superior, ovoid to subglobose, roughly tri- or tetragonous in cross section, slightly grooved along the septae, 3- or 4-locular, with 1 ovule per locule, sericeous; styles divergent, bi- or trifid, split up to more than half of their length, basally terete, the distal ends spathulately flattened, the lowermost part sericeous on the outside. *Fruits* large, capsular, subglobose, surface smooth, velutinous, with 3 or 4 distinct longitudinal ridges outside, apically rounded or narrowly attenuate towards and pointed at the apex, abruptly narrowed into the base, light brown when dry. *Seeds* ecarunculate, thick-discoid to subglobose, with suborbicular to broad-elliptic outline in dorsal view, dorsiventrally compressed, usually with a shallow, transmedian dorsal ridge, obtuse at both the micropylar and the chalazal end, medium brown to maroon with faint dark brown variegations, surface smooth; hilum large. *Embryo* straight, embedded in copious endosperm, cotyledons broad, flat.

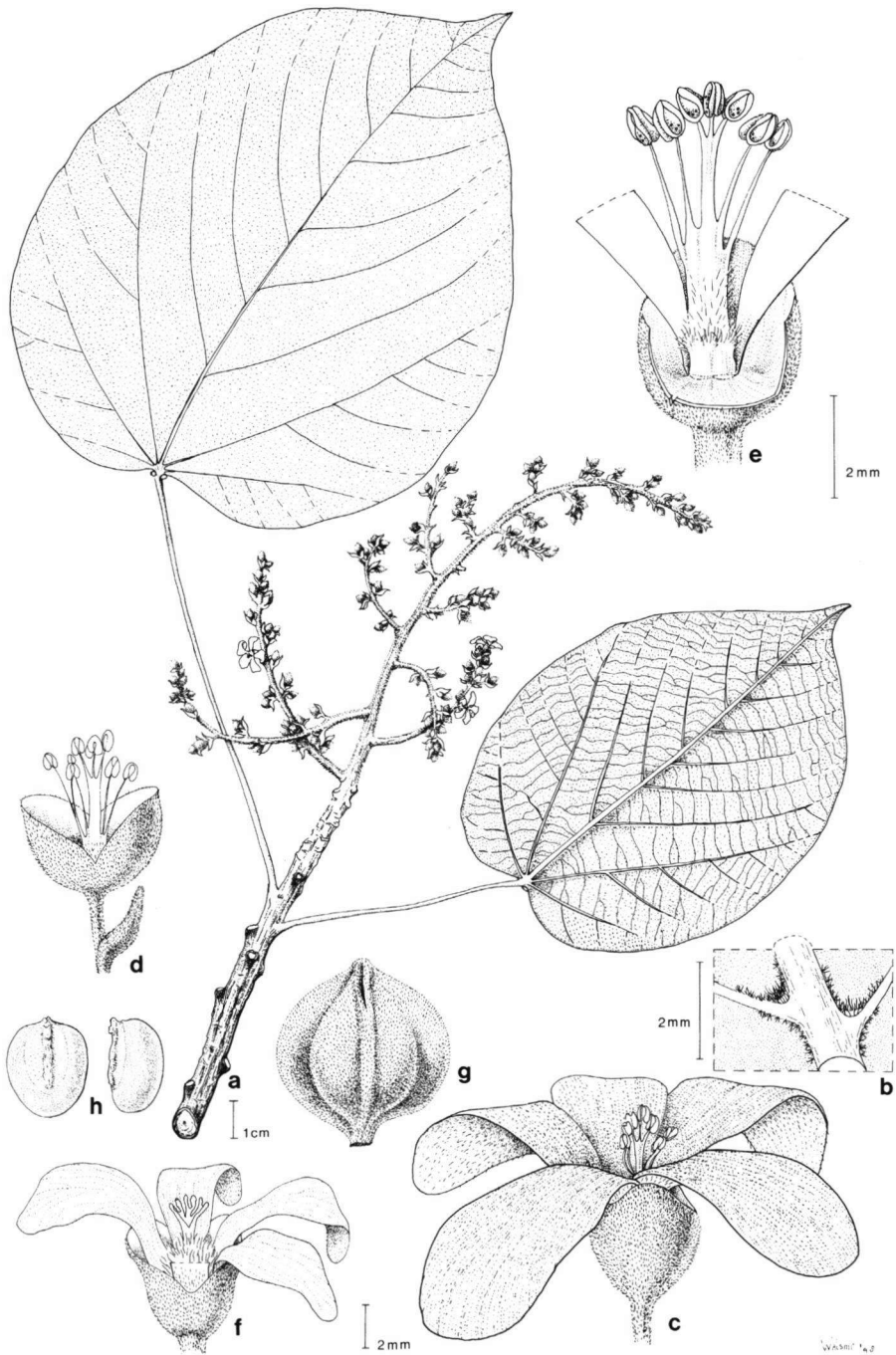
Distribution — *Reutealis* is a monotypic genus native to the Philippines (Luzon, Negros, Mindanao), also planted and naturalized in West Java.

### 1. *Reutealis trisperma* (Blanco) Airy Shaw — Fig. 2

*Reutealis trisperma* (Blanco) Airy Shaw, Kew Bull. 20 (1967) 395. — *Aleurites trisperma* Blanco, Fl. Filip. (1837) 755; Müll. Arg. in DC., Prodr. 15, 2 (1866) 724; Hemsl., Bull. Misc. Inform. (1906) 121; Pax in Engl., Pflanzenr. IV.147 (1910) 131; J.J. Sm., Meded. Dept. Landb. Ned.-Indië 10 (1910) 556; Merr., Sp. Blancoan. (1918) 228; Enum. Philipp. Flow. Pl. 2 (1923) 448; Backer & Bakh.f., Fl. Java 1 (1963) 478. — *Camirium trispermum* (Blanco) Kuntze, Rev. Gen. Pl. 2 (1891) 595. — Neotype (selected here): *Merrill Species Blancoanae 145* (neo L; iso W, 2 specimens), Philippines, Luzon, Cavite Province, Maragondon.

*Aleurites saponaria* Blanco, Fl. Filip., ed. 2 (1845) 519; Fl. Filip., ed. 3, 3 (1879) 156, t. 296 (for synonymy see Fern.-Vill., Nov. App., 1880, 191). — Lectotype (selected here): Blanco, Fl. Filip., ed. 3, 3 (1879) t. 296.

Fig. 2. *Reutealis trisperma* (Blanco) Airy Shaw. a. Habit; b. detail showing persistent stellate hairs in the axils of the major lateral veins on the lower leaf surface; c. staminate flower; d. staminate flower showing bract, bell-shaped calyx and androecium (petals removed); e. staminate flower showing staminal column and disc glands (calyx and petals partly removed); f. female flower (one petal partly removed); g. fruit; h: seed in ventral and side view [all NY; a & b: *Fontiveros 10*; c–e: *Liogier 17945*; f: *Aguiar 10*; g & h: *Beck 1276*].



Tree, up to 15 m tall. *Bark* pale grey to medium brown, lenticels few or absent. *Stipules* 4–6 by 2–3.5 mm. *Petiole* 4.5–25(–32) by 1–5 mm; glands at the apex 0.5–1.5 by 1–2 mm. *Leaf blade* (4–)8–16(–28) by (2.5–)7–15(–22.5) cm, ratio 1–1.3. *Inflorescences* (4–)8–20(–30) by (4–)8–21 cm; bracts 2.5–7 by 1–3.5 mm. *Staminate flowers*: 6–10 by 10–13 mm; pedicel 1.2–5 by 0.5–0.7 mm; buds 3–4 by 2–3 mm; calyx lobes 4–6 by 4–5 mm; petals 7.5–9.5(–13) by 2.2–4 mm, claw 2–3 by 0.8–1 mm, basally along the middle shortly (0.5–1 mm) adnate to the staminal column; disc glands triangular in dorsal view, strongly keeled on the back, 0.5–0.7 by 0.2–0.3 mm at the apex; outer filaments 2.7–3.5 mm long, inner filaments 3.5–5 mm long; anthers elliptical, 0.8–1.1 by 0.4–0.6 mm. *Pistillate flowers*: 7–8 by 8–10 mm; pedicel 1.5–5 by 1–2 mm; buds 3–5 by 2.5–3.5 mm; calyx lobes 3.5–4 by 3–4 mm; petals 6–14 by 3–5 mm, claw 2–3 by 0.8–1 mm; disc glands c. 0.15–0.2 mm long and wide; ovary 2.5–4 by 2–3 mm; styles 1.8–2 mm long. *Fruits* 3.5–5.5 by 3–5 cm. *Seeds* 22–32 by 22–28 by 17–20 mm.

Distribution — As the genus.

Ecology & Habitat — In forests at low and medium altitudes, but apparently nowhere abundant, occurring both in the forest and in and about towns as a cultivated tree.

Uses — The oil yielded by the seeds was formerly employed in the Philippines for the production of a weak soap which was in demand among sailors owing to its property of lathering in sea water (Airy Shaw, 1967; Pax, 1910).

Vernacular names — Philippines: Balukanag (Bisaya, Iloko, Tagalog); baguilumbang, balokanad, banukalad, banunkalag, calumban, kalumbang, lumbang-banukalad, lumbang-gubat (Tagalog) (Merrill, 1923).

Note — The species was endemic to the Philippines before it was introduced to West Java where it is now cultivated in some areas (Smith, 1910).

### 3. VERNICIA

*Vernicia* Lour., Fl. Cochinch. (1790) 586; Fl. Cochinch. ed. 2 (1793) 720; Airy Shaw, Kew Bull. 20 (1967) 394; G.L. Webster, Ann. Missouri Bot. Gard. 81 (1994) 114. — *Aleurites* J.R. Forst. & G. Forst. section *Dryandra* (Thunb.) Müll. Arg. in DC., Prodr. 15, 2 (1866) 723; Pax in Engl., Pflanzenz. IV.147 (1910) 132. — Type species: *Vernicia montana* Lour.

*Dryandra* Thunb., Fl. Jap. (1784) 13, t. 27, nom. rejic. [non R.Br., Trans. Linn. Soc. 10 (1810) 221, nom. conserv., Proteaceae]. — Type species: *Dryandra cordata* Thunb. [= *Vernicia cordata* (Thunb.) Airy Shaw].

[*Ambinix* Comm. ex Juss., Gen. Pl. (1789) 389, in synonymy of *Aleurites*.]

*Elaeococca* Comm. ex A. Juss., Euphorb. Gen. (1824) 38, nom. superfl.; Blume, Bijdr. (1825) 618 — Type species: *Elaeococca verrucosa* A. Juss [= *Vernicia cordata* (Thunb.) Airy Shaw].

Shrubs or trees, monoecious or sometimes dioecious, deciduous or evergreen. *Bark* pale grey, with many tiny brownish lenticels. *Indumentum* of whitish or fulvous to ferruginous, simple or bifurcate hairs, at least present on young shoots, leaves and petioles, glandular or stinging hairs absent. Young *twigs* terete, striate, pubescent, dark brown with bright lenticels. *Stipules* triangular-lanceolate or lanceolate, subglabrous, early caducous, leaving fairly prominent scars. *Petiole* terete, striate, pubescent when young, with two sessile or stalked glands adaxially at junction with blade. *Leaves* alternate, simple, ovate to broadly ovate or shallowly to moderately 3- or 5-



palmately lobed and then with a conspicuous gland at the nadir of each sinus, tardily glabrescent, upper surface scabrous to (sub)glabrous, lower surface (sub)glabrous except along the major veins and especially in the axils between the midrib and the secondaries; lobes triangular-deltoid; base truncate or shallowly to deeply cordate or reniform; margin entire; apex and lobes obtusely or acutely acuminate to slightly cuspidate; venation basally palmate, 3- or 5-veined from the base, pinnate along the midrib, with 4–6(–8) major lateral veins per side of the midrib, distinct on both sides. *Inflorescences* terminal, solitary, much-branched corymbiform thyrses, branching from the base, unisexual or bisexual and protogynous with a solitary terminal pistillate flower and several staminate flowers per cymule, axes pubescent when young; bracts inconspicuous, lanceolate, the lower ones sometimes persistent, the upper soon deciduous, marginally or entirely pubescent. *Flowers* unisexual, showy, slightly zygomorphic, white or reddish white to purple; buds ovoid to ovoid-ellipsoid, apex acuminate to apiculate; calyx closed in bud, later valvately rupturing into 2 (3), often unequal lobes, glabrous or pubescent outside, pubescent at the apex inside; petals 5 (6), free, imbricate, contorted, obovate, rounded at the apex, with conspicuous parallel veins, clawed, those of the staminate flowers basally adnate to the outermost stamens; disc of 5 or 6 (7) free, erect, alternipetalous, glabrous glands. *Staminate flowers*: pedicel slender, usually longer than in the pistillate flowers, glabrous to pubescent; stamens (7–)8–12(–14), in 2 whorls, united into a column, the outer ones free from each other but basal-ly adnate to both the petals and the central staminal column, the inner ones fused for over at least two thirds of their length; the staminal column (sub)glabrous to pilose, the free parts of the filaments glabrous; anthers basifixed to dorsibasifixed, opening introrsely with 2 longitudinal slits, glabrous; pistillode absent. *Pistillate flowers*: pedicel slender or stout, glabrous to pubescent; ovary superior, 3(–5)-locular, with 1 ovule per locule, sparingly pubescent or densely sericeous; styles  $\pm$  free or united at the base, bifid, glabrous or basally loosely or densely pubescent. *Fruits* large, capsular, ovoid to subglobose, tardily dehiscent, glabrous to pubescent. *Seeds* ecarunculate, obovoid to subglobose, dorsiventrally compressed, pointed or with a minute tip at the micropylar end, brown with longitudinally orientated beige variegations, smooth or conspicuously warty and ridged dorsally and ventrally; hilum large. *Embryo* straight, embedded in copious endosperm; cotyledons broad, flat.

*Distribution* — The genus *Vernicia* comprises 3 closely related species distributed from Burma to Indochina, Thailand, S China and Japan.

*Ecology & Habitat* — *Vernicia* occurs in more temperate latitudes or elevations than *Aleurites* and *Reutealis*.

#### KEY TO THE SPECIES

- 1a. Deciduous trees with flowers appearing before the leaves. Glands at the apex of the petiole sessile, tuberculiform or cushion-shaped. Inflorescences usually bisexual. Ovary 4- (or 5-)locular, gradually narrowing into the styles. Fruits spherical to subglobose or slightly compressed, apically sharply pointed, surface smooth or faintly lineate, but without any grooves or ridges. — SE Asia (S China, S Burma, N Vietnam) . . . . . **2. *V. fordii***

- b. Evergreen trees. Glands at the apex of the petiole clavately stalked and turbinate or slenderly stalked and capitate. Inflorescences usually unisexual. Ovary usually 3(–5)-locular, either gradually or abruptly narrowing into the styles. Fruits ovoid to subglobose, apiculate at the apex, surface wrinkled, with distinct longitudinal grooves and ridges ..... 2
- 2a. Glands at the apex of the petiole slenderly stalked, capitate, slightly divergent, hook-shaped to almost inrolled (at least when dry). Ovary abruptly narrowing into the styles. — Japan ..... 1. *V. cordata*
- b. Glands at base apex of the petiole clavately stalked, turbinate, apex concave (cup-shaped). Ovary gradually narrowing into the styles. — SE Asia (S China, Burma, Indochina, Thailand) ..... 3. *V. montana*

### 1. *Vernicia cordata* (Thunb.) Airy Shaw

*Vernicia cordata* (Thunb.) Airy Shaw, Kew Bull. 20 (1967) 394. — *Dryandra cordata* Thunb., Fl. Jap. (1784) 267, t. 27. — *Dyandra oleifera* Lam., Encycl. 2 (1786) 329, nom. superfl. — *Elaeococca cordata* (Thunb.) Blume, Bijdr. (1825) 618. — *Aleurites cordata* (Thunb.) R.Br. ex Steud., Nomencl. Bot., ed. 2 (1840) 49; Müll. Arg. in DC., Prodr. 15, 2 (1866) 724, p.p. excl. *Vernicia montana* and synonyms; Hemsl., Bull. Misc. Inform. (1906) 120, p.p., excl. *Vernicia montana* and synonyms; Pax in Engl., Pflanzenr. IV.147 (1910) 132; Gagnep. in Lecomte, Fl. Indo-Chine 5 (1925) 291, excl. *Vernicia montana* and synonyms; E. Walker, Fl. Okinawa S. Ryukyo Is. (1976) 646. — Lectotype (selected here): *Thunberg 23808* (UPS, n.v.; IDC microfiche 1036). *Elaeococca verrucosa* A. Juss., Euphorb. Gen. (1824) t. 11, f. 35; Spreng., Syst. Veg. 3 (1826) 884. — *Dryandra verrucosa* (A. Juss.) Royle, Ill. Bot. Himal. Mts (1836, 1840) 328, 452, p.p., only name. — Type: Hb. A. de Jussieu no. 16502 (P-JU, n.v.; IDC microfiche 6206-31). [*Aleurites japonica* Blume ex Scheff., Ann. Mus. Bot. Lugd.-Bat. 4 (1868) 120, name in synonymy.]

Tree, usually monoecious, small to medium-sized, evergreen, 7–10 m tall. *Indumentum* whitish to ferruginous. *Stipules* 2–4 by 1.2–1.6 mm. *Petiole* 4–16(–28) cm by 1–5 mm; glands at the apex slenderly stalked, capitate, slightly divergent, hook-shaped to almost inrolled (at least when dry), 3–4 mm long, stalk 0.3–0.5 mm diam., capitulum 0.8–1.2 mm diam. *Leaf blade* not or shallowly to moderately 3- or 5-lobed and then with a large, slenderly stalked, capitate gland at the nadir of each sinus, 10–20(–26) by 8–18(–26) cm, ratio 1–1.3, densely pubescent above and beneath when young, tardily glabrescent; apex and lobes acutely acuminate to slightly cuspidate, without a gland at the top. *Inflorescences* unisexual. *Staminate inflorescences* many-flowered, 7–23 by 10–20 cm; lower bracts often leaf-like, lanceolate, up to 4 by 1.7 cm, upper bracts becoming progressively smaller towards the apex of the inflorescence, linear-lanceolate to triangular, sharply acute, early caducous, 1.5–10 by 1–3 mm, margin densely hairy. *Flowers* white; buds 7–10 by 3–5 mm; calyx lobes 7–10 by 3–7 mm, glabrous outside, pubescent in the upper half or third inside; petals narrowly obovate-spathulate, 15–20 by 5–10 mm, claw 3–5 by 0.8–1 mm, pubescent inside on the claw, those of the staminate flowers showing a tuft of brown hairs around the place where the filament becomes free from the petal, otherwise glabrous. *Staminate flowers*: 14–22 by 14–20(–23) mm; pedicel 4–7 by 0.4–1 mm, (sub)glabrous; disc-glands subulate or cylindric-fusiform, slenderly triangular in outline, acute, 2–3 by 0.5–1 mm wide at the base; stamens 8–10, the 5 or 6 outer ones shorter than the 3–5 inner stamens, outer filaments 8–10 mm long, inner filaments 14–16 mm long, the free parts of the

filaments glabrous, the staminal column subglabrous to pilose; anthers ovoid, 1.5–2 by 0.8–1 mm wide. *Pistillate inflorescences* as the staminate ones, but slightly smaller in average, 9–13 by 10–16 cm. *Pistillate flowers*: (12–)14–20 by (12–)14–25 mm, pedicel slender, 2–4 by 0.5–1 mm, (sub)glabrous; disc glands 5(–7), tongue-shaped to ovate-triangular, obtuse, 2–2.5 by 0.5–1 mm; ovary ovoid to ellipsoid and trigonous (tetragonous) in cross section, abruptly narrowing into the styles, 3- (or 4-)locular, 4–5 by 3–4 mm, sericeous; styles bifid for one third to half of their length, 4–6 mm long, glabrous or with scattered simple, dark ferruginous hairs especially in the lower half. *Fruits* seen unripe, globose, usually 3- (or 4-)angled or -lobed, apiculate at the apex, with 3 (4) distinct longitudinal grooves and ridges, c. 4 by 3–5 cm. *Seeds* seen unripe, sub-orbicular in dorsal view, with a minute tip at the micropylar end, (12–)18 by (12–)18 by 9–14 mm, smooth.

Distribution — Japan (Hondo, various localities), also cultivated outside Japan.

Ecology & Habitat — In Central China the tree is usually cultivated in the mountains (200–2000 m) where it attains a height of c. 7 m in rocky barren spots with a thin soil. The tree does not need much maintenance and seed collecting is easy. The climate varies between snow in winter without severe frosts to c. 30 °C in summer. Presumably the species can also be grown in much more tropical surroundings (Hillier, 1906).

Uses — Seed provides oil to be used as fuel (Pax, 1910). The oil is almost destruction proof; it changes instantly into a jelly-like substance after heating at about 285–300 °C and is insoluble in all ordinary solvents and cannot be melted by further heating (Hillier, 1906).

Vernacular names — English: Japanese Wood Oil. China: Hwa tung. Japan: Abura giri, dokaje (Pax, 1910).

## 2. *Vernicia fordii* (Hemsl.) Airy Shaw

*Vernicia fordii* (Hemsl.) Airy Shaw, Kew Bull. 20 (1967) 394; Radcl.-Sm., Kew Bull. 28 (1973) 296. — *Aleurites fordii* Hemsl., Hooker's Icon. Pl. 29 (1906) t. 2801, 2802; Bull. Misc. Inform. (1906) 120, p.p., excl. *Vernicia montana* and synonyms; Bull. Misc. Inform. (1914) 3; Pax in Engl., Pflanzenr. IV.147 (1910) 132; Gagnep. in Lecomte, Fl. Indo-Chine 5 (1925) 291; Backer & Bakh.f., Fl. Java 1 (1963) 478; E. Walker, Fl. Okinawa S. Ryukyo Is. (1976) 644. — Lectotype (Radcliffe-Smith, 1973): *Henry 878* (K), China, Hupeh Province, Ichang.

Shrub or tree, monoecious, flat-topped, much branched, deciduous, up to 20 m tall. *Indumentum* fulvous to mostly ferruginous. *Stipules* 4–12 by 2–4 mm. *Petiole* (5–)20(–26) cm by 1–4 mm; glands at the apex with blade sessile, circular, tuberculiform or cushion-shaped, black in dry leaves, 0.3–0.5 by 0.5–2 mm. *Leaves* crowded at the apex of the shoots, not or sometimes shallowly to moderately 3-lobed and then with a sessile, discoid gland at the nadir of each sinus, c. 1 mm diam.; blade (4.5–)10–25 cm long, (3.5–)10–22 cm wide, ratio 1–1.2(–1.4), densely pubescent above and beneath when young, apex and lobes subacute or obtusely acuminate to slightly cuspidate, with a very small, sessile, discoid gland at the top (c. 0.5 mm diam.), 5-veined from the base. *Inflorescences* usually bisexual, appearing before the leaves, branching from the very base, (3–)8–16 by 7–21 cm, few-flowered, with one terminal (central) pistillate flower and (4–)6–7 lateral 3–7-flowered staminate cymules; bracts linear-lanceolate to subtriangular, sharply acute, 2–10 by 0.7–1.5 mm, densely hairy. *Flowers* reddish-white to purple, suffused and veined with pink, yellow in the centre, 25–30 by 25–35

mm diam.; buds 10–15 by 6–8 mm; calyx lobes 8–10 by 5–8 mm, pubescent at the apex outside and in the upper half inside; petals orbicular-ovate to broadly obovate-spathulate, 20–35 by 8–20 mm, claw 3–6 by 1.5–2 mm, sparingly pubescent outside in the lower half, otherwise glabrous. *Staminate flowers*: pedicel 8–18 by 0.5–1.2 mm, puberulous; petals basally shortly adnate to the outermost stamens; disc-glands subulate to triangular-lanceolate, acute, somewhat fleshy, whitish, 3–4.5 by 0.5–1 mm at the base; stamens (7–)8(–14), the (4–)5(–8) outer filaments 7–10 mm long, the 3(–6) inner filaments 11–15 mm long, filaments and column glabrous; anthers ovoid-ellipsoid, 1.5–2 by 0.5–1 mm. *Pistillate flowers*: pedicel slender, 5–14 by 1–2 mm, pubescent; disc glands as in the staminate flowers, but mostly slightly smaller, 2–4 by 0.8–1.0 mm at the base; ovary ovoid-subglobose, attenuate towards the base, gradually narrowing into the styles, 4- (or 5-)locular, 4–5 by 3–4 mm, sparingly pubescent; styles united at the base, 4–5 mm long, shortly bifid, glabrous or with scattered simple, dark ferruginous hairs especially in the lower half. *Fruits* spherical to subglobose or slightly compressed, apically sharply pointed, basally stiped, abruptly narrowed into the base, surface smooth or faintly lineate, but without any grooves or ridges; 4–6 by 3–5 cm, dull brown when ripe, sparingly brown sericeous, glabrescent. *Seeds* narrowly oboval in dorsal view, with a minute tip at the micropylar end, 20–25(–30) by 18–22 by 14–15 mm, conspicuously warty and ridged dorsally and ventrally.

Distribution — Native of SE Asia (S China, S Burma, N Vietnam), but also cultivated in other subtropical regions, e.g., the southeastern United States where it escaped from cultivation and is nowadays naturalized.

Ecology & Habitat — *Vernicia fordii* is adapted to cooler, more temperate conditions and not suitable for cultivation in tropical climates.

Uses — The seeds are pressed for oil in two different ways yielding two varieties of oil: White t'ung oil is drawn cold, is yellow, translucent, moderately thick and used in Central China for varnishing furniture and umbrellas, for oiling paper, and for lighting purposes. Black t'ung oil is extracted by heat and pressure. It is thick, blackish, opaque and cheaper than the other variety, in China used in putty for caulking boats and for varnishing them. In Europe and America also used in varnishes, paint, linoleum, etc.; it is of better quality than linseed oil (Hillier, 1906; Pax, 1910). The seeds have drastic purgative properties and can cause severe poisoning if eaten raw (Webster, 1967). The seed remnants are used as manure in China.

Vernacular names — English: T'ung Oil, Chinese Wood Oil. China: Hsiao t'ung shu, t'ung shu, t'ung yu, tung yan shu (Pax, 1910).

### 3. *Vernicia montana* Lour. — Fig. 3

*Vernicia montana* Lour., Fl. Cochinch. (1790) 587; Fl. Cochinch. ed. 2 (1793) 721; Airy Shaw, Kew Bull. 20 (1967) 394. — *Dryandra vernicia* Corr. Méllö, Ann. Mus. Hist. Nat. 8 (1806) 69, pl. 32, f. 1, nom. superfl. — *Elaeococca vernicia* (Corr. Méllö) Spreng., Syst. Veg. 3 (1826) 884, nom. superfl.; Baill., Hist. Pl. 5 (1874) 116 ('*Aleurites verniciflua*'). — *Elaeococca montana* (Lour.) Oken, Allgem. Naturgesch. 3 (1841) 1599. — *Aleurites vernicia* (Corr. Méllö) Hassk., Flora 25, Beibl. 2 (1842) 40. — *Aleurites montana* (Lour.) E.H. Wilson, Bull. Imp. Inst. Gr. Brit. 11 (1913) 460; Hemsl., Bull. Misc. Inform. (1914) 3; Merr., Trans. Amer. Philos. Soc. new ser., 24 (1935) 239; Backer & Bakh.f., Fl. Java 1 (1963) 478; E. Walker, Fl. Okinawa S. Ryukyo Is. (1976) 644. — Type: *Loureiro s.n.* (BM), Cochinchina.

*Aleurites cordata* auct. non Steud.: Müll. Arg. in DC., Prodr. 15, 2 (1866) 724; Hemsl., Bull. Misc. Inform. (1906) 120; Gagnep. in Lecomte, Fl. Indo-Chine 5 (1925) 291; all p.p., only *Vernicia montana* and synonyms.

*Dryandra verrucosa* auct. non Royle: Royle, Illr. Bot. Himal. Mts (1836, 1840) 328, 452, p.p., material.

Shrub or tree, usually monoecious, sometimes dioecious, flat-topped, much branched, evergreen, up to 10–15 m tall. *Indumentum* ferruginous. *Stipules* 3–5 by 2–3 mm, (sub)glabrous. *Petiole* 4.5–15(–23) cm by 1.5–4 mm; glands at the apex clavately stalked, turbinate, tip concave (cup-shaped), red in fresh leaves, exuding a sweet sap, 1.5–5 by 0.5–2 mm. *Leaf blade* not or very often (esp. on young trees and vigorous shoots) shallowly to moderately 3- or 5-lobed, with a large, sessile discoid, concave gland at the nadir of each sinus, (6–)10–20(–27) by (4–)10–20(–28) cm, ratio 1–1.4, densely pubescent above, sparingly so beneath, glabrescent, apex and lobes acutely acuminate to slightly cuspidate, without a gland at the top. *Inflorescences* usually unisexual. *Staminate inflorescences* many-flowered, much-branched corymbiform thyrses, significantly larger than the pistillate ones, (10–)15–25 by 15–32 cm, pubescent when young; lower bracts often leaf-like, lanceolate, up to 5.5 by 2 cm, upper bracts triangular-lanceolate to linear-lanceolate, 5–20 by 1–3 mm, densely hairy when young. *Pistillate inflorescences* as the staminate ones, but fewer-flowered and significantly smaller, (3–)5–12 by 4–15 cm. *Flowers* white, reddish brown in the centre, fragrant; buds 10–18 by 4–7 mm; calyx green at the base, otherwise deep pink to pinkish yellow, lobes 10–15 by 5–8 mm, (sub)glabrous outside, glabrous inside except for a minute tuft at the very apex; petals narrowly obovate-spathulate, rounded at the apex, 15–35 by 6–10(–15) mm, claw 6–8 by 1.5–2 mm, pubescent inside on the claw, those of the staminate flowers showing a tuft of ferruginous hairs around the place where the filament becomes free from the petal and somewhat further down, otherwise glabrous. *Staminate flowers*: 15–30 by 15–35 mm; pedicel 7–12 by 0.6–1 mm; disc-glands subulate or cylindrical-fusiform, slenderly triangular in outline, very long and acute, somewhat fleshy, 3–4.5 by 0.3–0.5 mm at the base; stamens (8–)10–12(–14), the 5–9 outer ones shorter than the 3–5(–8) inner stamens, outer filaments 10–16 mm long, inner filaments 12–21 mm long, the free parts of the filaments (sub)glabrous, the staminal column subglabrous to pilose; anthers ovoid, 2–2.5 by 1–1.5 mm. *Pistillate flowers*: 20–25 by 20–30 mm; pedicel rather short, stout, 3–6 by 1.5–2 mm, sparingly pubescent; disc glands shorter and wider as in the staminate flowers, triangular in outline, erect and appressed to the ovary, 1–2 by 0.7–1 mm at the base; ovary oblong-ovoid or ellipsoid and trigonous (tetra- or pentagonous) in cross section, narrowing into the styles, 3(–5)-locular, 4–5 by 3–4 mm, sericeous; styles bifid, 5–10 mm long, sericeous at the base, glabrous in the distal part. *Fruits* ovoid to subglobose with rounded-truncate base, apiculate at the apex, surface wrinkled with 3(–5) distinct longitudinal grooves and ridges and a few transverse ribs, 4–6 by 4–4.5 cm, sparingly brown pubescent, especially near the ridges, yellow when ripe. *Seeds* broadly oboval in dorsal view, pointed at the micropylar end, 20–30 by 20–25 by 11–15 mm, conspicuously warty and ridged dorsally and ventrally.

Distribution — Native of SE Asia (S China, Burma, Indochina, Thailand), also widely cultivated in Java and other tropical regions.

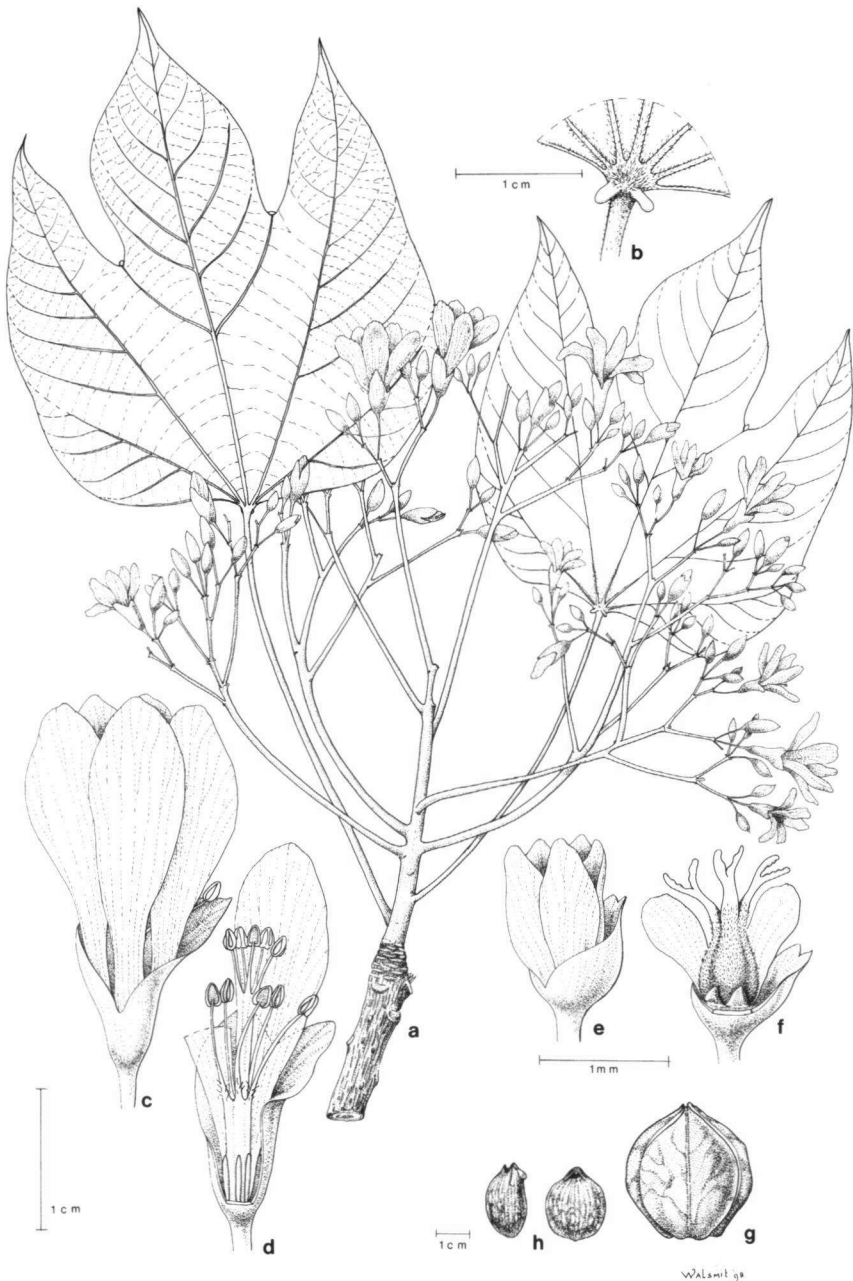


Fig. 3. *Vernicia montana* Lour. a. Habit with staminate inflorescence; b. detail showing foliar glands at junction between petiole and lamina; c. staminate flower; d. staminate flower showing androecium (calyx and petals partly removed; note the cylindric-fusiform disc glands); e. pistillate flower; f. pistillate flower (calyx and petals partly removed; note the short broadly-triangular disc glands); g. fruit; h. seed in side and dorsal view [a–d: Yuncker 4715, NY; e & f: Shiu Ying Hu 5200, US; g: Lei 759, NY; h: West 8702A, NY].

**Ecology & Habitat** — Forest or thicket, disturbed places (e.g., hill dipterocarp forest) and margins of primary evergreen forest, on dry, sandy soil and granite bedrock. Altitude 0–1200 m.

**Uses** — The oil is of commercial importance and used in about the same way as the oil from the seeds of *V. fordii*, i.e., for the manufacture of varnishes, paints, linoleum, etc. (Smith, 1981).

**Vernacular names** — English: Chinese Wood Oil. China: Mu-yu (Webster, 1967), Shan t'ung.

#### EXCLUDED SPECIES

*Aleurites erratica* O. Deg., I. Deg. & K. Hummel, *Phytologia* 38 (1978) 361. — Type: *O. Degener & I. Degener 24627* (holo TUB, ?, n.v.; iso BISH, MIN), Phoenix Islands, Canton Atoll.

After submission of the manuscript we got hold of one of the isotypes of *Aleurites erratica*.

As already mentioned above, the description of this species is solely based on a seed sample. Upon close investigation we can confirm that the plant to which the seeds belong is definitely a member of one of the uniovulate subfamilies of Euphorbiaceae. However, after careful comparison, we come to the conclusion that the shape and ornamentation of the seeds of *Aleurites erratica* is too different from that of the seeds of any of the species of *Aleurites*, *Reutealis*, or *Vernicia* to accept it as a member of one of these genera. Therefore, we suggest here to exclude the species from *Aleurites*.

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#### IDENTIFICATION LIST

The numbers after the collection references refer to the following species:

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|-------------------------------------|----------------------------|
| 1. <i>Aleurites moluccana</i>       | 4. <i>Vernicia cordata</i> |
| 2. <i>Aleurites rockinghamensis</i> | 5. <i>Vernicia fordii</i>  |
| 3. <i>Reutealis trisperma</i>       | 6. <i>Vernicia montana</i> |



- A series 2488: 1; 2704: 1; 3253: 1 — Adamson 10: 1 — d'Alleizette 6458: 1; 6458a: 4 — Amodjo 128: 1; 311: 1 — Anta 168: 1 — ANU series 1702: 1 — Apostol 7676: 1.
- Backer 10185: 3; 22781: 3; 33908: 1; 33909: 3; 33910: 3; 33912: 3; 36081: 3 — Bakhuizen van den Brink f. 3114: 1 — Balansa 1900: 1; 3287: 1; 3443: 1 — Baltisberger et al. 11824: 1 — Bangham & Bangham 941: 1 — Bartlett 8308: 1; 8743: 1 — Baumann 5510: 1 — bb 6166: 1; 9743: 1; 21348: 1; 21381: 1; 22477: 1; 24326: 1; 25450: 1; 25903: 1; 27131: 1; 27186: 1; 28755: 1; 29775: 1; 33591: 1 — Beck 1525: 1 — Becking 143: 1 — Beguin 495: 1 — Beumée A 913: 5 — Birnbaum 102: 1 — Bogor Botanical Garden IX.A.36: 5; IX.A.36a: 3; IX.A.38: 3; IX.A.42: 6; IX.A.48a: 3; IX.A.49: 1; IX.A.50: 1; XX.C.52b: 6 — Bonati 3723: 5 — Boufford & Bartholomew 24035: 5 — Brass 1991: 1; 3644: 1; 6494: 1; 7997: 1; 32660: 1 — F.B.H. Brown 427: 1; 909: 1 — BRUN series 5419: 1 — BS series 5159: 1; 5160: 3; 15585: 1; 22912: 3 — BSIP series 6099: 1; 6288: 1 — Buchholz 1397: 1 — Bünne-meijer 7675: 1; 8060: 1; 12486: 1 — Buwalda 4377: 1 — Buysman 2: 1; 359: 1 — BW series 1421: 1; 3983: 1; 7147: 1; 7709: 1; 10819: 1; 11080: 1; 11625: 1; 12493: 1; 13453: 1.
- Canton Christian College 12187: 5; 12269: 6 — Carr 11178: 1; 12451: 1; 12465: 1; 14119: 1; 14120: 1; 15757: 2; 15758: 1 — Chan Hung On 13904: 6 — Chand 4329: 6 — Chapin 732: 1; 839: 1; 845: 1; 950: 1 — Chen Ping En 2026: 5 — Cheo 18075: 5 — Chew RSNH 307: 1 — Chiao 7969: 5; 11993: 5; 12970: 5; 14252: 5; 18326: 5 — Chin 3434: 1 — Ching 2014: 6; 3275: 6; 6354: 6 — Ching & Chang 8570: 1 — Chow 147: 5; 871: 5 — Chow & Wan 80111: 1 — Christophersen 333: 1 — Christophersen & Hume 2438: 1 — Chun & Tso 44407: 1 — Chung 3344: 5 — J. Clemens & M.S. Clemens 3858: 1; 20203: 1 — M.S. Clemens 8119: 2; 8237b: 1; 40940: 2; 41761: 2 — Colfs 139: 1 — Cooray 69100901r: 1 — Cox 239: 1; 924: 1 — Cuming 663: 1 — Curtis 1210: 1.
- Danimihardja 2199: 1 — Decker 284: 1; 2795: 1 — O. Degener 14957: 1; 24627: 1 — O. Degener, Clay & Bertram 19329: 1 — O. Degener & I. Degener 27456: 1; 29615: 1; 35054: 1; 35321: 1; 36077: 2; 36082: 2 — O. Degener & Ordonez 14502: 1 — Deguchi 5014: 4 — Dickason 9394: 1 — Djamhari 578: 1 — Docters van Leeuwen-Reijnvaan 804: 1; 5113: 1 — Dolleschal 44: 1 — Douglas Simpson 60: 1 — Du 38: 5.
- Eames 48: 1 — Elbert 480: 1; 853: 1; 1900: 1; 2603: 1; 2603a: 1; 3630: 1; 3978: 1; 4112: 1; 4347: 1 — Elmer 8220: 1; 10893: 1; 17679: 1 — Endo 2181: 1.
- Fan & Li 324: 5 — FB series 456: 1; 2440: 3; 3145: 1; 4161: 1; 10025: 3; 26923: 6 — Fleury 37732: 6 — Florence 2097: 1; 3390: 1; 4286: 1; 5253: 1; 5578: 1; 5644: 1; 5979: 1; 6452: 1; 7532: 1 — Forbes 1351: 1 — Forest Guard Omar 7984: 1 — Forrest 26406: 5 — Fosberg 11360: 1; 35533: 1; 35534: 1; 60980: 1; 61154: 1; 62901: 1; 63684: 1 — Fosberg & Sachet 53171: 1.
- Gagné 1612: 1 — Gamble 13882: 1 — Garber 777: 1 — Geesink, Phanichapol & Santisuk 5732: 6 — Gillespie 3609: 1; 4249: 1 — Glassman 2867: 1 — Gräffe 3: 1; 17: 1; 62: 1; 605: 1 — Graham 3: 1 — Grant 3694: 1 — Green 2200: 5 — Griffith KD 4795: 1 — Guam Experiment Station 86: 1; 331: 1.
- Hahn 306: 1 — Hallé 7435: 1 — Hallier 697: 1; 4697: 1 — Handel-Mazzetti 1097: 5 — Hardial & Sidek 478: 1 — T.G. Hartley 10342: 1 — Heller 2431: 1 — A. Henry 9547: 1; 10587: 5 — Herbst 594: 1; 853: 1 — Hoh Hin-Cheung 1: 6 — Hoogland 5140: 1 — How 70593: 1; 71694: 6 — How & Chun 70025: 1 — S.H. Hu 10435: 6 — S.Y. Hu 5199: 6 — Hügel 4952: 1 — Hürilmann 157: 1; 508: 1 — Hyland 5406: 1; 5577: 1; 5737: 2; 6726: 2; 8014: 1.
- Iboet 298: 1 — Irvine 219: 1 — Iwatsuki, Murata, Dransfield & Saerudin S-537: 1.
- Ja series 2001: 1; 2364: 3; 3834: 1.
- Kahar 2010: 1 — Kajewski 242: 1; 1180: 2 — Kandilis 10321: 1 — KEP series 98380: 1 — KEP FRI series 32087: 1 — Kerr 6401: 1; 14638: 1; 19563: 1 — King's collector 258: 1; 8324: 1; 10846: 1; 86701: 1 — Kirch 37: 1 — Ko 50228: 5 — Koelz 22834: 5 — Kolomona Loo 32485: 1 — Koorders 1196: 1; 1785: 1; 1787: 1; 1791: 1; 1792: 1; 1794: 1; 1797: 1; 1799: 1; 1800: 1; 1801: 1; 1802: 1; 1803: 1; 11439: 1; 11448: 1; 12692: 1; 12866: 1; 14411: 1; 16805: 1; 20064: 1; 20586: 1; 20702: 1; 20949: 1; 22629: 1; 24608: 1; 25285: 1; 26890: 1; 28546: 1; 28725: 1; 29230: 1; 30577: 1; 36939: 1; 38347: 1 — Kostermans & Wirawan 132: 1 — Krayne 1: 6 — K'tung 6035: 6 — Kuruc J91: 1.

- LAE series 36526: 1; 60238: 1 — Lahaie 805: 1 — Lau 83: 1; 1822: 1 — Lauterbach 1575: 1; 6389: 1 — Leeuwenberg 9458: 6 — Lei 495: 6; 759: 6 — Leonard 4831: 1 — Levine 642: 1 — Liang 64049: 1 — Liao 10554: 1 — Lin 515: 5 — Linsley Gressitt 540: 6; 1605: 6 — Loher 4841: 1; 4842: 1; 4843: 1 — Lörzing 3587: 1; 13228: 1 — Lynn Zwickley 151: 1.
- MacDaniels 1633: 1 — MacKee 19772: 1 — Madulid 6788: 1 — Mail 1834: 1 — Maingay KD 1384: 1 — Marche 8: 1 — Martius 848: 1 — Maung Po Khant 15329: 6 — Maxwell 88-350: 6 — McClure 9175: 1; 9737: 6; 13059: 6; 13060: 6; 13066: 6; 13825: 5; 18514: 6 — McKee 3586: 1; 41224: 1 — Merrill 127: 1; 145: 3; 1888: 1; 2686: 1; 4166: 3 — Metzner 65: 1 — Ministry of Commerce, Bangkok 23: 1 — Mitchell 48: 1 — Moore 147: 1 — Morse 542: 6; 646: 1 — Mumford & Adamson 4: 1; 535: 1.
- NGF series 1166: 1; 1869: 1; 2509: 2; 3584: 1; 4006: 1; 7436: 2; 9163: 1; 9169: 2; 14503: 2; 16311: 2; 20562: 1; 23573: 2; 26729: 1; 33722: 1; 38807: 1; 44233: 1; 44575: 2 — Noorudin 6266: 1.
- Ogata 10241a: 1 — Ohashi et al. 24417: 5.
- Pacific Entomological Survey 4: 1 — Parks 16077: 1 — Penarubia CLP 1636: 1 — Philipson 10136: 1 — Pichon 2723: 6 — Pierot 925: 4 — Pleyte 454: 1; 1017: 1 — PNH series 37647: 1; 42223: 3 — Popta 1295: 6 — Prawiroatmodjo & Maskuri 1560: 1; 1579: 1 — Prawiroatmodjo & Soewoko 1823: 1 — Price 931: 6 — Pullen 5699: 2.
- Quayle 1252: 1; 1696: 1; 1816: 1 — Quayle & Curtis 418: 1.
- Rachmat 376: 1 — Rahmat Si Toroes 4847: 1; 5458: 1 — Ramlanto 62: 1 — Ramos 1923: 3 — Ranamu FD 1195: 1 — Rashid Z. O. B. 2447: 1 — Raynal 17810: 1 — Reching & Reching 144: 1; 997: 1; 1241: 1 — Remy 600: 1 — Rensch 622: 1 — Ridley 5561: 2 — Riesenberg 77: 1 — Robinson 332: 1 — Robinson & Boden Kloss 137: 1 — Rock 5066: 5; 6163: 5; 8089: 5 — Rutten 421: 1.
- S series 41942: 1 — SAN series 15316: 1; 34458: 1; 43901: 1; 44559: 1; 73471: 1; 117402: 1 — Schlechter 15573: 1 — Shah 38: 1 — Sieber 235: 1; 292: 1 — Sin 9305: 5 — Sinclair 5291: 1 — Singh 131: 5; 223: 5 — Singleton 96: 1 — A. C. Smith 23: 1; 1059: 1; 4308: 1; 7406: 1; 7945: 1; 8855: 1 — H. M. Smith 98: 1 — Soegandiredjo 61: 1 — Sørensen, Larsen & Hansen 1151: 1; 2942: 6 — Spence 403: 3 — Spire 1190: 1 — H. St. John 14214: 1; 14456: 1; 14558: 1; 14620: 1; 14684: 1; 14980: 1; 16211: 1; 18249: 1; 20448: 1; 20450: 1 — H. St. John, Blake & Smith 24280: 2 — H. St. John & C. M. Cooke f. 15794: 1 — H. St. John & Fosberg 15863: 1 — H. St. John & S. G. Wight 16110: 1; 16546: 1 — Stahl 1071: 1 — Stanley & Aulani Loo 32481: 1 — Sterly 1733: 1 — Steward & Cheo 84: 5; 477: 5; 848: 6; 1059: 5 — Steward, Chiao & Cheo 256: 5 — Stocker 602: 1 — Stoddart 2239: 1 — Stokes 19: 1; 32: 1; 118: 1; 126: 1; 174: 1 — Stone 3921: 1 — Streimann 8685: 1 — Sulit 31: 1 — Sykes 169704: 1.
- Taam 683: 6; 2022: 6 — Tagawa-Motozi 2091: 4 — Takamatsu 984: 1 — Thorel 671: 1 — Tilden 333: 1; 1032: 1 — Tsai 53586: 5 — Tsang 614: 1; 15571: 6; 20852: 5; 21043: 6; 23509: 5; 27417: 1; 28987: 6 — Tsang & Fung 480: 1 — Tsiang 2282: 6; 4924: 5; 9822: 5; 10468: 6 — Tso 20478: 5; 21533: 6 — Tsui 260: 5.
- University of San Carlos 902: 1.
- Valentine 1: 1 — Van Balgooy 1958: 1 — Van Balgooy & Van Setten 5690: 3 — Van Royen 3828: 1; 5094: 1 — Vanpruk 500: 1 — Veldkamp 7185: 1 — Veldkamp & Stevens 5918: 2 — Verdcourt 872: 1 — Versteeg 1960: 1 — Vidal 1747: 1; 3732: 3 — Vieillard 1146: 1; 1149: 1.
- Waas 207: 1 — Walker 7750: 1 — Walker et al. 6356: 5 — Wan & Chow 79178: 6 — Wang 33216: 1; 34002: 1 — Waterhouse 218: 1 — Wawra 243: 1; 298: 1 — Weiner MW-69-F20a: 1; MW-71-7-33a: 1 — Wheeler 12613: 1; 12644: 1 — Whistler W 928: 1; W 1293: 1; 5422: 1; 7449: 1 — Whitney Expedition 319: 1; 1542h: 1; 2213: 1; 2220: 1; 2257: 1; 2258: 1 — Wilder 904: 1 — Williams 2811: 1; 2852: 3 — Wilson 2031: 5; 2051: 5; 7138: 4 — Winit 282: 1.
- Yates 857: 1; 2249: 1 — Yen 424: 1 — Yinger, Dudley & Raulston 3791: 5 — Yip 279: 1 — Yoshida 1970: 1 — Yuncker 9396: 1; 9540: 1; 9702: 1; 15058: 1; 15460: 1; 15754: 1; 16135: 1.
- Zimmermann 107: 1 — Zollinger 131: 1.