

## THE MALESIAN SPECIES OF SARCOPTERYX RADLK. (SAPINDACEAE)

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### SUMMARY

The Malesian species of the genus *Sarcopteryx* are revised. Seven species are recognized, of which two, *Sarcopteryx crispata* and especially *S. squamosa* are very variable. Three new species are described: *Sarcopteryx caudata*, *S. crispata*, and *S. rubiginosa*.

### INTRODUCTION

The history of *Sarcopteryx* can be provided in a nutshell. The genus was described by Radlkofer (1879). He also provided a complete revision in 1933. Van der Ham (1977) transferred *Arytera sordida* to *Sarcopteryx* (in the present revision a synonym of *Sarcopteryx rigida*). Recently, Reynolds (1984) revised the Australian species and described three new species.

The specific delimitation in *Sarcopteryx* is quite difficult as the differences between the species are slight, especially in New Guinea. The genus as a whole provides a very homogeneous appearance. The five Australian species are well-recognizable when fruiting, but flowering specimens are sometimes hard to identify. The gland-like appendage on the anther may provide an additional character to separate the Australian species; *Sarcopteryx acuminata* and *S. reticulata* possess the connective gland (fig. 2a), while *Sarcopteryx martyana* and *S. stipata* lack this structure (fig. 2b). (Flowers of the easily recognizable *Sarcopteryx montana* are still unknown.)

*Sarcopteryx* is very badly known and usually confused with other genera, especially with *Guioa* (Van Welzen, 1989). It differs from the latter in the calyx, corolla, and fruit. The calyx of *Sarcopteryx* consists of five small equal sepals which are basally connate, *Guioa* has five larger free sepals of which the outer two are smaller. The petal type of *Sarcopteryx* is not found among the petal types of *Guioa*. The fruits of the Malesian species of *Sarcopteryx* are (slightly) winged, the mesocarp is woody in the basal part of the seedchambers and in the stipe; *Guioa* lacks wings and the mesocarp is not woody. The ariloid of *Sarcopteryx* normally shows a straight appendage which hides a tuft of hairs below the placenta; the appendage in *Guioa* is always curled and the hairs are lacking.

*Toechima erythrocarpum* subsp. *papuanum* (Leenhouts, 1988) is often confused with *Sarcopteryx squamosa*. When in flower both look very identical, the sepals and petals are alike. However, *Toechima* usually shows sac-like domatia in the leaflets, whereas *Sarcopteryx* normally lacks domatia or has shallow pockets at the most. The fruits of both genera are very different, just as the ariloid.

Three specimens which were tentatively identified as belonging to *Sarcopteryx* could not be matched with any of the seven Malesian species: *Idjan & Mochtar 384* (Moluccas, Halmahera, Babaneigo), *Kostermans 1261* (Moluccas, Morotai, G. Pare Pare), and *P. van Royen 5057* (Irian Jaya, Kebar Valley, Manokwari). *Kostermans 1261* is sterile, the other two are flowering. *P. van Royen 5057* resembles *Sarcopteryx squamosa* (and therefore *Toechima*) but has a hirsute indumentum. *Idjan & Mochtar 384* and *Kostermans 1261* have both a hirsute indumentum and ovate leaflets. They can belong to an undescribed species, but as the flowers of *Sarcopteryx* and *Toechima* are alike these three specimens remain filed as unidentified Sapindaceae.

### CHARACTERS IN SARCOPTERYX

In this chapter some characters of *Sarcopteryx* will be discussed in short.

#### *Leaflets*

The leaflets possess a petiolule except for *Sarcopteryx coriacea* where the petiolule exists of a pulvinus only. The leaflets are ovate to elliptic, normally asymmetric especially the attenuate base; the margin is always entire. An important character is the presence of (crispate) hirsute or sericeous hairs on the midrib. Domatia are usually absent, but very shallow pockets may be present. The leaflets usually possess small red glandular hairs on the lower surface, especially in the neighbourhood of the basal part of the midrib. Punctuation is often present and consists of very tiny pellucid glands (use handlens!). The venation is always raised, reticulate and especially in *Sarcopteryx caudata* very distinct, the nerves are especially apically marginally looped.

#### *Flowers*

Usually, male and female flowers can be distinguished. Male flowers tend to have large petals and stamens, while the anthers dehisce; the female flowers have smaller petals and shorter stamens, while the anthers remain closed. It is difficult to decide whether a flower is full-grown or not, normally when the small sepals open the petals and stamens are not yet full-grown and will continue their development. Measures of petals and filaments will therefore show too wide a range of variation.

#### *Sepals*

The sepals are small and all more or less equal in size. They are connate at the base. Pilosity is present on the outside and inside.

#### *Petals* (fig. 1)

The petals are normally obovate, clawed, sometimes with auricles near the claw (fig. 1a) but usually without (fig. 1b–d), with a truncate (fig. 1a–c) or an acute apex (fig. 1d). They are usually only basally pilose on the outside and inside. On the inside two scales are present which are densely pilose along the outer margin, top and inside surface; normally the hairs intertwine and the two scales will appear as one scale. Subapically on the backside of the scales a crest may develop. The crest, when well-developed, is usually flat, lobed, and glabrous except for the base (fig. 1a, b).

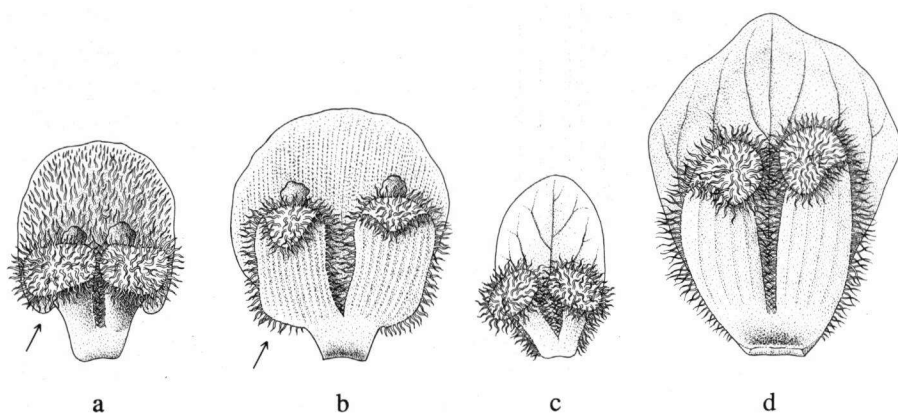


Fig. 1. Petals. a. *Sarcopteryx brachyphylla* Radlk. with auricled margin (arrow), apex truncate, crest present on scales (Fisher 62, L); b. *Sarcopteryx squamosa* (Roxb.) Radlk. without auricles (arrow), apex truncate, crest present on scales (Atjé 283, L); c. *Sarcopteryx rigida* Radlk. without auricles, apex truncate, without a crest on the scales (Van Valkenburg 33, L); d. *Sarcopteryx caudata* Welzen without auricles and crest, apex acute, larger and more elliptic than the petals of the other species (Schodde (& Craven) 4884, L); all  $\times 12.5$ .

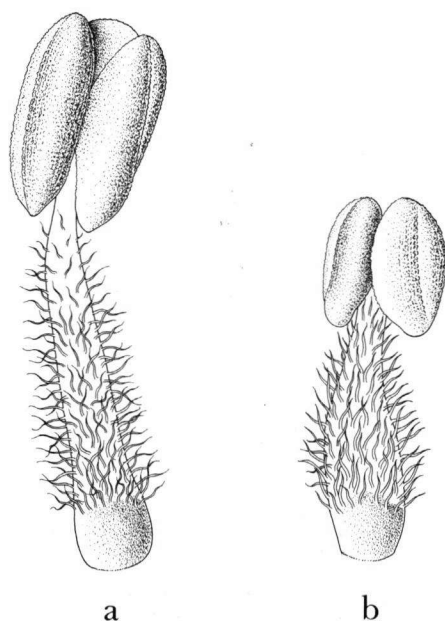


Fig. 2. Stamens: a. stamen with glandular structure between thecae (Brass 20297, L); b. stamen without glandular structure between thecae (Clark, Pickard & Coveny 1254, L); both  $\times 12.5$ .

### Anthers (fig. 2)

The anthers are usually papillate, show a few hairs, and often possess an appendaged connective. The appendage is normally multicellular and gland-like; especially some Australian species (see the Introduction) show this structure very well (fig. 2a).

### Ovary

The ovary is normally 3-locular, but occasionally 4 locules are present.

### Fruit (fig. 3)

The fruits are more or less obcordate, somewhat lobed, and show sometimes a small wing along the sutures. One to all lobes may develop. The fruits are smooth and glabrescent on the outside and smooth and glabrous inside. However, below the placenta a tuft of hairs may be present. The mesocarp is woody in about the lower third of the fruit: stipe and lower part of seed chambers. The stipe is measured from disc up to the beginning of the seed chambers (fig. 3, arrow).

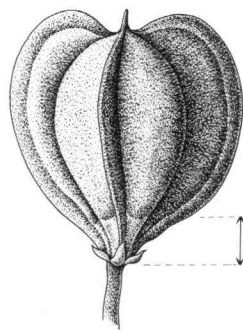


Fig. 3. Fruit of *Sarcopteryx brachyphylla* Radlk. (Pullen 7969, L.,  $\times 1.5$ ). Typical are the stipe (arrow) and the winged edges.

### Arilloid

The arilloid has normally a basal straight appendage (then hairs present below placenta) except for *Sarcopteryx caudata* which has a curled appendage and lacks the hairs. If the hairs are present they are normally hidden by the arilloid appendage.

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## SARCOPTERYX

*Sarcopteryx* Radlk., Sapind. Holl.-Ind. (1879) 19, 57, 97, 98; Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9 (1879) 486–490, 500, 544, 658, 659; Boerl., Handl. 1 (1890) 263, 268; Radlk. in Engler, Pflanzenr. 98 (1933) 1232–1238, fig. 36; Reynolds, *Austrobaileya* 2 (1984) 53–57, fig. 5; Fl. Austr. 25 (1985) 72–77, fig. 18a–f, map 92–96. — Type species: *Sarcopteryx squamosa* (Roxb.) Radlk. (lectotypification: Reynolds, 1984).

Shrub to tree. *Branchlets* smooth to slightly ribbed, sericeous to hirsute when young. *Leaves* 1–7-jugate. *Leaflets* alternate to opposite, usually petiolulate, ovate to elliptic, usually asymmetric, especially the base, thin to coriaceous, punctate or not; base attenuate; margin entire, flat to slightly recurved; apex acute to caudate, usually mucronulate; upper surface smooth, usually only pilose on midrib, often with wax; lower surface smooth, (slightly) sericeous or (crispately) hirsute on midrib; domatia at most shallow pockets; small red glands present; venation raised; nerves especially towards the apex marginally looped; veins reticulate, (very) distinct. *Inflorescences* usually in the upper leaf axils and pseudoterminal, usually only with a few branches, usually hirsute; cymules cincinnate (to dichasial). *Flowers* hermaphrodite but presumably functionally male or female, male flowers with large petals and stamens, anthers opening; female flowers with smaller petals and stamens, anthers not opening. *Sepals* 5, ovate, equal in size, basally connate, pilose. *Petals* 5, obovate, clawed, margin sometimes auricled near base, apex truncate to acute, outside and inside sericeous at base; scales present, densely pilose along outer margin, apex, and inner surface; crest present as small enation or well-developed, clavate and glabrous. *Disc* complete. *Stamens* 8; filament especially basally pilose; anthers usually papillate, usually slightly pilose, connective usually appendaged. *Pistil*: ovary densely hirsute, 3- or occasionally 4-locular; style and stigma triangular, not lobed, elongating in fruit. *Fruits* obcordate, somewhat lobed, slightly winged, stipe usually present, broadly cuneate, smooth, glabrescent; inside glabrous except for a hair tuft below the placenta and hidden by the arilloid appendage (absent in *Sarcopteryx caudata*); mesocarp woody in stipe and lower part of seedchambers. *Arilloid* completely covering seed, usually with a straight appendage, sometimes a curled appendage (*Sarcopteryx caudata*). *Seed* obovoid; hilum triangular, relatively large. *Embryo*: cotyledons usually secondarily laterally besides each other, apices often elongated and recurved.

Distribution – Moluccas, New Guinea, rain forests in E Australia.

Habitat & Ecology – Mainly found in primary, secondary, and montane (moss) forests, also along roads, rivers, and edges of forests. Soils: clay, sand, sandstone, volcanic soil, peat, occasionally ultrabasic; sometimes marshy. Alt.: sealevel up to 2800 m. Sometimes branches myrmecophilous. Sometimes plants occurring in regularly burned vegetation.

Note – Typical for this genus are the entire leaflets with conspicuous venation, the almost lack of domatia; the small flowers; the equal, basally connate sepals; the scaled and usually crested petal scales; the obcordate fruit with winged margins, woody mesocarp in the lower third, and usually a hair tuft below the placenta; and the appendaged, complete arilloid.

## KEY TO THE SPECIES

- 1a. Leaflets below glabrous or sericeous on basal part of midrib ..... 2
- b. Leaflets below hirsute or villose on basal part of midrib ..... 3
- 2a. Leaflets with a very distinct venation, apex cuspidate to caudate. Sepals 1.3–2.3 by 1.2–2 mm. Petals 2.8–4.3 by 2.2–2.5 mm, apex acute (fig. 1d). Ariloid with a curled basal appendix. Hairs below placenta absent . . . 2. *S. caudata*
- b. Leaflets with a distinct venation, apex acuminate to caudate. Sepals 0.7–1.7 by 0.7–1.8 mm. Petals 1.3–3.5 by 1.1–3 mm, apex truncate (fig. 1b). Ariloid with a straight appendix. Hairs present below placenta ..... 7. *S. squamosa*
- 3a. Leaves 1–5-jugate; petiolule up to 11 mm long. Leaflets ovate to elliptic, 3–18.3 by 1.2–7 cm, slightly to densely pilose ..... 4
- b. Leaves (1–)2–7-jugate; petiolule a pulvinus only. Leaflets ovate, 0.9–4.2 by 0.3–1.8 cm, densely pilose ..... 3. *S. coriacea*
- 4a. Leaflets punctate or not, with or without pockets; nerves at base marginally looped or not. Petals 1.1–2.5 by 0.8–2 mm, claw 0.1–0.5(–1.3) mm high, margin auricled (fig. 1a) or not near claw (figs. 1b–d); crest absent (fig. 1c) to well-developed (fig. 1a). Fruit with a 3.5–4.5 mm high stipe ..... 5
- b. Leaflets punctate, usually with shallow pockets; nerves marginally looped. Petals 2.6–2.8 by 2.4–2.8 mm, claw c. 0.7 mm high, margin auricled near claw (fig. 1a); crest well-developed (fig. 1a). Fruit with a 5–9 mm high stipe  
1. *S. brachyphylla*
- 5a. Crest on petal scales absent (fig. 1c) or slightly developed (fig. 1a). Leaflets often with shallow pockets ..... 6
- b. Crest on petal scales large (fig. 1a). Leaflets seldom with pockets  
4. *S. crispata*
- 6a. Leaflets ovate to elliptic, 3.7–17.2 by 1.5–5.5 cm, with shallow pockets below; apex acuminate to cuspidate (to caudate). Sepals 1.5–3 by 1–1.8 mm. Petals 1.3–2.5 by 1–2 mm, margin auricled near claw (fig. 1a) ..... 5. *S. rigida*
- b. Leaflets ovate (to elliptic), 3–8 by 1.8–4 cm, domatia absent; apex acuminate. Sepals 1.2–1.8 by 0.6–0.8 mm. Petals 1.1–1.4 by 0.8–1 mm, margin not auricled near claw (fig. 1b–d) ..... 6. *S. rubiginosa*

1. *Sarcopteryx brachyphylla* Radlk. – Figs. 1a, 3.

*Sarcopteryx brachyphylla* Radlk., Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 20 (1890) 265; Bot. Jahrb. 56 (1920) 297; in Engler, Pflanzenz. 98 (1933) 1237. — Type: *W. Sayer s. n.*, 1887 (M, holotype), Papua New Guinea, Mt Obree.

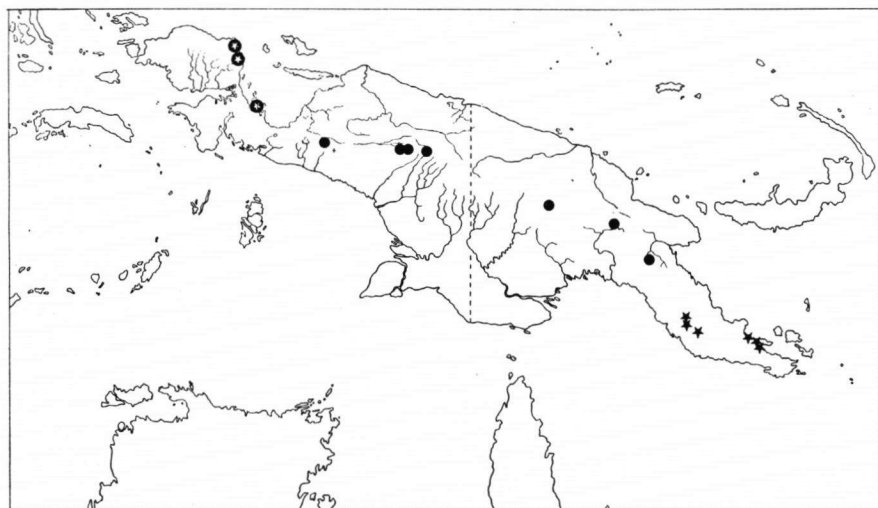
Tree. *Branchlets* smooth, crispy hirsute especially when young; flowering twigs 2–4.5 mm thick. *Leaves* 1–3(–4)-jugate; rhachis 1.3–13 cm long; petiolule up to 7(–11) mm long. *Leaflets* ovate to elliptic, 3.3–13.5 by 1.2–5.8 cm, asymmetric, coriaceous, punctate; base asymmetric; margin flat (to slightly recurved); apex (acute to) acuminate to cuspidate, usually mucronulate; upper surface smooth, mainly crispy hirsute on midrib, often with wax; lower surface hirsute, domatia usually present, shallow pockets; nerves marginally looped; veins distinct. *Inflorescences* in upper leaf axils and pseudoterminal, usually with a few branches, rather slender, hirsute,

up to 12.5 cm long, branches up to 5.2 cm long; cymules cincinnate (to partly dichasial), 2–4-flowered. *Bracts* and *bracteoles* triangular, sericeous; bracts up to 3 mm long; bracteoles up to 1.2 mm long. *Flowers* c. 6 mm in diam. *Sepals* ovate, 0.7–1.6 by 1–1.5 mm, sericeous. *Petals* obovate, blade elliptic, 2.6–2.8 by 2.4–2.8 mm, claw up to 0.7 mm high, broadly cuneate, margin auricled near claw, apex rounded, outside and inside basally sericeous; scales 1.3–1.8 mm long, very hairy along outer margin, apex, and inner surface; crest large, clavate, usually glabrous. *Stamens*: filament 2.6–3.2 mm long; anther 0.8–0.9 by 0.5–0.7 mm, not papillate, seldom with few hairs, connective appendaged. *Pistil*: male ovary c. 0.9 mm high, style and stigma c. 0.2 mm long; female ovary c. 2.8 mm high, style and stigma c. 2.9 mm long. *Fruits* 1.8–2.2 cm high by 1.6–2.1 cm broad, stipe 5–9 mm high, broadly triangular, with 2–4 mm broad wings along lobes; hair tuft below placenta. *Arilloid* with straight appendage. *Seed* obovoid, 7–12.5 by 5–6.7 mm. *Embryo* 7–9 by 5–5.5 mm; cotyledons secondarily laterally besides each other, apices usually not elongated except sometimes that of recurved lower one.

**Field notes** – Tree, 3–25 m, d.b.h. 10–40 cm. Outer bark dark brown to patchy grey and white, minutely tubercular with horizontal striations; inner bark fawn with small pale pink spots. Sapwood cream with black streaks. Leaves dark to bright shiny green above, pale below with rufous indumentum. Sepals green. Petals white; scales yellow. Stamens greenish. Ovary green; style yellow to reddish. Fruit red. Aril yellow to orange. Seed black.

**Distribution** – Papua New Guinea: Northern, Central, and Milne Bay Provinces (map 1a).

**Habitat & Ecology** – Found in primary hilly to montane rain forest, *Castanopsis* forest, moss forest, edge of forest. Soil marshy. Alt. 1500–2065 m. Flowering: June to Aug.; fruiting: June to Dec.



Map 1. Distribution of a. *Sarcopteryx brachyphylla* Radlk. (★); b. *S. caudata* Welzen (●); c. *S. coriacea* Radlk. (⊙).

Note – Typical is the presence of crispy hirsute hairs, punctation, rather large petals with big crests on the scales, large winged fruits with a long broadly triangular stipe. See also note under *Sarcopteryx rigida*.



Fig. 4. Habit of *Sarcopteryx caudata* Welzen (Schodde (& Craven) 4884, L.,  $\times 0.5$ ).



## 2. *Sarcopteryx caudata* Welzen, *spec. nov.* – Figs. 1d, 4; map 1b.

Folioli apice caudato venatione distinctissima. Sepala grandia 1.3–2.3 mm longa. Petala grandia 2.8–4.3 mm longa. Pili sub placenta desunt. Arillodium appendice crispa gaudet. — Typus: *Hoogland & Pullen 5437* (L, holo; iso in BM, BRI, K, US), Papua New Guinea, E Highlands Prov., Goroka Subprov., Daulo Camp, Asaro-Mairi Divide.

Tree. *Branchlets* slightly ribbed, sericeous (to hirsute) when young; flowering twigs 1–5 mm thick. *Leaves* 2–5-jugate; rhachis 2–16.3 cm long; petiolule up to 7 mm long. *Leaflets* elliptic, 3.5–11.1 by 1.4–3.9 cm, almost symmetric to asymmetric, coriaceous, not to seldom slightly punctate; base somewhat asymmetric; margin flat; apex cuspidate to caudate, mucronulate; upper surface smooth, (slightly) sericeous on midrib; lower surface (slightly) sericeous; domatia absent; nerves marginally looped; veins highly distinct. *Inflorescences* in upper leaf axils and pseudo-terminal, with a few branches, rather sturdy, sericeous-hirsute, up to 12.3 cm long, branches up to 3.7 cm long; cymules dichasial to cincinnate, 2–4-flowered. *Bracts* and *bracteoles* triangular, sericeous; bracts up to 2.3 mm long; bracteoles up to 1.9 mm long. *Flowers* 4.2–7 mm in diam. *Sepals* ovate, 1.3–2.3 by 1.2–2 mm, hirsute. *Petals* obovate, apex acute, male 3.8–4.3 by 2.2–2.5 mm, claw 0.2–0.3 mm high, scales 1.8–2.8 mm long; female 2.8–3.9 by 2.2–2.3 mm, claw c. 0.2 mm high, scales 1.3–2.3 mm long; scales very hairy along outer margin, apex, and inner surface, crest absent to minute. *Stamens*: male filament 3.2–9.6 mm long, female 1.3–2.2 mm long; anther 0.8–1.1 by 0.4–0.7 mm, glabrous, papillate, connective appendaged. *Pistil*: male ovary 0.4–0.7 mm high, female 1.8–2.8 mm high; male style and stigma 0.1–0.3 mm long, female 1.4–4.2 mm long. *Fruits* c. 1.4 cm high by 1.5 cm broad, smooth, glabrescent, stipe low, c. 3.5 mm high, with c. 1 mm broad wings along lobes; tuft of hairs below placenta absent. *Arilloid* with a curled appendage. *Seed* obovoid, c. 6 by 4.5 mm. *Embryo* c. 5.5 by 4 mm; cotyledons secondarily laterally besides each other, apices not elongated.

Field notes – Shrub to tree, 3–23 m high, d.b.h. 20–45 cm. Outer bark dark red-to grey-brown, smooth to with many pustular lenticels, with fine reticulate cracks and with fairly numerous horizontal ridges, 0.5–7 mm thick; under bark straw to dark brown; inner bark straw-brown to brown, c. 5 mm thick. Wood straw; heartwood pale brown to brown. Leaves dull pale green above, paler below. Sepals pale green. Petals white. Filaments pale green; anthers dark red. Gynoecium pale green. Fruit red-brown.

Distribution – Irian Jaya: Wissel Lakes, Baliem Valley, Valentijn Mts; Papua New Guinea: E Highlands and Morobe Provinces (map 1b).

Habitat & Ecology – Found in primary (*Nothofagus*), secondary, and montane forest. Soil: Clay, peat, white sandstone. Rather scarce to locally common. Alt.: 1750–2500 m. Flowering: April to June; fruiting: Aug. (based on 1 specimen).

Vernacular names – Kia, pehtepa (Hagen, Togoba dial.); kimigomah (Mairi, Wabung dial.); mak (Wahgi, Minj dial.); miobaberreh (Chimbu, Masul dial.); oera-oera (Dani); tato (Kapakoe); wamena-wallaik.

Note – Typical are the elliptic leaflets with sericeous indumentum and very long driptip; the large flowers, and the large petals which are much longer than the sepals. The western New Guinea specimens show leaflets with a somewhat less well-developed mucron and a somewhat shorter tip.

### 3. *Sarcopteryx coriacea* Radlk.

*Sarcopteryx coriacea* Radlk., Sapind. Holl.-Ind. (1879) 98 (without type); Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9 (1879) 544, 659 (typification); Nova Guinea 14 (1926) 183; in Engler, Pflanzenr. 98 (1933) 1235.— Type: *d'Urville 29118* (P, holo; iso in M), Irian Jaya, Waigiou Isl. (Waigeo), Offiak.

Shrub. *Branchlets* smooth, hirsute when young; flowering twigs 1.5–2.5 mm thick. *Leaves* (1–)2–7-jugate; rhachis 0.3–3.1 cm long; petiolule a pulvinus only. *Leaflets* ovate, 0.9–4.2 by 0.3–1.8 cm, (slightly) asymmetric, coriaceous, not punctate; base sometimes asymmetric; margin flat; apex acuminate, sometimes asymmetric, mucronulate; upper surface smooth, hirsute, glabrescent; lower surface densely hirsute; domatia absent; nerves marginally looped; veins very distinct. *Inflorescences* axillary (to pseudoterminal), not branching or with a few branches, slender, hirsute, up to 6.2 cm long, branches up to 5 cm long; cymules cincinnate, 2- or 3-flowered. *Bracts* and *bracteoles* triangular, sericeous; bracts up to 2 mm long; bracteoles up to 1.1 mm long. *Flowers* less than 2 mm in diam., presumably still young. *Sepals* deltoid, 0.8–1.4 by 0.6–1.1 mm, hirsute. *Petals* circular, male 1.3–1.8 by 1.1–1.6 mm, claw c. 0.3 mm, scale c. 0.8 mm high with a small glabrous crest; female c. 1 by 1 mm, claw c. 0.2 mm, scales c. 0.4 mm high, without crest; scales densely woolly hairy along outer margin, apex, and inner surface. *Stamens*: male filament c. 2.7 mm long, female c. 0.7 mm long; anther 0.4–0.6 mm long, usually papillate, glabrous, connective appendaged. *Pistil*: male ovary c. 0.6 mm high, female c. 1.2 mm high; style and stigma 0.1–0.3 mm long. *Fruit* 1–1.4 cm high by 0.9–1.2 cm broad, smooth, glabrous, stipe absent, with less than 0.5 mm wide wings along lobes, tuft of hairs below placenta. *Arilloid* with a straight appendage. *Seed* obovoid, c. 9 by 6 mm. *Embryo* c. 8.7 by 5 mm; cotyledons dorsoventrally above each other, upper larger, apex of latter elongated, straight.

Field notes — Shrub, 1–3 m high. Sepals light green to yellowish brown. Petals white (to yellow). Disc brown. Filaments white; anthers yellow to orange to brownish pink. Pistil brownish green. Fruit red to purplish.

Distribution — Irian Jaya: Vogelkop (map 1c).

Habitat & Ecology — Found in primary forest, secondary forest, edge of mossy forest, open heath, fire vegetation. Soil: coarse sand, grey clay. The species is rather scarce to locally common. Alt.: 800–2300 m. Flowering: Jan. to April; fruiting: Oct. to March.

Note — Typical are the very small, coriaceous, hirsute leaflets and small non-stiped fruits with very narrow wings.

### 4. *Sarcopteryx crispata* Welzen, *spec. nov.*

*A Sarcopteryx rigida* similis, petalorum squamis crista bene evoluta et domatiis raris differt. — Typus: *Clemens 709* (L), Papua New Guinea, Morobe Prov., Sattelberg.

(Shrub to) tree. *Branchlets* smooth to slightly ribbed, crispy hirsute especially when young; flowering twigs 2.5–6.5 mm thick. *Leaves* (1–)2–5-jugate; rhachis 1.7–26.3 cm long; petiolule up to 7 mm long. *Leaflets* ovate to elliptic, 3.7–18.3 by 1.8–

7 cm, symmetric to asymmetric, thin to coriaceous, punctate or not; base (sometimes) asymmetric; margin flat to slightly recurved; apex acute to acuminate (to cuspidate), usually mucronulate; upper surface smooth, mainly crispy hirsute on midrib; lower surface hirsute; shallow pockets seldom present; nerves mainly upwards marginally looped; veins distinct. *Inflorescences* in upper leaf axils and pseudoterminal, usually with a few branches, often rather sturdy, hirsute, up to 23.6 cm long, branches up to 7.6 cm long; cymules cincinnate (to partly dichasial), up to 5-flowered. *Bracts* and *bracteoles* triangular, sericeous; bracts up to 2 mm long; bracteoles up to 0.9 mm long. *Flowers* 3–4.8 mm in diam. *Sepals* ovate, 1.1–1.6 by 0.6–1.4 mm, sericeous. *Petals* obovate, blade rhomboid, 1.5–2.2 by 1.2–2 mm, claw 0.3–0.5 mm high, rather slender, margin without auricles, apex truncate to rounded, outside and inside basally sericeous; scales 0.6–1.7 mm long, very hairy along outer margin, apex, and inner surface; crest large, broad to high, clavate, usually glabrous. *Stamens*: male filament 3–4.4 mm long, female 1.4–2.5 mm long; anther with appendaged connective, papillate, usually with few hairs, male 0.7–1 by 0.6–0.8 mm, female 0.6–0.9 by 0.4–0.7 mm. *Pistil*: male ovary 0.6–0.7 mm high, style and stigma 0.2–0.4 mm long; female ovary 1.4–2.2 mm high, style and stigma 1.8–3.4 mm long. *Fruits* 1.9–2 cm high by 1.5–1.7 cm broad, smooth, glabrescent, stipe 3.5–4.5 mm high, broadly triangular, with 2–4 mm broad wings along lobes; axis with hairs below placenta. *Arilloid* with straight appendage. *Seed* obovoid, 7.5–8.5 by 4.5–6 mm. *Embryo* 6–8 by 4–4.3 mm; cotyledons secondarily laterally besides each other, apices elongated, that of lower or of both recurved.

Field note – Understorey (shrub to) tree, 3–33 m high, d.b.h. up to 60 cm; no buttresses. Outer bark brownish to black with numerous small pustular lenticels which sometimes form longitudinal lines or with shallow furrow of 1 cm broad, c. 0.5 mm thick; inner bark brown or red-brown streaks on paler background on the back and yellow-brown tinged with pink on the inside, 2–3 mm thick. Sapwood sometimes not defined, pale to brown; heartwood yellow-brown. Leaves pale to dark green above, below rusty pubescent on veins. Inflorescence axes, calyx, and style pale greenish. Buds brown pilose. Sepals green. Petals white; scales yellow. Disc yellow. Filaments white; anthers pinkish to red. Fruit light brownish yellow to red. Seed (presumably arilloid) yellow.

Distribution – Irian Jaya: S of the Vogelkop, Biak I., Noemfoor I., and along the N coast near the border of Papua New Guinea. Papua New Guinea: W Highlands, Morobe, Western, and Central Provinces. A somewhat disjunct distribution which is likely to be due to insufficient collecting.

Habitat & Ecology – Found in primary and secondary rain forest, in oak and *Nothofagus* forest, and along the road. Soil: Well-drained volcanic soil, sand, stone, clay. Alt.: 10–2000 m. Flowering: June to Nov. Young fruits: Nov. to March. Stems sometimes myrmecophilous.

Vernacular name – Aimomis (Noemfoor); mampias (Biak); morzipa (Anona).

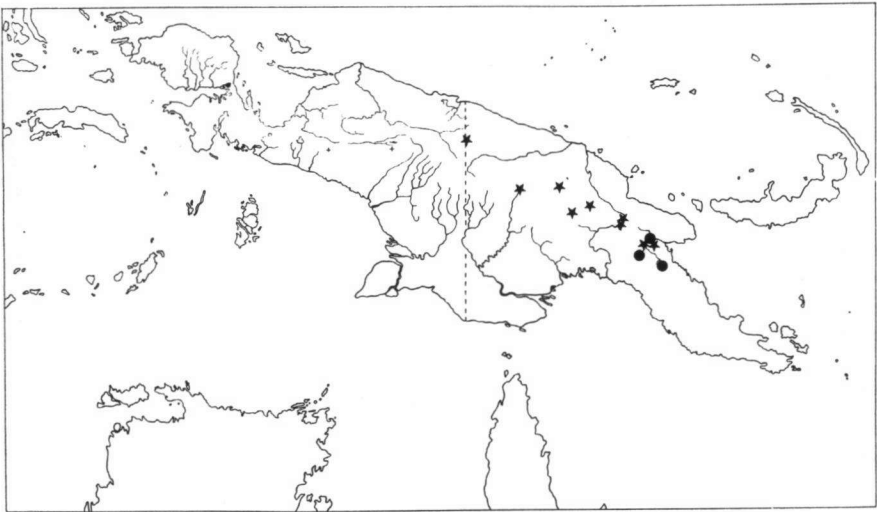
Note – Typical for this species are the crispate hirsute indumentum, the usually punctate leaflets with a short apex and seldom with domatia, the petals with rather large crests, and the shortly stiped fruits. See also the note under *Sarcopteryx rigida*.

### 5. *Sarcopteryx rigida* Radlk. — Fig. 1c.

*Sarcopteryx rigida* Radlk., Bot. Jahrb. 56 (1920) 296, fig. 2; in Engler, Pflanzenr. 98 (1933) 1236, fig. 36. — Lectotype (here proposed): *Ledermann 11500* (M), Papua New Guinea, Kaiserin Augusta Fluss.

*Arytera sordida* Radlk., Bot. Jahrb. 56 (1920) 301; in Engler, Pflanzenr. 98 (1933) 1279. — *Sarcopteryx sordida* (Radlk.) Van der Ham, Blumea 23 (1977) 290. — Type: *Ledermann 12492* (B, holo, †; iso in M), E Papua New Guinea, Kaiserin-Augusta-Fluss Exp., Fels Spitze. (See note 2.)

Tree. *Branchlets* smooth to slightly ribbed, crispy hirsute especially when young; flowering twigs 2–4 mm thick. *Leaves* 1–3(–4)-jugate; rachis 0.9–17.7 cm long; petiolule up to 9 mm long. *Leaflets* ovate to elliptic, 3.7–17.2 by 1.5–5.5 cm, almost symmetric to asymmetric, coriaceous, usually not punctate; base slightly asymmetric; margin flat to slightly recurved; apex acuminate to cuspidate (to caudate), not to mucronulate; upper surface smooth, mainly crispy hirsute on midrib, often with wax; lower surface hirsute; domatia shallow pockets; nerves usually marginally looped; veins distinct. *Inflorescences* in upper leaf axils and pseudoterminal, sometimes with a few branches, rather slender, hirsute, up to 16.2 cm long, branches up to 2.8 cm long; cymes cincinnate, 1–3-flowered. *Bracts* and *bracteoles* triangular, sericeous; bracts up to 2.7 mm long; bracteoles up to 1.1 mm long. *Flowers* 2.7–4 mm in diam. *Sepals* deltoid, 1.5–3 by 1–1.8 mm, sericeous. *Petals* obovate, blade rhomboid, 1.3–2.5 by 1–2 mm, claw 0.5–1.3 mm high, rather slender, margin auricled between claw and blade, apex rounded, outside and inside basally sericeous; scales 0.5–1.2 mm long, very hairy along outer margin, apex, and inner surface; crest absent or very small and then clavate and usually glabrous. *Stamens*: female filament 1.8–2.9 mm long; anther 0.6–1 by 0.4–0.7 mm, sometimes papillate, seldom with few hairs, connective sometimes appendaged. *Pistil*: female ovary 0.8–1 mm high, style and stigma 0.2–0.6 mm long. *Fruits* seen immature, winged, glabrescent; stipe low;



Map 2. Distribution of a. *Sarcopteryx rigida* Radlk. (★); b. *S. rubiginosa* Welzen (●).

axis below placenta with few hairs. *Arilloid* with straight appendage. *Seed* seen immature, obovoid. *Embryo* seen immature; cotyledons secondarily laterally besides each other.

Field notes – Understorey tree, 3–15 m high, d.b.h. 3–12 cm. Outer bark brown to light cream-grey, smooth, thin; inner bark orange. Wood white to light straw, hard. Leaves medium green to very dark green, below lighter green with rufous pubescence on veins; young leaflets with golden brown hairs, glabrescent. Flowers with brownish hairs. Sepals green. Petals white; scales yellow?. Filaments white; anther red. Pistil light green. Fruit red.

Distribution – Papua New Guinea: W Sepik, W Highlands, S Highlands, E Highlands, and Morobe Provinces (map 2a).

Habitat & Ecology – Found in *Nothofagus*–*Castanopsis* forest, lower montane rain forest. Alt.: 1600–2800 m. Flowering: Jan., Feb. Young fruits: May to Feb. (or Oct. to May).

Vernacular names – Palya (Enga); tomo.

Notes – 1. This species differs from *Sarcopteryx crispata* by the presence of pockets, usually of looped marginal veins, the absence of punctation, the auricled margins of the petals, and the absent or small crest. *Sarcopteryx rigida* differs from *S. brachyphylla* by the petals without or with a small crest and a smaller fruit with a short stipe.

2. The name *Sarcopteryx rigida* is preferred above *S. sordida*, because *S. rigida* was directly described in the correct genus and because the type is readily recognizable as a *Sarcopteryx*.

## 6. *Sarcopteryx rubiginosa* Welzen, *spec. nov.*

*A Sarcopteryx rigida* foliolis parvioribus sine domatiis petali margine unguem versus non auriculata differt. — Typus: *Vinas 18* (L, holo; iso in LAE; A, BFC, CBG, K, UPNG, n.v.), Papua New Guinea, Morobe Prov., Spreads Divide, Aseki-Menyamya Road, 9 km NW of Aseki, 7.18° S, 146.08° E.

Small tree. *Branchlets* usually ribbed, hirsute when young; flowering twigs 2–3.5 mm thick. *Leaves* 2- or 3-jugate; rhachis 2.7–7.1 cm long; petiolule up to 6 mm long. *Leaflets* ovate (to elliptic), 3–8 by 1.8–4 cm, somewhat asymmetric, coriaceous, not punctate; base somewhat asymmetric; margin flat; apex acuminate, not mucronulate; upper surface smooth, pilose on midrib; lower surface hirsute; domatia absent; nerves marginally looped; veins distinct. *Inflorescences* in upper leaf axils to pseudoterminal, not branching or with a few branches, slender, hirsute, up to 8 cm long, branches up to 2.4 cm long; cymules cincinnate, 1- or 2-flowered. *Bracts* and *bracteoles* triangular, sericeous; bracts up to 2 mm long; bracteoles up to 1.1 mm long. *Flowers* c. 3 mm in diam. *Sepals* ovate, 1.2–1.8 by 0.6–0.8 mm, hirsute. *Petals* circular to elliptic, 1.1–1.4 by 0.8–1 mm, claw 0.1–0.2 mm high, margin not auricled near claw, apex obtuse; scales 0.4–0.7 mm high, without crest, densely woolly hairy along outer margin, apex, and inner surface. *Stamens*: filament 0.7–1 mm long; anther 0.5–0.7 mm long, glabrous, papillate, with appendaged connective. *Pistil*: ovary 0.6–1 mm high; style and stigma 0.1–0.2 mm long. *Fruit* unknown.



Fig. 5. Habit of *Sarcopteryx squamosa* (Roxb.) Radlk. (Atjé 283, L,  $\times 0.5$ ).

Field notes – Tree, 7–10 m high, d.b.h. up to 16 cm. Outer bark (reddish) brown, rough; inner salmon to brown. Wood white, hard. Leaves shiny dark green above, below paler, veins brownish; young leaves red. Petals white.

Distribution – Papua New Guinea: Morobe Province (map 2b).

Habitat & Ecology – Found in montane (fagaceous) moss forest. Alt.: 1800–2300 m. Flowering: Nov., Dec.

Note – Typical are the rather small, coriaceous, petiolulate, hirsute leaflets, and subpilose anthers with an appendaged connective.

## 7. *Sarcopteryx squamosa* (Roxb.) Radlk. — Figs. 1b, 5.

*Sarcopteryx squamosa* (Roxb.) Radlk., Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 8 (1878) 303, nom. illeg. (genus not yet described); Sapind. Holl.-Ind. (1879) 19, 57, 97; Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9 (1879) 544, 659; Bot. Jahrb. 56 (1921) 295; in Engler, Pflanzenr. 98 (1933) 1234. — *Sapindus squamosus* Roxb., [Hort. Beng. (1814) 88, nom. nud.] Fl. Ind. 2 (1832) 282. — Holotype: *Roxburgh s.n.* (BR), Irian Jaya, Nassau-lant (= Nassau Mts: E Fak-Fak Prov., southern part of Snow Mts).

*Sarcopteryx melanophloea* Radlk., Sapind. Holl.-Ind. (1879) 19, 57; Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 9 (1879) 544, 659; in Engler, Pflanzenr. 98 (1933) 1234; Streimann, Pl. Upper Watut Watershed (1983) 170. — Syntypes: *Beccari PP 15 = FI 2786* (FI, M) and *FI 2787* (FI), New Guinea, Jobi I., Ansum.

*Sarcopteryx holconeura* Radlk., Sitzungsber. Math.-Phys. Cl. Königl. Bayer. Akad. Wiss. München 20 (1890) 266; in Engler, Pflanzenr. 98 (1933) 1233. — Type: *MacGregor s.n.*, 1890 (M, holo; iso in MEL, sheet no. 31988), E New Guinea, Fly River.

(Shrub to) tree. *Branchlets* smooth to somewhat ribbed, sericeous when young; flowering twigs 2–6.5 mm thick. *Leaves* 1–4(–5)-jugate; rachis 1.7–22 cm long; petiolule up to 5(–7) mm long. *Leaflets* ovate to elliptic, 4.6–23.5 by 1.3–8.4 cm, usually asymmetric, rather thin to coriaceous, usually punctate; base usually asymmetric; margin flat to sometimes somewhat revolute; apex acuminate to caudate, mucronulate; upper surface smooth, at most sericeous on midrib, usually with wax; lower surface not to (slightly) sericeous on midrib; domatia absent to very seldom few pockets apically; nerves mainly apically marginally looped; veins distinct. *Inflorescences* in upper leaf axils and pseudoterminal, usually with a few branches, rather slender, 0.8–2 mm thick, sericeous, up to 25.5 cm long, branches up to 11.4 cm long; cymules cincinnate (to partly dichasial), 2- or 3(–6)-flowered. *Bracts* and *bracteoles* triangular, sericeous; bracts up to 3 mm long; bracteoles up to 1.3 mm long. *Flowers* 2.5–5.2 mm in diam. *Sepals* deltoid to ovate, 0.7–1.7 by 0.7–1.8 mm, sericeous. *Petals* obovate, apex truncate, frayed, outside and inside especially basally sericeous; scales very hairy along outer margin, apex, and inner surface; crest small to large, often flat and linear, apically glabrous; male petals 1.7–3.5 by 1.8–3 mm, claw 0.2–0.7 mm high, scales 1–1.6 mm long; female petals 1.3–1.8 by 1.1–1.7 mm, claw 0.1–0.3 mm high, scales 0.5–0.9 mm high. *Stamens*: male filament 2.8–6.6 mm long, female 0.8–3.3 mm long; anther usually papillate, often with hairs, connective usually appendaged, male 0.5–0.8 by 0.3–0.7 mm, female 0.4–0.8 by 0.3–0.5 mm. *Pistil*: male ovary 0.3–1 mm high, style and stigma 0.1–1 mm long; female ovary 0.8–1.5 mm high, style and stigma 0.3–2.5 mm long. *Fruits* 1.2–2.1 cm high by 1–2.2 cm broad, smooth, glabrescent, stipe low, 3–6.5 mm

high, with 1–3 mm broad wings along lobes, tuft of hairs below placenta. *Arilloid* with a straight appendage. *Seed* obovoid, 5.5–10 by 3.7–6 mm. *Embryo* 5–8.5 by 3.2–5 mm; cotyledons secondarily laterally besides each other, apices elongated or not, if elongated usually curved or recurved.

Field notes – (Shrub to) tree (to liana?), 2–25 m high, d.b.h. up to 30 cm; low buttresses seldom present. Outer bark rather smooth, thin flaky to finely fissured, grey-green to dark brown, c. 5 mm thick; underbark green; inner bark pinkish straw to purplish to red-brown, hard, non-fibrous. Wood straw to orange-pink, surface washboard-like. Leaves above dark green, below light green. Indumentum brown. Flower fragrant. Calyx pale green to yellowish brown. Petals white; scales white; crest yellow. Disc yellowish green to red. Filaments white; anthers orange to red. Pistil yellowish green. Fruits purplish red; aril yellow to red; seed brown.

Distribution – Moluccas, N Irian Jaya, Papua New Guinea (mainly in the coastal provinces).

Habitat & Ecology – Found in primary and mainly secondary forest, especially along edges: road, mangrove, savannah, rivers. Often found on sometimes inundated land. Soil: often (silt) clay, also ultrabasic. Alt.: sealevel up to 1575 m. Usually common. Branches sometimes hollow and filled with ants. Flowering: Jan. to April, June to Sep.; fruiting: March to July, Sep. to Dec.

Vernacular names – New Guinea: Kokao; seraraboch (Maibrat); suru (Kaiye, Orme language); wow (Selogof).

Notes – 1. Typical are the lack of sericeous hairs on the leaflets, the long leaf apex, the short petals with truncate frayed apex, the almost united scales with usually a small to big crest, and the winged fruit.

2. Fernandez-Villar (Nov. App., 1883: 516) 'recorded' *Sarcopteryx* (*Sapindus*) *squamosus* and *Sarcopteryx melanophloea* for the Philippines. Merrill (Enum. Philipp. 2, 1923: 516) corrected this error.

3. *Sarcopteryx squamosa* is a rather variable species, perhaps consisting of sibling species which, unfortunately, do not show correlating distinctive characters yet. Features used by Radlkofer as thickness and shape of leaflets and colour of inflorescences, but also characters like presence of punctation, symmetry, sericeousness of the leaflets, size of the petals and the crests vary considerably, but do never correlate. The fruits are present in three different sizes, the most common one is the middle size. Hoogland 4200 and NGF (Vandenberg) 42169 show small fruits and NGF (Womersley) 24923 very large fruits. The latter is found at the edge of the distribution range of *Sarcopteryx squamosa* in the mountains. Because of the absence of correlating characters *Sarcopteryx squamosa*, *S. melanophloea*, and *S. holconeura* were united.

4. The type specimen of *Sarcopteryx holconeura*, MacGregor s.n. from the Fly River, is very atypical in comparison to the rest of the *Sarcopteryx squamosa* material. The thin leaflets show a peculiar shade of very light green, they are large, and the midrib below shows a shallow groove. Other material from different parts of New Guinea, e.g. NGF (Streimann) 28786, also shows the groove. Thin leaflets are also found in W and N New Guinea, just like big leaflets. Only the colour is typical, but can be due to the young age of the leaflets and/or the method of conservation.

5. LAE (Gideon) 73256 of Mt Riu, Tagula I., shows very small leaflets (1.7–3.7 by 0.8–1.6 cm) with an obtuse apex. At first sight this specimen seems to belong to a



different species, but the size of the leaflets and the deviating apex are the only characters in which it differs from *Sarcopteryx squamosa*, consequently it is identified tentatively as this species.

#### IDENTIFICATION LIST

The numbers refer to the species: *Sarcopteryx brachyphylla* Radlk. = 1, *S. caudata* Welzen = 2, *S. coriacea* Radlk. = 3, *S. crispata* Welzen = 4, *S. rigida* Radlk. = 5, *S. rubiginosa* Welzen = 6, *S. squamosa* (Roxb.) Radlk. = 7.

Aet (Exp. Lundquist) 720: 4 — Allison 259: 2 — ANU 2668: 2; 2678: 5 — Atjé (Exp. Hulstijn) 283: 7.

bb 31343: 4 — Beccari PP 15: 7 — Brass 7255: 7; 7331: 7; 8720: 4; 13801: 7; 13802: 7; 23024: 7; 27478: 7 — BW 1062: 4; 5207: 7; 5217: 7; 5228: 7; 8347: 4; 8846: 2; 12034: 4; 12542: 2; 13340: 3; 13357: 3; 14079: 3; 14174: 3; 14246: 3; 14953: 7; 15369: 7.

Carr 13646: 1 — Clemens 709: 4; 1059: 4 — Conn & students 222: 7.

Darbyshire & Hoogland 8208: 7.

Eyma 4951: 2.

Fisher 62: 1 — Forbes 897: 7; 907: 7.

Gjellerup 1033: 3.

Hartley 11676: 5; 12566: 6; 13693: 5 — Hollrung 677: 7 — Hoogland 4200: 7 — Hoogland & Pullen 5437: 2; 5447: 2.

Jacobs 9012: 4.

Kanehira & Hatusima 12825: 7 — Kostermans 2319: 3 — Kostermans & Soegeng 243: 7; 496: 4; 747: 2.

LAE 52489: 7; 54338: 1; 63302: 5; 70432: 7; 73256: cf. 7 — Ledermann 9954: 5; 11500: 5; 12492: 5.

Mangen 338: 2.

Nelson 140: 5 — NGF 1042: 4; 9113: 7; 17595: 1; 17596: 1; 19093: 7; 19264: 7; 19365: 7; 20126: 4; 23384: 7; 24923: 7; 28786: 7; 29017: 6; 29046: 5; 33376: 7; 34723: 1; 37283: 4; 37286: 5; 37459: 7; 39999: 4; 42169: 7; 44208: 7; 45099: 7.

Pleyte 799: 7; 932: 7 — Pullen 6722: 7; 7969: 1; 7994: 1.

Robbins 944: 5; 2409: 7 — P. van Royen 5565: 7 — P. van Royen & Sleumer 6565: 7; 8084: 3.

Schodde (& Craven) 4884: 2 — Sleumer & Vink 4272: 3.

Teijsmann HB 14255: 7 — Treub 129: 7.

UPNG 4985: 5; 7634: 4 — d'Urville 29118: 3.

Van Valkenburg 33: 5; 698: 7 — Vinas 18: 6.