

OXALIDACEAE (J. F. Veldkamp, Leyden)

Herbs, sometimes with scaly rhizomes, bulbs, bulbils or stolons, or woody perennials, shrubs, lianas or trees. *Leaves* penninerved, digitately or pinnately trifoliolate, imparipinnate or paripinnate, basal, alternate, subopposite or apically tufted. Stipules sometimes present. Petioles with basal joint, petiolules articulated. *Inflorescences* basal, axillary or pseudoterminal, cymose to pseudumbellate, rarely racemose, 1-many-flowered, bracteate and bracteolate. *Flowers* ♂, very rarely also ♂ specimens (*Dapania*), actinomorphic, 5-merous, hetero-tri-, -di-, or homostylous, sometimes cleistogamous. Pedicels articulate. *Sepals* imbricate, free or connate at base, sometimes with apical calli (*Oxalis*), persistent. *Petals* contort, quincuncial or cochlear, free but usually cohesive above the base ('pseudosympetal'), clawed (sometimes minutely so), glabrous or inside sometimes with minute papillae or pilose. *Filaments* 10, obdiplostemonous, connate at base into an annulus, persistent, the epipetalous (shorter) sometimes with a basal gland near the insertion of the petals, or sometimes with 2 scales or dark lines on the annulus (*Dapania*), rarely without anthers; the episepalous (longer) with a dorsal tooth (*Oxalis*) or hunchbacked; anthers dorsifixed, versatile, 2-celled, dehiscing extrorsely by longitudinal slits. No *disk*. *Ovary* 5-celled, superior; styles 5, terminal, persistent, free, in LF¹ and MF erect, in SF patent to recurved, rarely reduced (♂ flowers); ovules 1-2-several per cell in 1-2 rows, epi- and anatropous, pendulous, superposed, bitegmic. *Fruit* capsular, loculicid, 5-celled, dry, rarely fleshy and indehiscent. *Seeds* usually with an aril; endosperm copious, fleshy, rarely absent; embryo straight.

Distribution. 6(?) genera with c. 850 spp. Of the Malesian representatives *Oxalis*, the largest genus, is most numerous in S. America and S. Africa and *Biophytum* in S. America and Madagascar; *Dapania* has 2 spp. in Malesia and 1 in Madagascar; *Sarcotheca* (11 spp.) is endemic in Malesia, while *Averrhoa* (2 spp.) assumedly also originated here; it is now cultivated pantropically.

In Malesia there are 5 genera with 29 species, of which 14 endemic.

The generic distribution of the family offers in the Old World two remarkable patterns. First, that of *Dapania* which shows the characteristic disjunction between West Malesia and Madagascar. Second, that of *Oxalis sect. Acetosellae* which almost resembles that of *Euphrasia*, that is, a temperate genus with two stepping stones across the tropics (Luzon, New Guinea), otherwise bipolar. Fig. 2.

Ecology. Many members of the family have sensitive leaves and show sleeping movements, some being also seisonastic which is conspicuous in *Biophytum*.

Dispersal. The fleshy fruits of *Averrhoa*, *Dapania*, and *Sarcotheca* are no doubt eaten by various animals as bats, birds, and monkeys, and dispersed by them. The seeds of *Oxalis* and *Biophytum* have a peculiar ejaculative aril originally enveloping the entire seed which at maturity shoots them away for some distance (ZIEGLER, Ber. Bayer. Bot. Ges. 36, 1963, 61). The cultivated species of *Oxalis* which set no fruit in Malesia, are locally tenacious weeds through their bulbils. The native *Oxalis* species propagate also vegetatively, by stolons and root-stocks.

All *Oxalidaceae* have an arillate seed except the species of *Sarcotheca* and *Averrhoa bilimbi*.

On germination some remarks are made under the genus *Biophytum*.

Morphology. Episeptal rimae are found in some species of *Oxalis*, in most of *Dapania* and all *Sarcothecas*; in *Averrhoa* they are only inconspicuous, apical furrows. The most primitive state is probably represented in *Oxalis corniculata*. The septa fail to enlarge towards fructification, whereby the cells of the fruit are only united by their attachment to the central axis. The walls of the cells are pressed together and slits are formed, especially conspicuous by transparent ridges. These ridges are wide apart in the Malesian *Dapanias* and are slightly bent inwards. In *Sarcotheca* the septa are developed, at least in the lower half; in the upper half the rimae may be open and papillose inside, or closed and glabrous. Episeptal rimae are absent in all *Biophytums* and in *Dapania pentandra* from Madagascar.

(1) LF = long-styled form, MF = mid-styled form, SF = short-styled form.

Dehiscence of the fruits in *Biophytum* and *Dapania* is into a 5-rayed star. In *Oxalis* the valves remain united and only longitudinal loculicid slits are formed. *Sarcotheca* and *Averrhoa* have indehiscent fleshy fruits.

Anatomy. CHAUVEL, Rech. sur la famille Oxal. (1903) thesis; MOLL & JANS. Mikr. 2 (1911) 9 (*Averrhoa*); HEIMSCH, Lilloa 8 (1942) 97, 191; METCALFE & CHALK, Anat. Dicot. 1 (1950) 299.

Phytochemistry. Few phytochemical investigations were performed with members of the family. In fact, distinct constituents have been isolated only from a few species of *Oxalis*. The tendency shown by many species of *Oxalis* to accumulate large amounts of oxalic acid in water-soluble form is known since a long time. Leucocyanidins and leucodelphinidins have been demonstrated to be present in the leaves of some species of *Oxalis* and of *Averrhoa carambola* L. This agrees with the idea that *Oxalidaceae* represent the most primitive family of *Geraniales*. Probably the species described by plant anatomists as possessing 'tannin' cells are the ones which contain leucoanthocyanins in leaves. The bright yellow flower pigments of *Oxalis cernua* THUNB. are the aurone glycosides aureusin and cernuoides. A yellow quinonoid pigment was isolated from the bulbs of one species of *Oxalis* (*O. purpurata* JACQ. ?) and later identified with rapanone, a benzoquinone occurring frequently in myrsinaceous plants. Too little phytochemical information is available at present for a chemotaxonomical appreciation of systematic relationships of *Oxalidaceae*. It might be significant, however, that rapanone does also occur in *Connaraceae*. General reference: HEGNAUER, Chemotaxonomie der Pflanzen 5 (1969) 255. — R. HEGNAUER.

Pollination. *Heterostyly* is a common feature in the family, heterotriasty is observed in *Oxalis*, *Biophytum*, and *Averrhoa bilimbi*. This must be assumed to be the primitive condition, as is found in the allied *Connaraceae*. From it is derived a heterodistylous condition in *Sarcotheca* and *Dapania*, in certain species of *Oxalis* and *Biophytum*, and in *Averrhoa carambola*. A further derived, homostylous condition is found in certain species of *Oxalis* and *Biophytum*.

DARWIN concluded that the heterotriasty in a Ceylonese *Biophytum* which he examined, was also functional in analogy with *Oxalis* while in cleistogamous flowers¹ he observed that in some way the incompatibility factor seemed to be removed (The Different Forms of Flowers, ed. 1877, 181, 323). SALTER (J. S. Afr. Bot. Suppl. 1, 1944) confirmed by experiments that functional heterotriasty occurs in *Oxalis*. This was also found in S. American species of *Oxalis*. Miss P. MAYURA DEVI (J. Genetics 59, 1964, 41) found in Indian *Biophytum* in her experiments a significant incompatibility in illegitimate crossings, except for MF selfed with pollen of the long stamens. This means a loss of compulsory heterotriasty. In a later article (*ibid.* 1966, 245) she described another mid-homostylous form which proved excellently self-compatible. It is regrettable that she did not conserve voucher specimens bound to her experiments, as the identification of Indian *Biophytum* is in distinct confusion and more than one species is cited as *B. sensitivum*. The plants used by DEVI certainly do not belong to *B. sensitivum*, as in her pictures the corolla is much longer than the calyx.

Functional heterotriasty is apparently present in the introduced species of *Oxalis*, *O. deppoi* and *O. latifolia*, which in Malasia occur as SF only and have never been observed with fruit. *O. corymbosa*, although present with SF and MF, does not fruit either, but the flowers are often monstrous in this species. All three reproduce very successfully by bulbils and can become obnoxious weeds.

Biophytum fruticosum, *B. adiantoides* and *B. microphyllum* are also heterotriastylous. No experiments have been done.

Biophytum sensitivum and *B. reinwardtii sens. str.* are both in India and Malasia mid-homostylous.

Reduction to a single stylar form (LF) is found in *Oxalis magellanica* and *O. acetosella ssp. griffithii*; reduction to homostyly (MF) has very far progressed in both *O. corniculata* where LF occurs rarely (6 out of 105 plants examined; cf. also EITEN, Am. Midl. Natur. 69, 1963, 280) and *Averrhoa bilimbi*, where LF and SF were only observed once. The introduced *Biophytum dendroides* is apparently self-compatible, as only one form (LF) has been found at Bogor and in the glasshouses of the Botanical Gardens of Leyden and Groningen, where in the apparent absence of pollinators it is fully fertile and weedy.

Heterodistily (LF and SF) occurs in *Biophytum petersianum*, *Sarcotheca*, and *Dapania pentandra* from Madagascar. It is plausible that the ♂ flowers of the Malasian *Dapania* originated by an extreme reduction of the pistil in SF-flowers. *Averrhoa carambola* is heterodistylous for LF and MF. The latter type might well correspond with SF, as the shorter stamens are much reduced and without anthers.

More information about heterostyly and literature concerning this matter is given by ORNDUFF and by MULCAHY (Am. J. Bot. 51, 1964, 307 and 1045).

Palynology. See ERDTMAN, Pollen Morphol. & Plant Tax. 1 (1952) 302; HUANG, Taiwania 13 (1967) 70 and HUYNH, Bot. Jahrb. 89 (1969) 272.

Uses. Several species of *Oxalis* are cultivated as ornamentals, *Averrhoa* for its edible fruit. The wood of the ligneous *Oxalidaceae* is useless as timber. In Malaya the fruits of *Sarcotheca* are sometimes eaten. See also HEYNE, Nutt. Pl. (1927) 850.

Taxonomy. In Engler's Syllabus (2, 1964, 248) SCHOLZ divided the genera in 2 groups, A and B, on the aestivation and the number of ovules per carpel. Through this *Averrhoa* was joined to the affinity of *Oxalis* and *Biophytum*. However, the aestivation is inconstant. Moreover, the affinity of *Averrhoa* is

(1) In *Biophytum* I found also in not cleistogamous flowers opened anthers with good pollen already in bud (protrandry).

doubtless with *Sarcotheca* and *Dapania* in all other characters. These three genera form a very clear reticulate affinity.

The family is considered to be the most primitive of the *Geraniales* by HALLIER *f.* (Arch. Néerl. sér. 3B, 1, 1912, 109) and ENGLER (Nat. Pfl. Fam. ed. 2, 19a, 1931, 10). This primitive position is possibly the reason for the affinity with the *Connaraceae*, at which some authors have pointed (HALLIER *f.* New Phyt. 4, 1905, 158; Arch. Néerl. sér. 3B, 1, 1912, 109; SCHELLENBERG, Pfl. R. Heft 103, 1938, 127; TAKHTAJAN, Evol. Angiosp. 1959, 236). The latter family is usually placed near the *Leguminosae*. As a matter of fact specimens of *Rourea* and *Sarcotheca* were often confused and are very similar, the pistil and fruit excepted.

The closest allied family is *Geraniaceae* in which they were merged by BENTHAM & HOOKER *f.* In fact the American *Hypseocharis* seems to link both families. The only constant character was said by HALLIER *f.* (Beih. Bot. Centralbl. 39, ii, 1921, 172) to be the tenuinucellate ovules in *Oxalidaceae* and crassinucellate ovules in *Geraniaceae*, but *Hypseocharis* and many species of other genera have not been checked on the general validity of this character, as HALLIER *f.* himself admitted. And one must be very careful in this respect; for example HUTCHINSON (Fam. Fl. Pl. ed. 2, 1, 1959, 494) stated that *Oxalidaceae* have albuminous seeds, but some species of *Oxalis* are exalbuminous (*cf.* SALTER, J. S. Afr. Bot. Suppl. 1, 1944, 26); he stated also that *Oxalidaceae* are exstipulate, but stipules are found in all *Biophytums* and also in some species of *Oxalis* (*sect.* *Acetosella*, *O. corniculata*, etc.).

HUTCHINSON's division of *Oxalidaceae* into three different families belonging to three different orders seems not to have a reliable basis as *Averrhoa* cannot be divorced from *Sarcotheca* and *Dapania* and there is no reason for admitting a preponderant importance to their ligneous habit; besides many species of *Biophytum* and *Oxalis* are dwarf shrubs.

KEY TO THE GENERA

1. Herbs or dwarf shrubs, rarely up to 1½ m high. Leaves 3(–4)-foliolate, or paripinnate, herbaceous. Fruit a dry capsule.
 2. Leaflets 3–4. Capsule with the valves remaining attached to the central axis. 1. *Oxalis*
 2. Leaflets 6 or more, pinnate. Capsule dehiscing into a 5-rayed star, without leaving a columella. 2. *Biophytum*
1. Shrubs, trees or lianas, much higher. Leaflets 1 or 3, or leaves imparipinnate, 2-many-jugate. Fruit fleshy, dehiscent into a 5-rayed star or indehiscent.
 3. Leaflets 1 or 3, chartaceous or subcoriaceous. Lateral petiolules articulate, after dropping leaving a short stalk on the rachis. Ovules 1–2 per cell.
 4. Lianas. Inflorescences racemose. Petals inside glabrous. Fruit dehiscent into a 5-rayed star. Seeds arillate. 3. *Dapania*
 4. Shrubs or trees. Inflorescences paniculate. Petals minutely papillose inside. Fruit indehiscent (but episeptal rimae sometimes open!). Seeds exarillate. 4. *Sarcotheca*
 3. Leaves imparipinnate, 2-many-jugate, herbaceous or papyraceous. Lateral petiolules after dropping not leaving a stalk on the rachis. Ovules 3–7 per cell. 5. *Averrhoa*

1. OXALIS

LINNÉ, Gen. Pl. ed. 5 (1754) 198; Sp. Pl. (1753) 433; Knuth, Pfl. R. Heft 95 (1930). — Fig. 1.

Annual or perennial herbs (or dwarf shrubs, extra-Mal.), some stemless with rhizomes or bulbs. *Leaves* digitately or pinnately 3(–4)-foliolate; leaflets in Mal. *spp.* (except *O. barrelieri*) ± sessile. Stipules when present adnate with the base of the petiole. *Peduncles* basal from bulbs or solitary and axillary. *Inflorescences* cymose to umbellate, 1-many-flowered. Bracteoles 2–several, sometimes with apical calli. Pedicels articulate at base and sometimes beneath the calyx. *Sepals* shortly connate at base, with or without apical calli. *Petals* coherent above the claw, contort, glabrous. *Filaments*: longer ones sometimes with a dorsal tooth. *Stigma* cylindrical and minutely bilobed to peltate, sometimes papillose. Ovules 1 to c. 10, in 1–2 rows per cell. *Capsules* loculicid by longitudinal slits, sometimes with episeptal rimae. *Seeds* 1–c. 10 per cell, usually few; aril bivalved, ejaculatory; testa smooth, or with transverse ridges or longitudinal furrows.

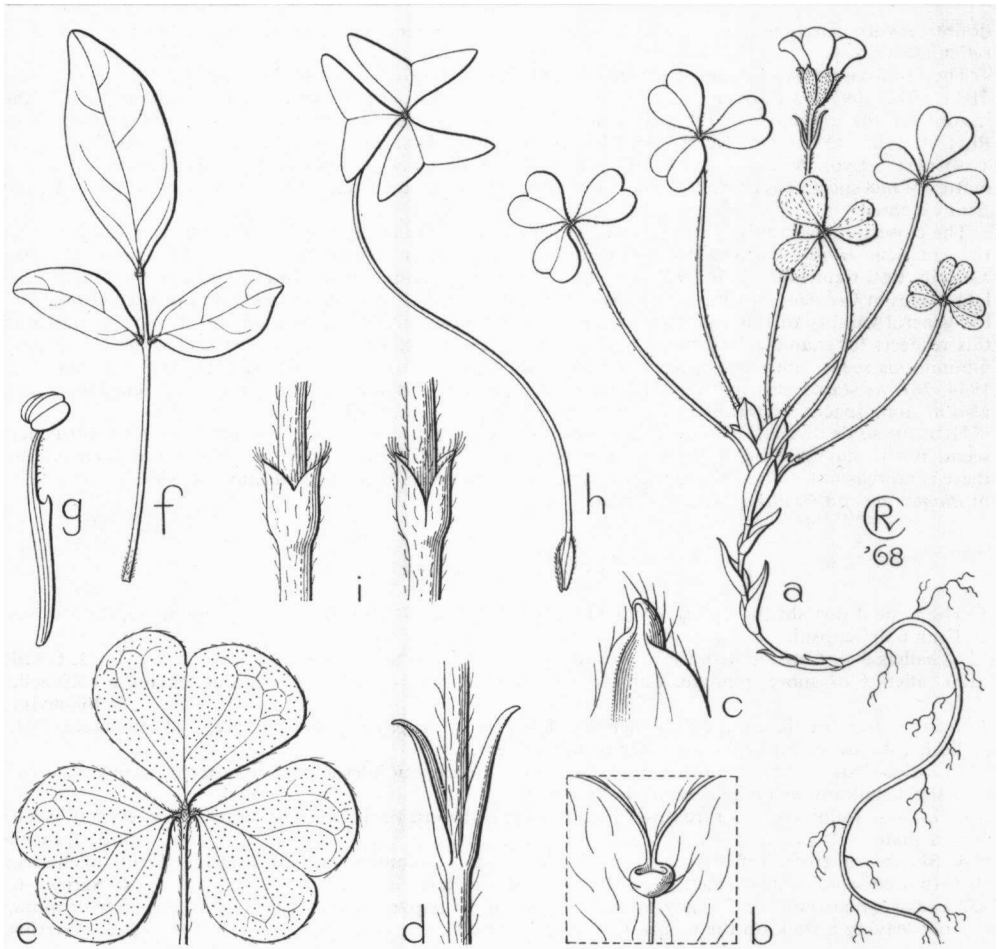


Fig. 1. *Oxalis magellanica* FORST. f. a. Habit, $\times 12$, b. 'callus' of leaf, $\times 12$, c. apex sepal, $\times 12$, d. bracteoles, from both sides, $\times 4$. — *O. corymbosa* DC. e. Leaf, $\times 1$. — *O. barrelieri* L. f. Leaf, nat. size, g. dentate stamen, $\times 12$. — *O. acetosella* L. ssp. *griffithii* HARA. h. Leaf, nat. size, i. bracteoles, from both sides, $\times 4$ (a–d BALGOOY 252, e BACKER 37150, f–g BOERLAGE s.n. a. 1880, h–i STEINER 1990).

Distr. Cosmopolitan, at least 700 spp., mainly from S. America and the Cape, in *Malesia* 3 native spp.; others introduced and escaping, sometimes becoming weedy. Fig. 2 (§ *Acetosella*).

Ecol. *O. acetosella* ssp. *griffithii* and *O. magellanica* are (in *Malesia*) both characteristic mountain plants, above 2200 m. *O. corniculata* is rather indifferent to altitude.

Morph. The longer filaments are frequently thickened in the basal part, as in *Biophytum*. The apex of the thickening may emerge as a small tooth, e.g. in *O. latifolia*, *O. deppii*, and *O. barrelieri*. This tooth does not carry a vascular trace (NARAYANA, J. Jap. Bot. 41, 1966, 321).

For heterostyly see under the family.

An important study of the morphological diversity and taxonomy of the S. African species is provided by SALTER (J. S. Afr. Bot. Suppl. 1, 1944).

Notes. Pending a revision of the S. American species, Miss LOURTEIG (Paris) advised me to accept the names of the introduced species in the current sense.

Sizes of petiole and pedicels are given only for the portion above their articulation, as the part below it is too variable. The length of a 2-lobed leaflet is measured from the base to the apex of the lobe. The length of the filaments includes that of the basal, fused, annular part.

KEY TO THE SPECIES

1. Leaves along a distinct, supraterranean, creeping to erect stem. No bulbs.
2. Shrublet. Petioles phyllodial, leaflets 0-3, often minute. Peduncles abortive. Flowers 1-9 in a fascicle, yellow. Cultivated in Java (§ *Heterophyllum*) (*O. rusciformis* MIKAN) **O. fruticosa** RADDI
2. Herbaceous. Petioles not phyllodial, leaflets not reduced. Peduncle distinct.
3. Leaf pinnately 3-foliolate (rachis developed under terminal leaflet). Leaflets elliptic to oblong, apex not notched. Petals pink with yellow base (§ *Thamnoxyis*). **1. O. barrelieri**
3. Leaf digitately 3-foliolate. Leaflets obcordate. Petals yellow (§ *Corniculatae*). **2. O. corniculata**
1. Stemless herbs with bulbs or subterranean rhizomes; leaves all basal.
4. Rhizome, no bulbs. Inflorescence 1-flowered. Sepals with 0-1 greenish, round apical callus. Petals white (§ *Acetosellae*).
5. Stipules conspicuous, much wider than the petiole. Leaflets up to 1¼ by 1¼ cm, obcordate; beneath whitish and glaucous and with a pale callus in the notch. Bracteoles 2, free, not vaginate, subglabrous. Sepals pubescent, with 1 pale apical callus. **3. O. magellanica**
5. Stipules narrow, slightly broader than petiole, not very conspicuous. Leaflets 1-3 by 1¼-4 cm, fishtail-shaped; beneath not whitish and glaucous, ecallose. Bracteole 1, emarginate to bifid, vaginate, with an apical brown hair-tuft. Sepals subglabrous, ecallose. **4. O. acetosella ssp. griffithii**
4. Bulbs, no rhizome. Inflorescence 2-many-flowered. Sepals with 2-4 orange apical calli. Petals red or purple with greenish to yellowish base.
6. Outer tunics many-nerved, fibrous-withering. Leaflets 4(-6), obdeltoid, not notched, not punctate, at apex sometimes with 2 minute calli. Umbel with many bracts. Filaments crispy-ciliate, the longer with a dorsal tooth. Sepals with 4 linear calli. Petals red (bluish when dry) (§ *Polyoxalis*). **5. O. deppel**
6. Outer tunics 3-several-nerved, not fibrous. Leaflets 3, obcordate or fishtail-shaped. Sepals with 2 oblong apical calli. Petals purple (bluish when dry) (§ *Jonoxalis*).
7. Stolons apically bulbiferous. Outer tunics membranaceous, transparent, several-nerved. Leaflets fishtail-shaped, not punctate, notch often with 2 minute calli. Bracts of umbellate inflorescence 2, opposite. All filaments moderately ciliate, the longer with a minute tooth. **6. O. latifolia**
7. Stolons absent, bulb consisting of many small bulbs; outer tunics papyraceous, brownish, 3-nerved. Leaflets broadly obcordate, minutely punctate all over the surface, especially along the margins, ecallose. Bracts of the cymose, contracted inflorescence many. Shorter filaments glabrous, the longer ciliate, without a tooth. **7. O. corymbosa**

1. Oxalis barrelieri LINNÉ, Sp. Pl. ed. 2 (1763) 624; RIDL. Fl. Mal. Pen. 1 (1922) 330; KNUTH, Pfl. R. Heft 95 (1930) 65; HENDERSON, Mal. Wild Fl. (1959) 47, fig.; BACKER & BAKH. f. Fl. Java 1 (1963) 245. — *O. sepium* ST. HIL. Fl. Bras. Merid. 1 (1825) 89; PROGEL, Fl. Bras. 12, 2 (1877) 505, incl. var. *picta* PROGEL.; KNUTH, Pfl. R. Heft 95 (1930) 64; HEYNE, Nutt. Pl. (1927) 151. — Fig. 1f-g.

Erect herb, stem up to 1½ m, without bulbs or stolons. Stem branched, sparsely patent to appressed-reflexed pubescent, glabrescent; hairs simple, straight or bent below the middle, eglandular. Leaves usually more or less opposite, pinnately 3-foliolate, exstipulate; petiole 2-9 cm, appressed-puberulous; leaflets elliptic to oblong, base cuneate to emarginate, apex obtuse to rounded, not notched, ecallose, glabrous above, margins strigose, especially at base, beneath pale and glaucous, sparsely to moderately appressed pubescent, terminal leaflets largest, 1-3½ by ½-2½ cm. Peduncles 3-5½ cm, pubescent, once or twice dichasially forked; branches up to 4½ cm, 4-16-flowered, the bracts opposite the flowers. Bracteoles minute, ciliate, ecallose. Pedicels 1½-3 mm, glabrous. Sepals 2-4 by ½-1¼ mm, ovate-lanceolate, acute, glabrous or with a few hairs, ecallose, 3-nerved. Petals 6-9 by 2-2½ mm, obovate-lanceolate, apex rounded, after anthesis rolling inwards, pink, lower half greenish with yellow spots, glabrous. Filaments (MF) ¾-1 and

1¾-2¼ mm, the shorter glabrous, the longer with a dorsal tooth, patent-hairy. Ovary 1 by ½ mm, glabrous; styles (MF) 1-1½ mm, ascendingly strigose; stigmas small, capitate; ovules 4 per cell, in 1 row. Fruit 5-10 by 3-5 mm, slightly ovoid, 5-angular, apex and base 5-lobed, glabrous; episeptal rimae present. Seeds 3-4 per cell, 1½ by 1 mm, ± flattened-ovoid; testa transversally ridged.

Distr. Native of tropical S. America, cultivated and established in many places, the oldest collected specimen from Bogor dates from BOERLAGE, a. 1888; in *Malesia*: Sumatra, Banka, Malaya, Java, Papua (Central Distr.).

Ecol. Around gardens, along roads, in hedges, fields, and village groves, along rivers, grassy places with shade, up to 1500 m.

Vern. *Tjalingtjing*, *J, bëlimbing tanah*, Banka, *kopomani*, Tamil.

Uses. The leaves are eaten for their sour taste. Note. Although only the MF form is found in *Malesia*, fertile seed is formed; there is apparently no functional heterostyly.

2. Oxalis corniculata LINNÉ, Sp. Pl. (1753) 435; ZUCC. Abh. Ak. Wiss. Münch. 1 (1830) 230, incl. var. *repens* (THUNB.) ZUCC.; PLANCH. in Houtte, Fl. Serres 12 (1857) 205, incl. var. *atropurpurea* PLANCH.; MIQ. Fl. Ind. Bat. 1, 2 (1859) 135; EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 436; F.-VILL. Novis. App. (1880) 32; GUILLAUMIN,

Fl. Gén. I.-C. 1 (1911) 610; BACK. Schoolfl. Java (1911) 170, *incl. var. javanica* (BL.) BACK.; KNUTH, Notizbl. Berl.-Dahl. 7 (1911) 300, *incl. var. sericea* KNUTH; RIDL. Fl. Mal. Pen. 1 (1922) 330, *incl. var. villosa* HOOK. f. ex RIDL. [*sphalm.*? *var. villosa* HOHENACKER, cf. YOUNG, Watsonia 4 (1958) 57]; WIEGAND, Rhodora 27 (1925) 113; KNUTH, Pfl. R. Heft 95 (1930) 146; MASAMUNE, Fl. Geogr. Stud. Yakushima (1934) 257, *incl. ssp. repens* (THUNB.) MASAM.; KNUTH in Fedde, Rep. 48 (1940) 3, *incl. var. papuana* KNUTH; HARA, Enum. Sperm. Jap. 3 (1954) 8; EITEN, Taxon 4 (1955) 99; Am. Midl. Natur. 69 (1963) 257; BACK. & BAKH. f. Fl. Java 1 (1963) 246; VELDCK., Fl. Thail. 2 (1970) 17. — *O. repens* THUNB. Diss. Oxal. (1781) 16, fig.; BL. Bijdr. (1825) 243; B. L. ROBINSON, J. Bot. 44 (1906) 311; MERR. En. Born. (1921) 311; En. Philip. 2 (1923) 323. — *O. javanica* BL. Bijdr. (1825) 243; MIQ. Fl. Ind. Bat. 1, 2 (1859) 135. — *O. acetosella* (non L.) BLANCO, Fl. Filip. (1837) 388. — *O. boridiensis* KNUTH in Fedde, Rep. 48 (1940) 3.

Perennial herb, ascending to erect, rooting at the nodes; main root sometimes much thickened and woody; stems several from the main root, branching above the ground, puberulous to pubescent (hairs mainly 1-celled). Leaves scattered, distant, or in small tufts. Stipules indistinct to small, sometimes conspicuous, up to 3 by 1 mm, rectangular. Petiole 1–5½(–10) cm, appressed to patently puberulous. Leaflets broadly to elliptic-obcordate, 4–20(–25) by 5–18(–25) mm, incised up to half-way, ecallose, lobes rounded, rarely obtuse; upper surface glabrous to sericeous; beneath paler, sometimes glaucous, sparsely pubescent to sericeous. Peduncles up to 20 cm, usually much shorter, sparsely puberulous to sericeous. Inflorescence cymose to pseudo-umbellate, 1.5(–8)-flowered. Flowers usually MF, rarely LF. Bracts 2–several, subopposite to whorled, ovate-lanceolate, acute, puberulous, sometimes with septate hairs. Pedicels up to 20 mm, articulate at base and beneath calyx, in fruit straight to sharply bent at the articulations, but the fruit always erect. Sepals lanceolate, obtuse to rarely obliquely retuse with narrow pale margins, 2–6 by ½–2 mm, sparsely puberulous to sericeous, sometimes with septate hairs. Petals spatulate-oblong to lanceolate, 3½–10 by 1–7 mm, apex rounded to emarginate, after anthesis apically crumpled, yellow, with darker or lighter base. Filaments glabrous, the longer edentate, in MF 1–4 and 3–6 mm, the shorter rarely with abortive anthers, in LF 2¾–3½ and 3½–4½ mm. Ovary 1½–2 by ¾–1 mm, ellipsoid to cylindric, puberulous; styles in MF 1–4 mm, in LF 3–4 mm, minutely ciliate, sometimes mixed with minute septate hairs; stigmas small, cylindric, sometimes flattened and minutely bifid, papillose; ovules (1)–5–11 per cell, in 1 row. Fruit 9–20(–24) by 2–4 mm, usually linear-cylindric, sometimes ellipsoid, pentagonal, acuminate, minutely puberulous, hairs reflexed or patent to ascending in upper half, mixed with patent, septate hairs; episeptal rimae closed, inconspicuous; cells inside sparsely to moderately

strigose. Seeds (0)–5–11 per cell, 1 by ¾ mm, flattened-ovoid; testa with c. 3 regular rows of 7–10 transversally connected rows of ridges.

Distr. Cosmopolitan, origin unknown, in Malesia several forms occur; throughout Malesia, three times collected in Celebes and Borneo and scarce in Malaya (Malacca, Perak, Penang; a common weed in Singapore Bot. Gardens).

Ecol. In many islands a common weed on all sorts of disturbed soil, in grassfields, gardens estates, along roads and river-banks, on walls, etc., in Java up to 2200, in New Guinea to 3000 m.

Vern. Sikap dada, M (Sing.), asim-asim, atim-atim, lela, Atjeh, daun asem (ketjil), (djukut) tjalintjing, sémanggi, sémanggèn, J, tjembijjèna, Mad., mala mala, Ternate, kuja kawiana, Alor; Philip.: daraisig, Bik., iayo, kungi, malabalugbugdagis, Pamp., kanapa, Ig., marasiksik, Ilk., pikhik, Iv., salamági, Bon., susokoyili, taingangdaga, Tag.; New Guinea: keketi, Tumba, puggepagl, Yoowi, songongom, Wapi, girobi, Musa, Safia, jampijamp, Enga, Yogos, gagari, Eng, Kapiam, kwibant, Maring, kale, Gabaul, tenaquipu, Jimi.

Uses. Cf. HEYNE, Nutt. Pl. (1927) 850. According to VINK (n. 16308) from Uinba, Nonaminj Divide, Kubor Range, W. Highlands, New Guinea (20-8-1963) used 1) "In marrying ceremony the young woman takes fresh leaves and makes a gag of it with salt and cold water; the gag is chewed and the juice is spit on pigmeat, which is given to the new husband. 2) When the garden gives a bad production of sweet potato, the woman looking after the garden puts a bundle of the leaves in her girdle to get a higher production."

Note. A most complex and variable species. Many infraspecific taxa have been described, but all appear to be linked by intermediate forms. The following extremes can be recognized;

'var. repens THUNB.' Small, decumbent plants. Leaflets rather dark, small, glabrous to moderately strigose. Inflorescences few-flowered, flowers small. Throughout Malesia, a form of exposed, sunny places.

'var. atropurpurea PLANCH.' Plant brownish to purplish *in vivo*, dark green when dry; petals more or less flushed or blotched with reddish brown *in vivo*, fading to whitish or yellowish in drying. Cultivated and escaping.

'var. sericea KNUTH' (= 'var. trichocaulon LÉVL.' according to HARA, 1954; no material of this seen). Large pubescent plant, foliose apices of stems erect or ascending; stipules minute, leaflets strongly pubescent, terminals large, longer than broad, incised for 1/5–1/3 of leaflength, floral parts relatively large; ovules and seeds 1–5 per cell; fruit oblong, stout, pubescence ascending at least in upper half. Eastern New Guinea and New Britain (Formosa? Japan? Korea?). Shaded river-banks, open places in forest, edges of paths and trails, grassfields.

3. *Oxalis magellanica* FORST. f. Comm. Gött. 9 (1789) 33; HOOK. f. Fl. Nov. Zeh. 1 (1853) 42, fig.; Fl. Tasm. 1 (1860) 59; BENTH. Fl. Austr. 1 (1863) 300; HOOK. f. Handb. N. Zeal. Fl. (1864)

38; REICHE, Fl. Chile 1 (1896) 339; KNUTH, Pfl. R. Heft 95 (1930) 230. — *O. lactea* HOOK. Comp. Bot. Mag. 1 (1836) 276; SKOTTSB. The Plant World 18 (1915) 129; CHEESEMAN, Man. N. Zeal. Fl. ed. 2 (1925) 536; CURTIS, Stud. Fl. Tasm. 1 (1956) 96; ALLAN, Fl. N. Zeal. 1 (1961) 238. — Fig. 1a–d.

Stemless herb with stolons, without bulbs. Rhizome pink to brownish, glabrous with distinct, amplexicaul scale-like remains of leafbases. Stipules much broader than the petiole, conspicuous, membranaceous, brown, glabrous. Petioles 1–8½ cm, reddish. *Leaflets* obcordate, 4–13 by 4–12 mm, incised up to ½ of the length, lobes rounded; upper surface usually glabrous; beneath pale, glaucous, appressed-strigose glabrescent, with a ± prominent, greenish to brownish callus at the notch. *Peduncles* few, below basal articulation ½–2 cm, above 1–6½ cm, sparsely appressed- to patently pubescent; bracteoles 2, subopposite, 2½–7 by 1–1½ mm, lanceolate, acute, free, very sparsely strigose to glabrous, ecallose, placed in upper ¾–¾th. Buds erect. *Flowers* solitary, only LF. *Sepals* elliptic to obovate-oblong, 3–5 by 1½–2¼ mm, acute to truncate and minutely 3-lobed (apex or middle lobe cucullate, sometimes inconspicuous by the hairs, seemingly callose), sparsely to moderately pubescent and somewhat glaucous, margined, slightly shorter to equal to the fruit. *Petals* white, 8–11½ by 4–6 mm, spatulate, somewhat oblique, apex rounded to emarginate, glabrous to ± ciliate. *Filaments* (LF) 3–4½ and 4½–5½ mm long, glabrous, edentate. *Ovary* 1–2 by 1–2 mm, glabrous; styles 3–5 mm,

glabrous; stigma disk-shaped; ovules 2–5 per cell, in 1 row. *Fruit* 3–6 by 3–5 mm, glabrous, finally nodding. *Seeds* 1–3 per cell, 1½ by 1 mm, ± flattened-ovoid, shiny, brownish, smooth to slightly lengthwise furrowed.

Distr. Southern Andine S. America, New Zealand, Tasmania, and the Victorian Alps; in *Malesia*: New Guinea, on the high mountains (Wilhelm, Otto, Kubor Range, Finisterre Range, Sarawaket Range, Wilhelmina), 2200–3700 m.

Ecol. Subalpine to alpine, on shaded, moist to wet, humous soil, among grasses and mosses, sometimes on tree-trunks or rocks. *Fl.* May–Nov.

Vern. *Chimbaemagl*, Chimu.

Notes. According to SKOTTSBERG *l.c.* the S. American specimens would differ in having less distinctly obcordate leaflets, peduncles not exceeding 1 cm, and flowers only *c.* 5 mm across. The New Zealand botanists accordingly call the species in New Zealand *O. lactea*, but ALLAN added that some specimens from Chile (in K) approach the New Zealand form.

A comparative study of Chilean, Australasian, and Papuan specimens showed that SKOTTSBERG's differentiation does not hold and that only one species is concerned.

4. *Oxalis acetosella* LINNÉ, Sp. Pl. (1753) 433.

ssp. griffithii (EDGEW. & HOOK. f.) HARA, J. Jap. Bot. 30 (1955) 22; Fl. E. Him. (1966) 168, 638, 661. — *O. griffithii* EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 436; KNUTH, Pfl. R. Heft 95

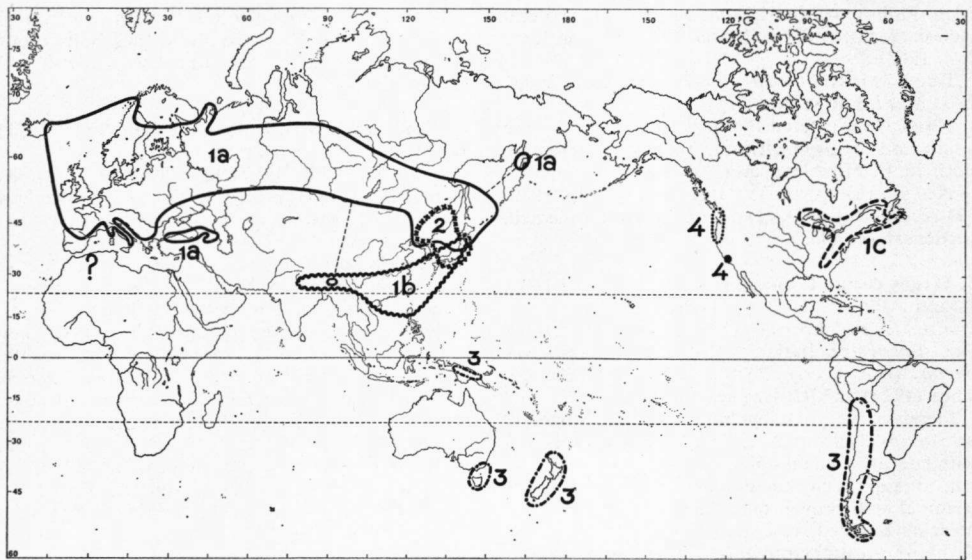


Fig. 2. Distribution of *Oxalis* § *Acetosellae*. 1a. *O. acetosella* L. *ssp. acetosella*, 1b. *ditto*, *ssp. griffithii* HARA, 1c. *ditto*, *ssp. montana* HULTÉN, 2. *O. obtriangulata* MAXIM., 3. *O. magellanica* FORST. f., 4. *O. oregana* NUTT.

(1930) 234; OHWI, Fl. Japan (1965) 580. — Fig. 1b-1.

Stemless herb with stolons, without bulbs. Rhizome dark brown, usually scaly, sparsely pubescent to glabrous. Stipules shorter and \pm broader than the basal part of the petiole. Petioles 4½–22 cm, greenish, red-tinged, pubescent; below articulation flattened, thickened, persistent, finally \pm woody, brownish when dry, moderately to densely pubescent. *Leaflets* 1–3 by 1¼–4 cm, broadly obtriangular, fishtail-shaped, the straight upper edges forming a very wide angle, incised up to halfway, lobes rounded to obtuse; upper surface subglabrous to sparsely appressed-strigose; beneath paler, not glaucous and with denser pubescence, midrib \pm thickened in notch. *Peduncles* 1–2, below basal articulation up to ½ cm, above 5–11 cm (shorter in cleistogamic flowers), subglabrous to densely pubescent, especially distally; bracteoles \pm halfway or higher, partly connate-vaginate, midrib dorsally pubescent, apex with hairy brown tuft, ecallose. *Sepals* 3–6¾ by 1½–2½ mm, oblong, rounded to emarginate, not cucullate, ecallose, subglabrous, edge closely ciliate. *Petals* 8–19 by 4–8 mm, spatulate-oblong, truncate to emarginate, often oblique, white, often with lavender veins and yellowish base *in vivo*. *Filaments* (LF) 1¾–3½ and 3–6 mm, glabrous, edentate. *Ovary* 2–3½ by 1½ mm, glabrous; styles (LF) 3–6 mm, glabrous; stigma minute, more or less hook-like, entire; ovules 1–5 per cell. *Fruit* 6 by 5 mm, ovoid, acute, glabrous, nodding. *Seeds* 1–2 per cell, 2½ by 1½ mm, flattened-ovoid, \pm smooth to lengthwise ridged, light brown.

Distr. From India (Sikkim, Bhutan, Khasia) through China to Japan and Formosa; in *Malesia*: Philippines (N. Luzon: Mt Pulog), two collections (STEINER 1990, March 1961; JACOBS 7361, Jan. 1968).

Ecol. Mossy forest ravine, probably 2500–2900 m. *Fl.* Jan–March. Fig. 2.

HARA (1966) stated that it is found more to the south and at lower altitudes than *ssp. acetosella*, both in E. Himalaya and in Japan.

Notes. FERNANDEZ-VILLAR (Novis. App. 1880, 32) recorded true *O. acetosella* L. from a medical garden at Manila.

5. *Oxalis deppel* LODD. Bot. Cab. 15 (1828) 1500; KNUTH, Pfl. R. Heft 95 (1930) 288; BACK. & BAKH. f. Fl. Java 1 (1963) 246; MATTHEW, Rec. Bot. Surv. India 20 (1969) 56. — *O. tetraphylla* (non CAV.) BACK. & SLOOT. Handb. Thee (1924) 157, t.; HEYNE, Nutt. Pl. (1927) 851.

Stemless herb from bulbous base, no rhizome, no stolons. Bulb up to 2½ by 2 cm, ovoid, acute, with lateral, sessile bulbils; tunics up to 2½ by 1½ cm, ovate, acute, acuminate or bilobed with terminal leaf, brown, many-nerved, outer fibrous, margins bearded, rest glabrous, inner becoming fleshy. Innovations brownish pilose. Petioles up to 40 cm, glabrous or with a few hairs. *Leaflets* 4(–6), unequal, 2½–6½ by 1¾–6½ cm, obdeltoid, entire to slightly retuse and \pm apiculate (tip often \pm folded and occasionally with 1–2 minute

calli underneath), glabrous to sparsely pubescent, usually with dark V-shaped marking in lower third, epunctate. *Peduncles* up to 50 cm, \pm glabrous. *Inflorescence* pseudo-umbellate, 6–25-flowered. Bracts many, up to 2½ mm, ovate, acute to acuminate, glabrous or with strigose margin, ecallose or with minute apical calli. Pedicels up to 3 cm, glabrous. *Sepals* 5–7(–10) by 1½–3 mm, elliptic to lanceolate, obtuse to emarginate, glabrous, ciliate on edge, c. 7-nerved, apical calli 2–6, usually 4, linear, inconspicuous, orange. *Petals* 1½–2½ by ½–1¼ cm, spatulate-oblong, rounded to retuse, often oblique, glabrous, dark red, when dry often bluish with greenish base. *Filaments* (SF) 3½–4½ and 6–6½ mm, (LF) 6 and 10 mm, the shorter with a few, the longer with many patent, crisped cilia, dentate. Ovary and staminal tube c. ½ mm stipitate. *Ovary* 1½–5 by 1–3 mm, ellipsoid, glabrous; styles (SF) 1 mm long, (LF) c. 15 mm, glabrous, dark when dry; stigmas cylindrical, \pm bilobed, later \pm peltate, not papillose; ovules 3–5 per cell, in 1–2 rows.

Distr. Native of Mexico, cultivated and escaping; in *Malesia* hitherto only found in Java (Tjinjiruan); introduced before 1911, now quasi-spontaneous.

Ecol. Locally naturalized in mountain *Cinchona* estates, c. 1600 m, sometimes gregarious, propagating by bulbils; fruit unknown from Java. Apparently functionally heterostylous. In *Malesia* only the SF has been found so far. Dimensions of the LF have been taken from MATTHEW, l.c. Vern. *Tjalingtjing badak*, tj. gedé, S.

Uses. Ornamental plant and for ground-cover, but difficult to eradicate; leaves eaten as vegetable (HEYNE, 1927).

Note. *O. tetraphylla* CAV., with which this species has often been confused, has bulbiferous stolons, emarginate, not apiculate leaflets, and smaller flowers.

6. *Oxalis latifolia* H. B. K. Nov. Gen. Sp. 5 (1821) 184, t. 467; KNUTH, Pfl. R. Heft 95 (1930) 273; HEYNE, Nutt. Pl. (1927) 851; SYMON, Trans. R. Soc. S. Austr. 84 (1961) 75; YOUNG, *Watsonia* 4 (1958) 63. — *O. intermedia* (non A. RICH. ?) BACK. & BAKH. f. Fl. Java 1 (1963) 246.

Stemless herb from bulbous base, no rootstock; bulb ovoid, up to 5 by 2 cm, acute, with numerous, basal, \pm erect stolons, with a few small scales, ending in ovoid, acute bulbils pale brown when dry; tunics many, outer up to 5 by 2 cm, ovate, acuminate or with terminal leaf, membranous, transparent, white, nerves 3 to several, orange; inner becoming fleshy. Petiole up to 20 cm, \pm glabrous. *Leaflets* \pm equal, 1½–7½ by 2–8½ cm, broadly obdeltoid, fishtail-shaped, incised up to halfway, glabrous, beneath subglaucous, often with 2 orange calli in notch, epunctate. *Peduncles* up to 25 cm, slightly hairy. *Inflorescence* umbellate, 5–13-flowered. Bracts 2, c. ½ mm, ovate, margin glabrous to strigose, minutely callose or ecallose. Pedicels up to 2 cm, glabrous, filiform. *Sepals* 4–4½(–6) by 1½–2(–3) mm, oblong, obtuse, glabrous, indistinctly 3–5-nerved; apical calli

2, orange, not confluent, c. 1 mm long, minutely hastate. *Petals* 10–20 by 3–6(–8) mm, narrowly obtriangular, truncate, ± oblique, red-purplish with greenish base, crumpled after anthesis. *Filaments* (SF) 2½–3(–4) and 4–5(–6) mm, puberulous, the longer with a minute tooth. Ovary and staminal tube c. ½ mm stipitate. *Ovary* 1½ by ¾ mm, apically sparsely ciliate on the ribs; styles (SF) c. 1 mm, sparsely ciliate; stigma peltate, c. ¼ mm ø, not papillose; ovules 3–6 per cell, in 1–2 rows.

Distr. Native of Central and tropical S. America; cultivated and escaping, e.g. in *Malesia*: Java (Preanger Mts; W. Java: Gedeh, Lembang, Tjnjiruan).

Ecol. In gardens, fields, and estates, 1250–1550 m. No fruits are recorded from Java, the plant is apparently functionally heterostylous. It is difficult to eradicate because of the many bulbils.

Vern. *Tjalintjing*, S.

Note. *O. intermedia* A. RICH. (Ess. Fl. Cuba, 1842, 315) is said to be more pubescent and to have edentate, longer filaments. As the teeth are minute, however, they might easily be overlooked.

7. *Oxalis corymbosa* DC. Prod. 1 (1824) 696; RIDL. Fl. Mal. Pen. 1 (1922) 330; BACK. & SLOOT. Handb. Thee (1924) 155, t.; HEYNE, Nutt. Pl. (1927) 851; SYMON, Trans. R. Soc. S. Austr. 84 (1961) 74; BACK. & BAKH. f. Fl. Java 1 (1963) 246. — *O. martiana* ZUCC. Denkschr. K. Ak. Wiss. Münch. 9 (1824) 144; BACK. Schoolfl. Java (1911) 170; MERR. En. Philip. 2 (1923) 323; KNUTH, Pfl. R. Heft 95 (1930) 250. — *O. violacea* (non L.) HALL. f. Med. Rijksherb. Leiden 12 (1912) 19. — Fig. 1e.

Stemless herb from bulbous base, no rhizome, no stolons; bulb globose, c. 1 cm ø; bulbils many, clustered, globular to ovoid, acute; outer tunics brown, papyraceous, up to 20 by 6 mm, ovate to oblong, acuminate or with terminal leaf, margins glabrous to long-bearded, distinctly 3-nerved; inner pale and fleshy. Petiole up to 30 cm, patently villose. *Leaflets* ± equal, 1½–4½ by 1¾–5½ cm, broadly obovate, incised for ¼, lobes rounded, sometimes ± overlapping; upper surface subglabrous, beneath appressed-puberulous; minutely orange-punctate all over the surface, especially along the margins. *Peduncle* up to 35 cm, hairy in various degree. *Inflorescence* often up to twice forked; pseudo-umbels 2–12-flowered. Bracts many, c. 1 mm long, elliptic, rounded, pale, with strigose margin and 0–3 orange, linear calli in the middle. *Pedicels* up to 2½ cm, ascendingly appressed-strigose. *Sepals* 3½–5(–6) by 1–2 mm, oblong, acute, apex minutely bifid to the 1–3 orbicular to oblong, with 2 orange, apical calli, ± puberulous, 3–5-nerved. *Petals* 11–20 by 4–7 mm, spatulate-oblong to -lanceolate, obtuse to truncate, often oblique, light reddish purple with

darker veins, yellowish at base. *Filaments* (MF) 2–3 and 5–6 mm, (SF) 3½–4 and 5–6 mm; the longer dorsally ciliate, edentate. Ovary and staminal tube c. ¾ mm stipitate. *Ovary* 2 by 1 mm, abundantly ascendingly ciliate to glabrous; styles in MF 1¾–2 mm, in SF 1–1¼ mm long, abundantly ciliate; stigma bilobed, papillose, c. 1 mm ø; ovules 3–8 per cell, in 1–2 rows. Fruit not seen.

Distr. Native in tropical S. America, naturalized in many parts of the World; in *Malesia* cultivated and escaping in Java (introduced from Sydney before 1848), W. Sumatra, Malaya, and Philippines (Luzon).

Ecol. In fields, road-sides, and estates, often as a gregarious weed, 400–1450 m. No seed is set; propagation is by the many bulbils, which make it a difficult plant to eradicate.

Vern. *Tjalintjing beureum*, *tj. gedé*, *tj. tégel*, *S. kembang gélas*, *J. asam-puja*, Padang.

Uses. Occasionally cultivated; the leaves are sometimes used as a substitute for tamarind (HEYNE).

Terat. No fruits have been recorded, although two stylar forms occur, possibly in the same populations, but certainly in the same environment. The reason for inability of fruit-setting probably lies in the common occurrence of monstrous flowers.

Sometimes the filaments broaden and form petaloid structures, occasionally still with the anthers present in reduced state. More often there is a transition of the anthers towards carpel-like structures. In the least monstrous forms the connective is flabelliform with patent outer walls of the anthers. The next step is an apical elongation and even more developed anther-cells. The elongation may bear a stigma-like structure. Especially when there is an extra filamentous whorl between the inner (longer) filaments and the pistil extreme cases occur. These 'filaments' may finally resemble stipitate, free carpels with a full grown style and papillose stigma; they are apparently open on the introrse side. Ovules have not been seen, but may be present as they are very small and transparent even in the normal plant. It is possible that these 'filaments' fuse with the pistil, as occasionally more than 5-merous pistils carrying ovules are observed with the stipitate alongside. Thus there seem to be transitional stages between the anthers and pistil!

Once a sepal was observed to arise from the centre of a deformed pistil.

Notes. *O. articulata* SAVIGNY (in Lamarck, Encycl. Bot. 4, 1798, 686) from Argentina, is often confused with this species. *O. articulata* differs in the presence of a tuberous rhizome, by the deeper obovate leaflets that have large spots, and the denser pubescence.

O. violacea L. (Sp. Pl. 1753, 434) from N. America, has emarginate, obdeltoid leaflets, punctate with two brown calli at the notch.

2. BIOPHYTUM

DC. Prod. 1 (1824) 689; EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 436; KNUTH, Pfl. R. Heft 95 (1930) 391; STEEN. Bull. Jard. Bot. Btzg III, 18 (1950) 449. —

Oxalis sect. Biophytum ENDL. Gen. Pl. (1839) 1172; MIQ. Fl. Ind. Bat. 1, 2 (1859) 134; PROGEL, Fl. Bras. 12, 2 (1877) 482. — Fig. 3-4.

Erect annual herbs or usually sympodially branched dwarf shrubs. *Leaves* paripinnate in tufts at the end of the stem or branches, with setaceous stipules; leaflets opposite, subsessile, terminal pair mostly different from the others, their acroscopical half of base cuneate, basiscopical half rounded to truncate, rachis prolonged in a mucro. *Flowers* terminal in a usually peduncled, bracteate pseudo-umbel, heterodi-, tri- or homostylous. Pedicels articulate at base. *Sepals* glabrous inside, \pm free. *Petals* contort, glabrous, coherent above the claw. *Filaments*: shorter ones with a more or less pronounced callus at base, longer ones always edentate. *Styles* in LF and MF ciliate; stigmas terminal, subulate and entire or spoon-shaped to flattened, crenate to bifid; ovules 3-6 per cell, alternating in 2 rows. *Capsule* finally loculicid to the base, forming a 5-rayed star. *Seeds* 1-6 per cell, aril white, thin, at maturity bivalved and ejaculatory.

Distr. Pantropical, possibly some 70 spp., in Malesia 7 spp. among which one escaped and another introduced.

Ecol. *B. dendroides* is obviously escaped from the Bogor Botanic Garden and became naturalized in the immediate vicinity of Bogor. *B. reinwardtii* and *B. sensitivum* are weeds in anthropogenic places; it is doubtful whether the former is indigenous. The three ligneous species, *B. adiantoides*, *B. fruticosum* and *B. microphyllum* are forest dwellers. *B. petersianum* is a widely spread annual which prefers places subject to a pronounced dry season, as also shown by its absence from the great ombrogenous forest belt in Malaya, Borneo and Sumatra and scarcity in West Java (some local spots N of Bandung).

For heterostyly see under the family.

Germination is insufficiently known and seems variable. SHETTY (Proc. Symp. Recent Adv. Trop. Ecol. Varanasi, 1968, 213-224) found that in *B. sensitivum* (a name not checked by me through voucher specimens) seed collected at Varanasi (Benaras, at c. 25° NL) at the beginning of the (dry) winterseason failed to germinate 'under any condition' for the first 8½-9 months and showed hereby to possess a dormancy period. Germination capacity decreased again considerably after 11-12 months. During the first month of the germination period it needed thorough washing by which SHETTY concluded to the presence of a water-soluble inhibitor; besides optimal temperature needed for germination was found to be 30-40° C. Whether this behaviour holds also for Malesia is unknown; it is common in regions without a dry or cooler season.

I have made germination tests with *B. dendroides* in the Leyden Hortus where the seeds germinated in a very short time.

Morph. I have raised seedlings of *B. dendroides* of which the germination is epigaic. The first leaves, which bear successively 2, 4, 6, and more leaflets, originate from the plumule which remains between the cotyledons. Simultaneously the hypocotyl starts to lengthen, forming the initial stem carrying the leaf tuft at its apex. When this cycadoid first stage is formed, one finds below the tuft usually a collar of reflexed bristles below the leaf-scars of fallen leaves. In the annual species, characterized by a pithy (compressible) hypocotylar stem, there is usually one apical tuft, exceptionally there are two, both sessile. In the perennial ligneous species other tufts are formed, either on short-shoots or by genuine lateral distinctly sympodial branching.

The *sympodial branching* of the suffruticose species is very characteristic; it is partly by thick short-shoots on which the cortex is covered by leaf-scars, withering with age, and partly by long-shoots which carry always under the pseudo-umbel of leaves a reflexed tuft of hairs, the shoot itself showing no leaf-scars. In the tuft are many, often finally reflexed narrow to needle-like stipules. The peduncle of the inflorescence resembles the 'internode' of the long-shoots, but it carries on top a fascicle of narrow cuspidate bracts, the inner ones of which bear flowers.

In *B. reinwardtii* and *B. adiantoides* it may happen that in the pseudo-umbel some reduced leaves occur. This can be found also in *B. fruticosum* (KAUDERN 438); of this species a still more remarkable specimen has been collected at Sse Mao (Pl. Yunnan & Mekong), Prince H. d'ORLEANS (in P) where the pseudo-umbel has produced a new umbel with reduced leaves and flowers, exactly similar to a normal long-shoot. This also occasionally occurs in *B. reinwardtii* (RANT s.n., 1922, do, 1924, BEUMÉE 4848, KOORDERS 29864). A remarkable case of proliferation difficult to account for.

'Callus' of the shorter filaments. At the base of the annulus below the shorter (epipetalous) filaments there is a usually dark coloured tumidity, sometimes cup-shaped, in front of the petals. Similar ones have already been noticed in *Hypseocharis* by BAILLON (Adansonia 10, 1873, 363; Hist. Pl. 5, 1874, 26, 41, f. 56, 57) and in some species of *Oxalis* by BAILLON (1874) and PROGEL (Fl. Bras. 12, 2, 1877, t. 111 and 113, 6). HALLIER f. discussed their taxonomical value as similar structures occur in *Geraniaceae*,

Limnanthaceae and *Linaceae* (Beih. Bot. Centralbl. 39, ii, 1921, 165). NARAYANA (*in litt.*) found they have no vascular trace in *B. candolleianum* (called '*B. intermedium*', in J. Jap. Bot. 41, 1966, 321). The callosities are possibly homologous with the scales found in *Dapania* on the annulus at the base of the shorter filaments (VELDKAMP, Blumea 15, 1967, 523).

The indument is made up of setaceous, simple hairs. In the inflorescences small, septate, capitate, glandular hairs and/or minute, red, club-shaped glands may be present.

Syst. I agree with VAN STEENIS that the subdivision of the genus as given by KNUTH is unsatisfactory and new criteria must be considered. The first provisionally proposed *sect. Sensitiva* (with the generic type species *B. sensitivum*) for annual species and *sect. Prolifera* (type species *B. proliferum*) for the suffruticose species. But the situation might be more complicated and a subdivision has to wait for a complete revision of the genus.

KEY TO THE SPECIES

1. Leaves 3-9-jugate; leaflets orbicular to elliptic; veins \pm perpendicular to the midrib, few. Flowers sessile in centre of tuft, (in Mal.) rarely on a peduncle up to 1½ cm. Unbranched annual.
 1. *B. petersianum*
1. Leaves 7-32-jugate; leaflets elliptic to lanceolate; veins oblique to the midrib, many. Flowers in distinctly peduncled pseudo-umbels.
 2. Midrib of leaflets (not terminal pair) at base \pm median.
 3. Bracts of pseudo-umbel bushy, setaceous, 3-6 mm. Calyx with long, simple hairs. Perennial, finally (always?) branched; stem woody, not compressible, old parts reflexed. Petals \pm equalling the sepals. Sepals 1½-2 times as long as the fruit. 2. *B. dendroides*
 3. Bracts of pseudo-umbel ovate-attenuate, 1-3 mm. Calyx puberulous and with septate-glandular hairs. Annual, never branched; stem soft, pithy, compressible, old parts caducous.
 4. Sepals \pm equalling the petals, in fruit 4-7 mm long, longer than the pedicels, 1½-2 times as long as the fruit. 3. *B. sensitivum*
 4. Sepals \pm half as long as the petals, in fruit 2¼-4 mm long, shorter than the pedicels, \pm as long as the fruit. 4. *B. reinwardtii*
 2. Midrib of leaflets (not terminal pair) at base excentric, in basisopic corner. Perennials, ligneous, at least finally branched.
 5. Leaves 14-32-jugate. Terminal leaflets 3-6½ by 1½-3 mm, obovate-oblong, as long as the preceding. Sepals in fruit 3-7-nerved, 1-2 times as long as the fruit. Fruit puberulous in upper half.
 5. *B. microphyllum*
 5. Leaves 18-27-jugate. Terminal leaflets 9-22 by 3-8 mm, oblanceolate, as long as the preceding. Sepals in fruit 5-12-nerved, 1¼-2 times as long as the fruit. Fruit glabrous.
 6. *B. adiantoides*
 5. Leaves 7-17-jugate. Terminal leaflets 5-20 by 3-8 mm, obovate to obovate-oblong, and as long as the preceding (rarely elliptic-oblong and longer than the preceding: *var. papuanum*). Sepals in fruit 3-6-nerved, slightly exceeding the fruit or \pm equalling it (*var. papuanum*). Fruit apically puberulous. 7. *B. fruticosum*

1. *Biophytum petersianum* KLOTZSCH in Peters, Reise Mossamb. Bot. 1 (1862) 81, t. 15; STEEN. Bull. Jard. Bot. Btzg III, 18 (1950) 452; BACK. & BAKH. f. Fl. Java 1 (1963) 246; EXELL, Fl. Zamb. 2 (1863) 158; VELDK. Fl. Thail. 2 (1970) 18. — *Oxalis apodiscias* TURCZ. Bull. Soc. Nat. Moscou 36 (1863) 595. — *Oxalis petersianum* (KLOTZSCH) C. MUELL. in Walp. Ann. 7 (1868) 502. — *B. apodiscias* (TURCZ.) EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 437; GUILLAUMIN, Bull. Mus. Hist. Nat. Paris 15 (1909) 124; Fl. Gén. I.-C. 1 (1911) 606. — *Oxalis sessilis* BUCH.-HAM. ex WALL. [Cat. (1831) n. 4344, *nom. nud.*] ex BAILL. Bull. Soc. Linn. Paris 1 (1886) 598, *nom. superfl. illeg.*; BAILEY, Queensl. Fl. 1 (1899) 180. — *B. sessile* (BUCH.-HAM. ex BAILL.) KNUTH, Pfl. R. Heft 95 (1930) 406, *nom. illeg.* — Fig. 3e-f.

Small annual. Stem simple, rarely up to 15 cm long. Leaves 3-9-jugate; rachis ½-3½ cm, glabrous to appressed-pubescent, mainly on the nodes; leaflets often overlapping, terminals 1¼-1½ times as long as the preceding, 2-8 by 2-5 mm,

obovate, \pm oblique, midrib excentric; other leaflets triangular to orbicular-elliptic, midrib \pm median; apex rounded to obtuse, glabrous or with sparsely ciliate margin; nerves few, \pm perpendicular to midrib, conspicuous. *Peduncle* (in Mal.) rarely present up to 1½ cm, appressed-strigose. Pedicels 1-3 mm, with some bristly hairs under calyx. *Sepals* 3-5 by ¾-1½ mm, ovate-lanceolate, acute, sparsely hairy to subglabrous, in fruit 5-8-nerved, longer than pedicel, \pm exceeding the fruit. *Petals* lanceolate, 5-6 by 1 mm, apex retuse, yellow in lower half, orange and red in upper, or orange. *Filaments* glabrous, (LF) 1-1¼ and 1½-2 mm, (SF) 1 and 2 mm long. *Ovary* ½-1½ by ½-1 mm, \pm glabrous; styles in LF 1-1½ mm, stigma flattened, crenate, in SF ½ mm, stigma flattened, bifid; ovules 4-5 per cell. *Fruit* 3-4 by 2-2½ mm, apically ciliate on the ribs. *Seeds* 3-4 per cell, c. ¾ by ½ mm, with two longitudinal ridges, in between with transverse rows of small tubercles.

Distr. Tropical Africa, Madagascar, tropical

SE. Asia (Ceylon, India, Burma, Thailand, Indo-China); in *Malesia*: all islands or island groups, except the Malay Peninsula, Sumatra, and Borneo.

Ecol. The distribution in *Malesia* is reflecting a distinct preference for areas subject to a fairly well pronounced dry season and besides heliophilous habitats. This explains the absence from the Malay Peninsula, Sumatra and Borneo and its scarcity in West Java (only a few spots N of Bandung). Ascending to 1500 m (Mt Kawi). *Fl. fr.* Jan.-Dec.

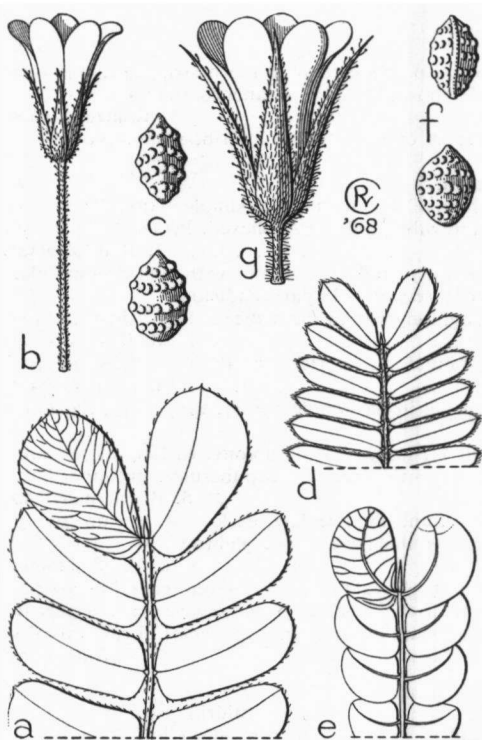


Fig. 3. *Biophytum reinwardtii* KLOTZSCH. *a.* Terminal part of leaf, $\times 2$, *b.* flower, $\times 4$, *c.* seeds, lateral and frontal, $\times 12$. — *B. microphyllum* VELDCK. *d.* Terminal part of leaf, $\times 2$. — *B. petersianum* KLOTZSCH. *e.* Terminal part of leaf, $\times 2$, *f.* seeds, lateral and frontal, $\times 12$. — *B. sensitivum* DC. *g.* Flower, $\times 12$ (*a*, *c* JUNGHUHN s.n., *b* GARRETT 243, *d* CONKLIN 291, *e-f* HEURN s.n., *g* BUNG PHENG 859).

Vern. *Kutjinggan*, *J. babonit*, *nibuwat-perut*, *Andjai*, *Kebar Valley*, *W. New Guinea*.

Uses. In the *Kebar Valley* eaten by women and pigs to increase their fertility (VERSTEGH BW 738); a decoction is used in *Mozambique* as a remedy for snake-bite (EXELL, *Fl. Zamb.* 2, 1963, 159) and in the *Congo* as a purgative for children (WILCZEK, *Fl. Congo* Beige 7, 1958, 18).

Note. *Malesian* specimens are always small

with rarely a peduncle. In *Africa* plants may attain 40 cm with much longer peduncles.

2. *Biophytum dendroides* (H. B. K.) DC. *Prod.* 1 (1824) 690; GUILLAUMIN, *Bull. Mus. Hist. Nat. Paris* 15 (1909) 125; KNUTH, *Pfl. R. Heft* 95 (1930) 399; STEEN, *Bull. Jard. Bot. Btzg III*, 18 (1950) 453; Reinwardtia 1 (1952) 477; BACK. & BAKH. *f. Fl. Java* 1 (1963) 247. — *Oxalis dendroides* H. B. K. *Nov. Gen. Sp.* 5 (1821) 194; PROGEL, *Fl. Bras.* 12, 2 (1877) 516. — **Fig. 4.**

Perennial. Stem woody, becoming coarse (not compressible), up to 15 cm, finally (always?) branched, old parts reflexed. *Leaves* 9–16-jugate; rachis $2\frac{1}{2}$ –7 cm, hirsute mainly at the nodes leaflets often overlapping, terminals 4–10 by 2–6 mm, asymmetric, falcate, others smaller, truncate at base, elliptic to oblong, less asymmetric, with median midrib; apex obtuse, apiculate, upper surface sparsely hairy, underneath more so; nerves many. *Peduncle* 1–3½ cm, up to 7-flowered, appressed-pubescent. *Pedicels* 1½–3½ mm, club-shaped, shorter than the conspicuous, setaceous, 3–6 mm long bracts. *Sepals* 6–8 by 1–3 mm, ovate, oblong to lanceolate, apex attenuate, acute, base hairy, in fruit 5–8-nerved, longer than pedicel, 1½–2 times as long as the fruit, equal to \pm shorter than the corolla. *Petals* 7–8 mm, lanceolate, rounded, pink to lavender. *Filaments* (LF) $2\frac{1}{2}$ –3 and $3\frac{3}{4}$ –5 mm, the longer ones with a few cilia. *Ovary* 2 by 1 mm, apically ciliate; styles (LF) 2–2¾ mm long; stigma subulate, entire; ovules 4–6 per cell. *Fruit* 3–5 by 2½ mm, apically puberulous on the ridges. *Seeds* 1–6 per cell, 1 by ½ mm, with two longitudinal ridges, in between with \pm longitudinal rows of tubercles.

Distr. Native of tropical S. America; in *Malesia*: locally naturalized near *Bogor* (W. Java), c. 250 m.

Originally grown in the *Botanic Gardens*, first collection *a.* 1893, spontaneous in the *Gardens a.* 1905, in 1917 also collected in the vicinity of *Bogor*.

Ecol. Shady, grassy places. *Fl. fr.* Jan.-Dec.

3. *Biophytum sensitivum* (L.) DC. *Prod.* 1 (1824) 690; BL. *Bijdr.* (1825) 242; EDGEW. & HOOK. *f. Fl. Br. Ind.* 1 (1874) 436, incl. var. *cumingianum* (TURCZ.) EDGEW. & HOOK. *f.*; KING, *J. As. Soc. Beng.* 62, ii (1893) 199; GUILLAUMIN, *Bull. Mus. Hist. Nat. Paris* 15 (1909) 126; *Fl. Gén. I.-C.* 1 (1911) 608; RIDL, *Fl. Mal. Pen.* 1 (1922) 331; MERR. *En. Philip.* 2 (1923) 324; KNUTH, *Pfl. R. Heft* 95 (1930) 393; STEEN, *Bull. Jard. Bot. Btzg III*, 18 (1950) 452; BACK. & BAKH. *f. Fl. Java* 1 (1963) 247; VELDCK. *Fl. Thail.* 2 (1970) 19. — *Herba sentiens* RUMPH. *Herb. Amb.* 5 (1750) 302. — *Oxalis sensitiva* LINNÉ, *Sp. Pl.* (1753) 434; JACQ. *Oxal. Monogr.* (1794) 42; WILLD. *Sp. Pl.* 2 (1799) 804; PERS. *Syn.* 1 (1805) 519; ZUCC. *Abh. K. Ak. Wiss. Münch.* 1 (1830) 273; ROXB. *Fl. Ind. ed. Carey* 2 (1832) 457; W. & A. *Prod.* 1 (1834) 142. — *Oxalis cumingiana* TURCZ. *Bull. Soc. Nat. Moscou* 31 (1858) 426. — *B. cumingii* KLOTZSCH in Peters, *Reise Mossamb. Bot.* 1



Fig. 4. *Biophytum dendroides* DC. as a weed in the Leyden Hortus (Photogr. Miss R. VAN CREVEL).

(1862) 85. — *B. cumingianum* (TURCZ.) EDGEW. in Edgew. & Hook. f. Fl. Br. Ind. 1 (1874) 436. — *B. sensitivum* var. *nervifolia* (non EDGEW. & Hook. f.) F-VILL. Novis. App. (1880) 33. — Fig. 3g.

Annual. Stem simple, up to 35 cm, pithy (compressible), smooth. *Leaves* 7–12(–14)-jugate; rachis 5–10(–16½) cm, sparsely strigose; leaflets rarely overlapping; terminals 8–18 by 3–10 mm, ± asymmetric, falcate-obovate, midrib excentric; other leaflets symmetric, elliptic, margins ± parallel, base truncate, not drawn out, midrib median; apex rounded, apiculate, ± acroscopic; ± glabrous; nerves many, little conspicuous. *Peduncles* up to 14 cm, up to 10-flowered, appressed-strigose and with patent septate-glandular hairs. *Pedicels* 1½–3½ mm. *Bracts* ovate-attenuate, 1½–3 mm. *Sepals* 4–7 by ½–1½ mm, ovate-lanceolate, acute, strigose and glandular-hairy,

in fruit 5–9-nerved, longer than pedicels, 1½–2 times as long as the fruit, ± shorter than the corolla. *Petals* 5–7 by 1–2 mm, lanceolate, truncate, base yellow, limb with purplish and yellow lines. *Filaments* (MF) 1–1½ and 2–2½ mm, the longer ciliate. *Ovary* ½–¾ by ½–½ mm, apically ciliate; styles (MF) ½–1 mm, often clasping the anthers of the longer filaments and tearing them off; stigmas flattened, crenate to bifid; ovules 2–5 per cell. *Fruit* 3–4 by 2 mm, apically puberulous and minutely septate-glandular hairy on the ribs. *Seeds* 0–3 per cell, ¾–1 by ½–¾ mm, transversely tubercled and ridged.

Distr. Widely spread in Indo-Malesian tropics, common and throughout *Malesia* but not yet recorded for New Guinea.

Ecol. Shady places, waste land, river-banks, under damp thickets, etc., up to 250 m. *Fl. fr.* Jan.–Dec.

Vern. Sumatra: *daun kutjangan, si-hirpud, si-kèrpud*, Batak, alud for *Mimosa pudica*); *krambilan, kutjangan, turularé, J, indja payong*, Djakarta, *kalapaan, ki-payung, S, tindoh-tindoh, Patjira, Celebes, daun hidoep, kurang-kurang, m'niran utan*, Moluccas, *bulutu, Kau, Halmahera, gogiolu, Galela, Halmahera, galofino, ? igo-igo*, Ternate, *obat godog*, Obi, *pagègga, paginga*, Sula Is., *runtili*, Talaud; Philip.: *damóng-bingkálat, makahia, makahiang-laláki*, Tag., *damon-húya, hoyahoya, lubi-lubi*, Bis., *guyankan*, Sub., *mahihlin*, Ilk., *niug-niug*, Sul.

Uses. In the Philippines the powdered seeds are used as a vulnerary. A decoction of the roots is used for gonorrhoea and stones in the bladder. A decoction of the plant is said to cure diabetes mellitus, in the Sula Is. it is used for pregnancy diseases (BLOEMBERGEN 4365), on the Karo Plateau of N. Sumatra to diminish the female libido (GALOENGI 49), in Ternate for chest-complaints, here the ashes with lime-juice are given for stomach-aches. A reputed medicine for tuberculosis (HEYNE, 1927, BURKILL, 1935, and QUISUMBING, Medic. Pl. Philip., 1951).

Note. It has appeared that what in African Floras has been referred to *B. sensitivum* is really a different species, *B. helenaë* BUSC. & MUSCHL., which has a corolla $1\frac{1}{2}$ –2 times as long as the calyx, more pairs of leaflets, is not annual and is sometimes branched, and has a seed structure as in *B. petersianum* (VELDKAMP, Blumea 16 (1968) 137).

4. *Biophytum reinwardtii* (ZUCC.) KLOTZSCH in Peters, Reise Mossamb. Bot. 1 (1862) 85; EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 437, incl. var. *metziana* EDGEW. & HOOK. f. l.c. 438; RIDL. Fl. Mal. Pen. 1 (1922) 331; KNUTH, Ph. R. Heft 95 (1930) 395; STEEN. Bull. Jard. Bot. Btzg III, 18 (1950) 453; Reinwardtia 1 (1952) 477; BACK. & BAKH. f. Fl. Java 1 (1963) 247; VELDK., Fl. Thail. 2 (1970) 19. — *B. sensitivum* var. *reinwardtii* (ZUCC.) GUILLAUMIN, Bull. Mus. Hist. Nat. Paris 15 (1909) 127. — *Oxalis reinwardtii* ZUCC. Abh. K. Ak. Wiss. Münch. 1 (1830) 274; MIQ. Fl. Ind. Bat. 1, 2 (1859) 134. — *B. sensitivum* (non L.) F. M. BAILEY, Queensl. Agric. J. 23 (1909) 262. — *Toddavaddi* RHEEDE, Hort. Mal. 9 (1689) 33. — Fig. 3a-c.

Annual. Stem simple, up to 35 cm, medullary, compressible, smooth. *Leaves* 6–11(–14)-jugate; rachis $2\frac{1}{2}$ –6(–9 $\frac{1}{2}$) cm, sparsely puberulous; leaflets rarely overlapping, terminals largest, 7–18 by 4–7 mm, asymmetric, obovate, midrib excentric, curved; others elliptic, symmetric, base truncate, not drawn out, margin \pm parallel, midrib median, straight to slightly curved; apex rounded, apiculate, \pm glabrous, margins sparsely strigose; nerves many, oblique, little conspicuous. *Peduncles* up to $6\frac{1}{2}$ (–12 $\frac{1}{2}$) cm, patent to appressed-strigose and septate-glandular hairy, up to 8-flowered. *Pedicels* up to 7 mm; bracts ovate-attenuate, 1–1 $\frac{1}{2}$ mm. *Sepals* $2\frac{1}{4}$ –4 by $\frac{1}{2}$ –1 mm, ovate-lanceolate, acute, in fruit 3–8-nerved, $\frac{1}{2}$ – $\frac{2}{3}$ as long as pedicel, \pm as long as fruit, \pm half as long as corolla. *Petals* 6–8 by 1–2 mm, elliptic-

to oblanceolate, apex rounded to emarginate, base yellow, above with red to purplish veins. *Filaments* (MF) $1\frac{1}{2}$ and 2–3 mm, the longer sparsely ciliate. *Ovary* $\frac{1}{2}$ –1 by $\frac{1}{3}$ – $\frac{1}{2}$ mm, glabrous; styles (MF) $\frac{1}{2}$ – $\frac{3}{4}$ mm; stigma flattened, crenate to bifid; ovules 3–4 per cell. *Fruit* 2–3 by 2–2 $\frac{1}{2}$ mm apically puberulous and minutely septate-glandular-hairy on the ribs. *Seeds* 1–3 per cell, c. 1 by $\frac{1}{2}$ mm, transversely ridged and tubercled.

Distr. Tropical SE. Asia, in *Malesia*: Malay Peninsula, Java (common), SW. Celebes (Makassar, a. 1918, one collection), and E. New Guinea ((Boku, BAILEY, l.c.).

Ecol. Shady places, waste land, river-banks, under damp thickets, etc., up to 800 m.

Vern. *Biskutjingga, krambilan, kutjangan, piskutjingga, pis-geong, J, inger, Nusa Kambangan, kakalapaän, ki pajong*, Md, *indja pajung* M.

Uses. Cultivated as medicine, used against smallpox and rashes ('*sakit injo*') (EDELING s.n.) and in India against fever (HOHENACKER 144).

Note. The restricted distribution might point to an early introduction, but it was in BLUME's and JUNGHUHN's time already a common plant in Java.

5. *Biophytum microphyllum*, sp. nov. — Fig. 3d.

Fruticulus usque ad 30 cm altus, ramosus. Folia 18–32-jugata. *Rachis* 4–8 cm longa. *Foliola minuta, paria terminalia* 3–6 mm longa, $1\frac{1}{2}$ –4 mm lata, obovato-oblonga, precedentibus aequilonga; cetera lanceolata, basis parte acroscopica truncata, saepe lobata; apex centralis, rotundatus vel obtusus; costa basi excentrica. *Flores ad pseudo-umbellulas longe pedunculatas digesti. Sepala* 4–6 $\frac{1}{2}$ mm longa, 1–2 mm lata, ovato-lanceolata, acuminata, in fructu 3–7-nervosa, pedicellis 1–1.6-plo longiora, fructibus 2–3-plo longiora. *Petala sepalis* $1\frac{1}{2}$ vel duplo longiora. *Fructus distaliter paulo ciliatus*. — *Typus*: SULIT & CONCKLIN PNH 16905 (L, holotype, PNH).

Perennial. Stem woody, up to 30 cm, branched. *Leaves* (5)–18–32-jugate; rachis 4–8 cm, slender, often curved, rusty puberulous, especially at the nodes; leaflets rarely overlapping, terminals 3–6 by $1\frac{1}{2}$ –4 mm, obovate-oblong, \pm as long as the preceding, midrib \pm median; others lanceolate, basis copical half of base rounded, acroscopical half truncate, often drawn out, midrib excentric, margins \pm parallel; apex central, obtuse to rounded, apiculate; upper surface appressed-puberulous, beneath \pm more pubescent; nerves many. *Peduncle* 2–5 $\frac{3}{4}$ cm, appressed to patently pubescent, eglandular. *Pedicels* 5–9 mm long, appressed- to patently puberulous, eglandular. *Sepals* 4–6 $\frac{1}{2}$ by $\frac{3}{4}$ –2 mm, lanceolate, acuminate, the outer three much wider, \pm half as long as the corolla, in fruit 3–7-nerved, $\frac{3}{8}$ to \pm equalling the pedicel, c. $1\frac{1}{8}$ times as long as the fruit (excl. styles). *Petals* 7–9 by 1–2 $\frac{1}{2}$ mm, apex rounded, white to lavender. *Filaments* (MF) $2\frac{3}{4}$ –3 $\frac{1}{2}$ and 4–5 $\frac{3}{4}$ mm, (LF) $\frac{3}{4}$ and $1\frac{1}{2}$ mm, the longer ciliate. *Ovary* $1\frac{1}{2}$ by 1 mm, glabrous; styles (MF) $2\frac{1}{2}$ –3 mm long, (LF) not seen in anthesis; stigma minutely bifid; ovules 3–4 per cell. *Fruit* 2–3 by 2 mm, puberulous in upper half.

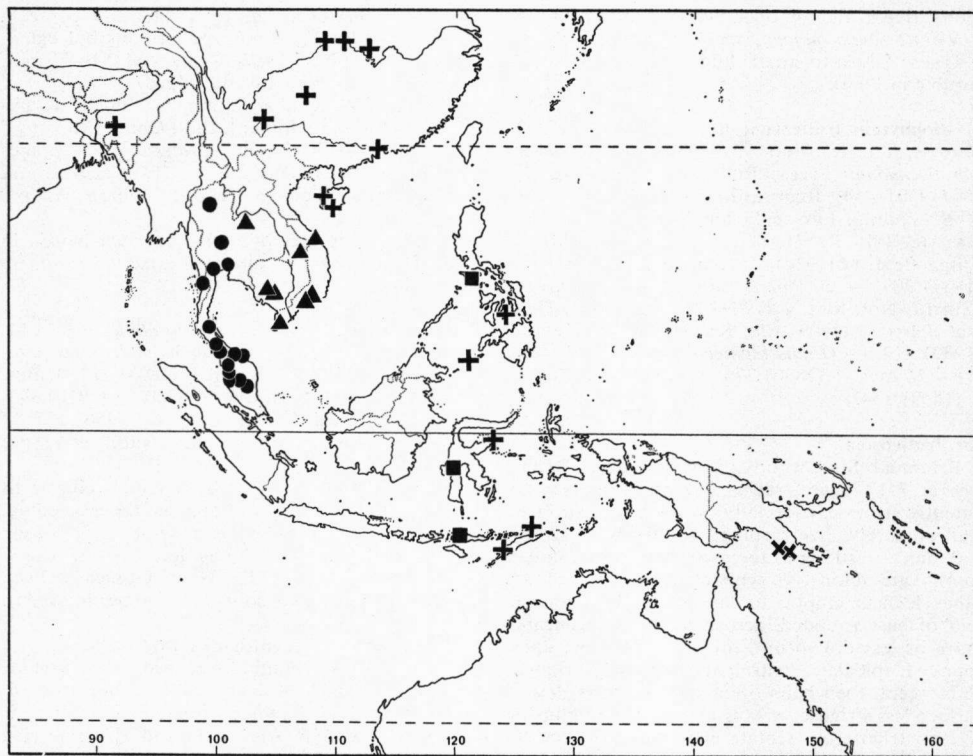


Fig. 5. Distribution of *Biophytum fruticosum* BL. var. *fruticosum* (+), ditto, var. *papuanum* VELDK. (x), *B. adiantoides* WIGHT (●), *B. thorelianum* GUILLAUMIN (▲), and *B. microphyllum* VELDK. (■).

Seeds 3–4 per cell (no ripe ones seen).

Distr. *Malesia*: Philippines (E. Mindoro: Mt Yagaw), SW. Central Celebes (Pasui), and Lesser Sunda Is. (W. Flores). Only four collections. Fig. 5.

Ecol. In crevices of rocks on forest edge, once on limestone, 400–600 m, apparently *fl.* and *fr.* all year.

Vern. *Huya-huya-ili*, *tagurignük-sa-ili*, Mang., Philip.

6. *Biophytum adiantoides* WIGHT ex EDGEW. & HOOK. *f. Fl. Br. Ind.* 1 (1874) 437; KING, *J. As. Soc. Beng.* 62, ii (1893) 200; GUILLAUMIN, *Bull. Mus. Hist. Nat. Paris* 15 (1909) 124; *Fl. Gén. I.-C.* 1 (1911) 609; RIDL, *Fl. Mal. Pen.* 1 (1922) 331; KNUTH, *Pfl. R. Heft* 95 (1930) 397; VELDK., *Fl. Thail.* 2 (1970) 20.

Perennial. Stem woody, usually branched, up to 30 cm high. *Leaves* 18–27-jugate; rachis 7–17 cm, yellowish appressed to patently pubescent; leaflets rarely overlapping, terminals 9–22 by 3–8 mm, oblong to lanceolate, widest at or above the middle, \pm as long as the preceding, midrib \pm median; others asymmetric, elliptic to oblong, basiscopical half of base rounded, acrosopical half truncate, more or less drawn out, margins

otherwise \pm parallel, midrib excentric at base; apex central, rounded, apiculate; above sparsely strigose, hairs often in three rows, to glabrescent, beneath more strigose; nerves many. *Peduncle* 5–19½ cm, up to 9-flowered, puberulous, sometimes with a few septate-glandular hairs. *Pedicels* 5–17 mm, puberulous and with a few gland hairs. *Sepals* 4½–6 by 1–1½ mm, lanceolate, acute, sparsely strigose to glabrous, sometimes with a few septate gland hairs, ½–2/3 as long as the corolla, in fruit 5–12-nerved, half to \pm equally as long as the pedicel, 1¼–2 times as long as the fruit. *Petals* 9–10 by 1–2½ mm, lanceolate, apex rounded to truncate, white with yellowish base. *Filaments* in SF 1½–3½ and 4½–6½ mm long, in MF 1½ and 5¾ mm long, in LF 1–1½ and 2¾–4 mm long, the longer ciliate. *Ovary* 1 by ½–¾ mm, glabrous; styles puberulous, in SF ½–1¼ mm, in MF 2½ mm, in LF 4–6 mm long; stigma flattened, crenate to bifid; ovules 2–4 per cell. *Fruit* 3–4 by 2–3 mm, glabrous. *Seeds* 2–3 per cell, 1–1¼ by ¾–1 mm, with transverse tuberculated ridges.

Distr. S. Vietnam, Cambodia, Thailand, Tenasserim, and in *Malesia*: northern half of the Malay Peninsula (Perlis, Perak, Pahang). Fig. 5. Ecol. In crevices of (limestone) rocks

along rivers and in open woods, up to 300 m.

Vern. *Daun pajong, maiong, pajong ali*, M.

Uses. Given to small children against stomach trouble in Perak.

7. *Biophytum fruticosum* BL. Bijdr. (1825) 242; KNUTH, Pfl. R. Heft 95 (1930) 412 in annot. sub *B. nudum*; STEEN. Bull. Jard. Bot. Btzg III, 18 (1950) 454; Reinwardtia 1 (1952) 477, p.p. — *B. esquirolii* LÉV. in Fedde, Rep. 12 (1913) 181; KNUTH, Pfl. R. Heft 95 (1930) 413; MERR. Lingn. Sc. J. 13 (1934) 31; REHDER, J. Arn. Arb. 18 (1937) 209. — *B. thorelianum* var. *sinensis* GUILLAUMIN, Not. Syst. 1 (1909) 25; Bull. Mus. Hist. Nat. Paris 15 (1909) 128; KNUTH, Pfl. R. Heft 95 (1930) 413. — *Oxalis blumei* ZUCC. Abh. K. Ak. Wiss. Münch. 1 (1830) 276; MIQ. Fl. Ind. Bat. 1, 2 (1859) 134.

var. *fruticosum*.

Perennial. Stem woody, branched, up to 50 cm. Leaves 7–17-jugate; rachis 3–9 cm, appressed to patently strigose, especially on the upper surface; leaflets rarely overlapping; terminals 5–12 by 3–8 mm, \pm as long as the preceding, obtriangular to obovate-oblong, \pm symmetric, midrib median; other leaflets elliptic to lanceolate, basiscopical half of base rounded, acroscopical half truncate, more or less drawn out, midvein excentric; apex rounded, apiculate, central; above densely strigose, glabrescent, then hairs often in three rows, lower surface less strigose; nerves many. Peduncle up to 13 cm, strigose, no septate glandular hairs, up to 10-flowered. Pedicels up to 9 mm. Sepals $3\frac{1}{2}$ –6 by 1–1½ mm, ovate-lanceolate, densely to sparsely strigose, no septate glandular hairs, in fruit 3–7-nerved, $\frac{3}{8}$ as long as the pedicel, slightly exceeding the fruit, c. $\frac{2}{3}$ as long as the corolla. Petals $5\frac{1}{2}$ –10 by 1–2½ mm, lanceolate, obtuse, white to pink. Filaments in SF 2–3 and $3\frac{1}{2}$ –4 mm, in MF 2–2½ and 3 mm, in LF 1½–4 and 2½–5 mm long, the longer always ciliate. Ovary ½–1 by ½–1 mm, apically with a few cilia to glabrous; styles in SF ½ mm, stigma bifid, flattened; in MF 2½–4 mm, in LF 2–5 mm, stigma subulate

to slightly flattened, entire; ovules 2–4 per cell. Fruit 2½–4 by 2½–3 mm, puberulous but eglandular in upper half. Seeds 2–4 per cell, 1 by ¼ mm, transversely tuberculate and ridged.

Distr. SW. China (Yunnan, Hupeh, Kouy-Tschiou, Canton, Hainan), Indo-China (Mekong), NE. India (Silhet); in Malesia: Philippines (Bohol; Sulu Is.: Bengao I.), E. Celebes, and Lesser Sunda Islands (S. Central Timor; S. Wetar). Fig. 5.

Ecol. In crevices of rocks, on river-banks, in thickets and shaded cultivated areas on sand, up to 800 m.

var. *papuanum*, var. *nov.* — *Oxalis albiflora* F. v. M. Vict. Natur. 8 (1892) 164, *nom. nud.* — *B. albiflora* F. v. M. Vict. Natur. 9 (1893) 112; J. Bot. 31 (1893) 325; KNUTH, Pfl. R. Heft 95 (1930) 397; STEEN. Bull. Jard. Bot. Btzg III, 18 (1950) 455. — *Oxalis papuana* F. v. M. Vict. Natur. 9 (1893) 112, *nom. altern.*

Terminal leaflets 14–20 by 6–8 mm, elliptic to oblong, \pm 1.3 times as long as the preceding. Pedicels 9(–25) mm. Sepals in fruit \pm $\frac{3}{8}$ as long as the pedicel. Fruit \pm as long as the calyx.

Distr. Malesia: SE. New Guinea (Owen Stanley Range), two collections (type not seen). Fig. 5.

Ecol. Stony stream-banks in forests.

Note. In his preliminary revision VAN STEENIS accepted a much wider specific concept of *B. fruticosum* than handled here, in merging *B. adiantoides* with *B. fruticosum* and also referring the specimens here distinguished as *B. microphyllum* to it. In fact all three native Malesian fruticose *Biophytums* and *B. thorelianum* GUILLAUMIN from Indo-China (fig. 5) differ from allied continental species (*B. nudum*, *B. proliferum*, *B. intermedium*, and *B. polyphyllum*) in having the midrib obliquely inserted at the base and the Asian ones having them median. However, the Malesian material can be sorted into three taxa, although it must be admitted that the great scarcity of collections makes it difficult to find the parameters of their variability.

3. DAPANIA

KORTH. Ned. Kruidk. Arch. 3 (1854) 381; HALL. f. Beih. Bot. Centralbl. 34, ii (1917) 25; KNUTH, Pfl. R. Heft 95 (1930) 419; VELDKAMP, Blumea 15 (1967) 523. — Fig. 7i.

Glabrous lianas. Leaves estipulate, unifoliolate; petioles articulate with a constriction (in herb.). Inflorescences racemose, ramiflorous and axillary, solitary to fascicled. Flowers (in Mal.) androdioecious. Sepals connate in lower half, margins ciliate, glabrous inside. Petals apotact or paract, rarely quincuncial, (in Mal.) free and glabrous inside, minutely clawed, red to white. Filaments (in Mal.) antheriferous, between the filaments with scales on the annulus, these sometimes reduced to dark lines. Ovary glabrous, reduced and sterile in δ plants. Ovules in δ 1–2 per cell, in σ 0–1. Capsule fleshy, yellowish green (red when dry),

loculicid to the base, 1–6-seeded, valves patent; (in Mal.) episeptal rimae present, open to base. *Seeds* up to 2 per cell; testa smooth, hard, yellowish red, terminally thickened around the micropyle, splitting lengthwise under pressure; aril present, enveloping the seed, attached to the entire length of the adaxial raphe, fleshy, bright to whitish yellow, margin irregular crenate, with oily drops; embryo with the cotyledon $1\frac{1}{2}$ –2 times as long as the straight, oblique radicle.

Distr. Madagascar (1 *sp.*), in *Malesia* (Sumatra, Malaya, Borneo) 2 *spp.*

Ecol. Lianas in forests, swamps, near rivers, obviously usually on poor soil, at low altitude.

KEY TO THE SPECIES

1. Leaves up to 15 cm, base cuneate to rounded. Sepals glabrous, except the ciliate margin.

1. *D. racemosa*

1. Leaves longer than 15 cm, base deeply emarginate. Sepals puberulous outside.

2. *D. grandifolia*

1. *Dapania racemosa* KORTH. Ned. Kruidk. Arch. 3 (1854) 381; PLANCHON, Ann. Sc. Nat. Bot. IV, 2 (1854) 266; MIQ. Fl. Ind. Bat. 1, 2 (1859) 134; STAFF in Hook. f. Ic. Pl. III, 10 (1891) t. 1997; HALL. f. Beih. Bot. Centralbl. 34, ii (1917) 25; KNUTH, Pfl. R. Heft 95 (1930) 420; VELDKAMP, Blumea 15 (1967) 552, f. 1d–g. — *D. scandens* STAFF in Hook. f. Ic. Pl. III, 10 (1891) t. 1997; KING, J. As. Soc. Beng. 62, ii (1893) 201; HALL. f. Beih. Bot. Centralbl. 34, ii (1917) 25; RIDL. Fl. Mal. Pen. 1 (1922) 334; KNUTH, Pfl. R. Heft 95 (1930) 420, f. 28a–e.

Large liana, up to 30 m long, 20 cm ϕ , rather profusely branched. *Leaves* $5\frac{3}{4}$ –15(–25) by $2\frac{1}{2}$ – $6\frac{3}{4}$ cm, oblong to lanceolate, pergamentaceous to subcoriaceous, acute to cuspidate, base cuneate to rounded; petiole 3–10 by 1–2 mm, petiolule 2–6 by 1–2 mm. *Racemes* solitary to fascicled, in δ 1–3 together, 3– $13\frac{1}{2}$ cm, in σ 1–15 together, 2– $5\frac{1}{2}$ (– $12\frac{1}{2}$) cm; rachis puberulous, glabrescent. Pedicel (lower joint 0–1 mm, upper $\frac{1}{4}$ – $\frac{1}{2}$ mm) not covered by the minute, broadly ovate, acute bract $\frac{1}{4}$ – $\frac{1}{2}$ by $\frac{1}{2}$ mm. *Calyx* $1\frac{1}{2}$ –2 mm high, glabrous to sparsely puberulous outside. *Sepals* $\frac{1}{2}$ – $1\frac{1}{2}$ by $\frac{3}{4}$ – $1\frac{1}{4}$ mm, broadly ovate to elliptic, rounded to emarginate. *Petals* 3–4 by 1– $1\frac{1}{4}$ mm, obovate-oblong to lanceolate, often rolled back at anthesis, obtuse to rounded, darker. *Filaments* in δ $\frac{1}{4}$ – $\frac{1}{2}$ and $\frac{3}{4}$ –1 mm, in σ 1–3 and $1\frac{1}{2}$ –4 mm long. *Pistil* in δ $1\frac{1}{2}$ – $2\frac{1}{2}$ mm, in σ $\frac{1}{2}$ – $\frac{3}{4}$ mm; styles in δ 1– $1\frac{1}{4}$ mm, in σ very short, acute. *Fruit* obovoid with cuneate base, 5–11 by 6–10 mm, after dehiscence 9–22 mm ϕ . *Seeds* 4–5 by $1\frac{1}{2}$ mm; radicle $1\frac{1}{4}$ – $1\frac{3}{4}$ mm long, cotyledons 2– $2\frac{1}{2}$ by $\frac{3}{4}$ –1 mm.

Distr. *Malesia*: Sumatra, Malaya, Borneo. Fig. 6.

Ecol. Dense jungle, swamp forest, on poor soils, up to 750 m. *Fl. fr.* Jan.–Dec.

Vern. *Batieg-batieg*, *dapan*, Sumatra; *bélimbing bait*, M, *jaloai*, Brunei, *kara-raka*, Iban; *paukiang*, Malacca, *sélabun akar*, Selangor.

Note. A large-leaved form occurs in North Sumatra.

2. *Dapania grandifolia* VELDKAMP, Blumea 15 (1967) 525, f. 1h–p. — Fig. 7i.

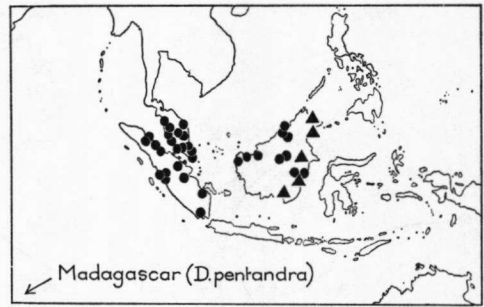


Fig. 6. Distribution of *Dapania racemosa* KORTH. (●) and *D. grandifolia* VELDK. (▲).

Liana, or treelet, up to 27 m, 7 cm ϕ . *Leaves* coriaceous, ($10\frac{1}{2}$ –) $16\frac{1}{2}$ –31 by $4\frac{1}{2}$ –11 cm, oblong to lanceolate, widest at or below the middle, base retuse to deeply emarginate, apex acute to attenuate; petiole 2–6 by 2– $3\frac{1}{2}$ mm, stout, petiolule 1–3 by 2– $3\frac{1}{2}$ mm. *Racemes* \pm densely and \pm patently puberulous, not glabrescent, in δ 1–5 fascicled, 3–5 cm long, in σ 1–2 together, 4–8 cm long. Bracts boat-shaped, sometimes recurved, $\frac{3}{4}$ –1 by $\frac{1}{2}$ –1 mm, broadly ovate, acute, covering the minute (c. $\frac{1}{2}$ mm long) pedicel, but not the base of the calyx. *Calyx* $1\frac{3}{4}$ – $2\frac{1}{2}$ mm high, pale to brown puberulous. *Sepals* 1– $1\frac{1}{2}$ by $\frac{3}{4}$ – $1\frac{1}{2}$ mm, suborbicular to ovate, acute to rounded. *Petals* 4–5 by $\frac{1}{2}$ – $1\frac{1}{4}$ mm, obovate-lanceolate, rounded, base attenuate. *Filaments* in δ 2– $3\frac{1}{2}$ and 3–4 mm, in σ $\frac{1}{2}$ – $\frac{3}{4}$ and $\frac{3}{4}$ –1 mm. *Pistil* in δ reduced, sterile, $\frac{1}{2}$ – $\frac{3}{4}$ by $\frac{1}{4}$ – $\frac{1}{2}$ mm, ovoid; styles minute, acute; σ : ovary $1\frac{3}{4}$ by 1 mm, styles 2 mm. *Fruit* before dehiscing 9–11 by 6–8 mm, suborbicular to ovoid, after dehiscence 20–22 mm ϕ . *Seeds* $4\frac{1}{2}$ –5 by $1\frac{1}{2}$ – $1\frac{3}{4}$ mm; embryo 4 mm long, radicle $1\frac{1}{4}$ by $\frac{1}{3}$ mm, cotyledons $2\frac{1}{2}$ by $1\frac{1}{4}$ mm.

Distr. *Malesia*: NE. to SE. Borneo. Fig. 6.

Ecol. Primary forest, on flat to undulating land on clay near rivers. *Fl. fr.* Jan.–Dec.

Vern. *Salung kapit*, Dusun.

4. SARCOTHECA

BLUME, Mus. Bot. Lugd. Bat. 1 (1850) 241; HALL. f. Med. Rijksherb. Leiden 1 (1911) 1; KNUTH, Pfl. R. Heft 95 (1930) 420; VELDKAMP, Blumea 15 (1967) 527 — *Roucheria* MIQ. Fl. Ind. Bat. 1, 2 (1859) 136. — *Connaropsis* PLANCH. ex HOOK. f. Trans. Linn. Soc. 23 (1860) 166. — Fig. 7a-h.

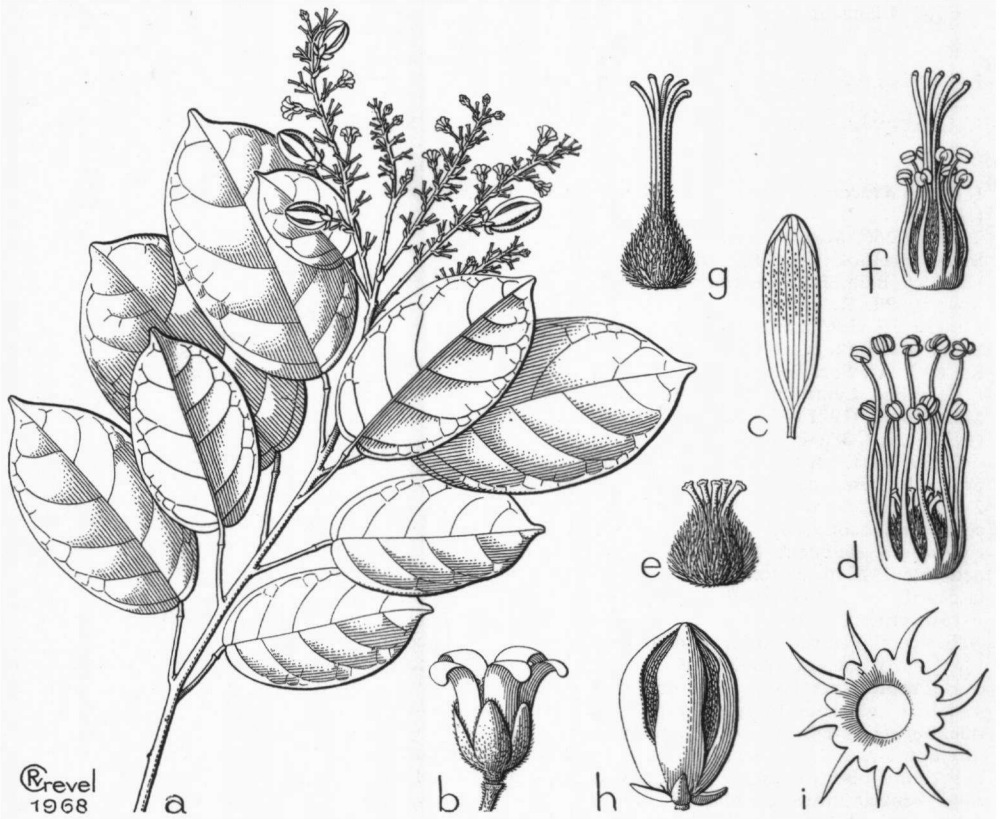


Fig. 7. *Sarcotheca glauca* HALL. f. a. Habit, $\times \frac{2}{3}$, b. flower, $\times 4$, c. petal, $\times 6$, d. stamens and ovary (SF), $\times 10$, e. ovary (SF), $\times 10$, f. stamens and ovary (LF), $\times 10$, g. ovary (LF), $\times 10$, h. fruit, $\times 2$. — *Dapania grandifolia* VELDK. i. Annulus with scales and filaments, $\times 10$ (a, h PUASA BNB 5484, b-c, f-g LAJANGAH SAN 33612, d-e MUJIN SAN 33562, i KOSTERMANS 10104).

Shrubs or trees; innovations pubescent. *Leaves* estipulate, 1- or 3-foliolate; petioles articulate, with a constriction (in herb). *Panicles* axillary or pseudoterminal, one to few together; flowers in more or less stalked cymes, scattered along a simple or sparsely branched rachis; cymes subtended by small caducous bracts, occasionally by a reduced petiole (petioloid), or rarely a small leaf. *Flowers* heterodistylous. *Sepals* unequal, shortly connate at base, inside appressed strigose, persistent (except in *S. diversifolia*). *Petals* contorted, sometimes paratact, inside with minute papillae in the upper half. *Filamental* annulus without scales. *Ovules*

2 per cell. *Fruit* fleshy, red at least when dry, with ± distinct episeptal rimae sometimes lighter and minutely papillose inside (at least when dry). *Seeds* exarilate; testa smooth to transversely rugose, hard, reddish, splitting irregularly by pressure; embryo with a straight radicle in line with the cotyledons which are 3-5 times as long as the radicle.

Distr. *W. Malesia*: Sumatra, Malaya, Borneo, Celebes. Fig. 8.

Ecol. Primary and secondary forest on poor soil at low altitude. *Fl. fr.* Jan.-Dec.

Uses. The fruit, although acid, is eaten in curry, sajur, and manisan and is said to be a remedy against coughing. The timber is light and of small dimension, neither very strong nor durable, sometimes used for roofs.

Notes. The genus has often been confused with *Rourea* AUBL. (*Connaraceae*) which differs from *Sarcotheca* in having free carpels, 2 collateral ovules, seeds with an aril, and a dry, indehiscent, 1-celled and 1-seeded fruit.

The species of the genus are closely related and most of them occupy small ranges; in several cases close allies show replacing areas. With a broader species concept several species would be reduced to sub-specific rank, notably the triad *S. monophylla* from Malaya, *S. glauca* from Borneo, and *S. celebica* from Celebes.

KEY TO THE SPECIES

- 1. Leaves trifoliolate, laterals sometimes caducous, leaving a scar. Mature fruit greenish yellow when fresh (red when dry!); more than 1½ cm long.
- 2. Calyx 3-5 mm high, outside pale puberulous to glabrous, not persistent in fruit. 1. *S. diversifolia*
- 2. Calyx 2½-3 mm high, outside brown puberulous, persistent in fruit. 2. *S. griffithii*
- 1. Leaves unifoliolate; no lateral scars. Mature fruit red when fresh; less than 1½ cm long.
- 3. Mature leaf puberulous to pubescent beneath, also between the nerves.
- 4. Panicles not or barely exceeding the leaves. Petals 4-7 mm long. Rimae obscure, glabrous inside.
- 5. Leaves 8-23 by 3-8½ cm, margins never paler. Calyx 1¼-2 mm high. 4. *S. laxa*
- 5. Leaves 5-11¼ by 2-3½ cm, margins usually paler. Calyx 2-3¾ mm high. 8. *S. ferruginea*
- 4. Panicles exceeding the leaves. Calyx 3-3½ mm high. Petals 6-8 mm long. Rimae conspicuous, lighter and minutely papillose inside. 10. *S. ochracea*
- 3. Mature leaf beneath at most sparsely puberulous on the nerves.
- 6. Calyx (and often panicle also) glabrous to finely *pale* puberulous. Rimae obscure and glabrous inside.
- 7. Panicle glabrous, stout. Cymes sessile, flowers in glomerules along the rachis. 3. *S. glomerula*
- 7. Panicle puberulous, slender. Cymes stalked. 4. *S. laxa*
- 6. Calyx at least at the base (and panicle) *rusty* puberulous. Rimae conspicuous, inside lighter and minutely papillose.
- 8. Leaves 4-13½ cm long. Panicle up to 13 cm, erect, ± compact (lax in *S. celebica*).
- 9. Cymes not ± secund. Basal parts of pedicels all ± equal.
- 10. Leaves when dry brown to reddish brown. Basal parts of pedicels 0-2 mm long. Calyx 1¼-2¼ mm high, persistently puberulous outside, reddish brown when dry.
- 11. Leaves 4-10 cm long, acuminate to cuspidate. Panicle ± dense, pedicels with shorter and reduced upper joint (c. ½ mm). 6. *S. monophylla*
- 11. Leaves 6-13½ cm long, cuneate-acute to faintly acuminate; venation above more prominent than in the other two species. Panicle slender, lax, joints of pedicel ± equal (up to 1½ mm). 7. *S. celebica*
- 10. Leaves when dry palish to olive green, 4½-11 cm long, acuminate. Basal part of pedicels 2-6 mm long. Calyx 2-3 mm high, outside glabrescent in fruit, except for base and margins, crimson when dry. 5. *S. glauca*
- 9. Cymes ± secundly branched. Basal part of one pedicel per cyme usually elongated, up to 5 mm. Nerves of leaf beneath often reddish when dry. 9. *S. rubrinervis*
- 8. Leaves 7½-28½ cm long. Panicle usually pendulous, slender, usually much longer than 13 cm.
- 12. Leaf widest at the middle, apex gradually acute to caudate, base obtuse to rounded. Nerves often reddish when dry. Petiolules 2-4 by 1-2 mm. Cymes ± secundly branched, basal part of one pedicel elongated, up to 5 mm. Claw of petals ⅔-1 mm long. 9. *S. rubrinervis*
- 12. Leaf widest at or above the middle, margins ± parallel, apex abruptly acuminate to caudate, base truncate to emarginate. Nerves concolourous with intervenium when dry. Petiolules 3-9 by 1-3 mm. Cymes not ± secundly branched, basal part of pedicels ± equal. Claw of petal ¼-½ mm long. 11. *S. macrophylla*

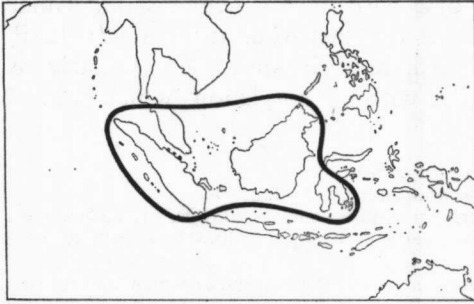


Fig. 8. Distribution of *Sarcotheca* BL.

1. *Sarcotheca diversifolia* (MIQ.) HALL. f. Med. Rijksherb. Leiden 1 (1911) 2; VELDKAMP, Blumea 15 (1967) 529, f. 2a-c. — *Rourea diversifolia* MIQ. Fl. Ind. Bat. Suppl. 1 (1860) 528. — *Connaropsis diversifolia* KURZ, J. As. Soc. Beng. 39, ii (1870) 69, excl. syn. *C. griffithii*. — *Santalodes diversifolium* O. KUNTZE, Rev. Gen. Pl. 1 (1891) 155. — *Connaropsis acuminata* PEARSON, Kew Bull. (1906) 2. — *S. acuminata* HALL. f. Beih. Bot. Centralbl. 34, ii (1917) 27. — *S. subtriplicornis* HALL. f. Lc. — *Connaropsis grandiflora* RIDL. Kew Bull. (1930) 75.

Shrub or tree, up to 27 m high, to 90 cm σ , often buttressed (90 cm high, 135 cm out, 5 cm σ). Leaves trifoliolate, papyraceous to subcoriaceous, ovate to elliptic-oblong to -lanceolate, glabrous, acute to caudate, base acute to truncate, venation not very conspicuous; nerves 1-5 pairs, usually \pm prominent, veinlets not as finely reticulate as in *S. griffithii*; lateral leaflets 3-9½ by 1-3¾ cm, terminal ones 5½-18 by 2-6¾ cm; petiole 6-25 by 1-2½ mm, rachis (5-)-9-27 by ¾-2 mm; petiolules 4-7 by ¾-2 mm. Panicles shorter than subtending leaf, 1-4 together, loosely branched, 1-8½(-13½) cm, ferruginous-puberulous, glabrescent; branches flattened, 2-30(-40) mm long; bract or petioloid ovate, acute, up to 7 mm. Pedicels: lower joint 2½-5 mm, upper 1-3 mm; Calyx 3-5 mm high, outside pale puberulous to glabrous, purplish, \pm caducous in fruit. Sepals 2¼-5 by 1¼-3 mm, broadly ovate to oblong, acute to emarginate. Petals 7-11 by 2-5 mm, obovate-oblong to -lanceolate, rounded to emarginate, 1-2 mm clawed, lilac or pink to scarlet or red. Filaments in SF 2¾-3½ and 3¼-4½ mm, in LF 1½-2¼ and 2¼-3 mm, the longer occasionally without anthers. Pistil pale puberulous to glabrous, in SF 1¼-2½ mm, in LF 3½-5 mm; styles in SF ¼-1 mm, in LF 2¼-4; ovary 1-2 by ¾-1¼ mm, ellipsoid. Fruit white to greenish when fresh (red when dry), ellipsoid, glabrous, 16-31 by 9-20 mm; rimae inconspicuous. Seeds 7½ by 5 mm, testa smooth; cotyledons 4½ by 4 mm, radicle 1½-¾ by ¼ mm.

Distr. Malesia: N. Sumatra (off Sibolga: Morsala I.), Borneo.

Ecol. First and second storey of primary and secondary forest on wet, well-drained, poor soil

(e.g. podsolized sand) on undulating to flat land, up to 900 m.

Vern. *Bélimbing bulat*, *M, buah piang*, Iban, *iba jantan*, Suluk, *kandis(-daham)*, Tidong, *kérapa-kérapa*, *pérapan macas*, Tutong Dusun, *kadazan, tabaus, tébarus*, Brunei.

2. *Sarcotheca griffithii* (PLANCH. ex HOOK. f.) HALL. f. Med. Rijksherb. Leiden 1 (1911) 2; KNUTH, Pfl. R. Heft 95 (1930) 425; VELDKAMP, Blumea 15 (1967) 531, f. 2e-f. — *Connaropsis griffithii* PLANCH. ex HOOK. f. Trans. Linn. Soc. 23 (1860) 166; EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 440; KURZ, J. As. Soc. Beng. 39, ii (1870) 69; KING, *ibid.* 62, ii (1893) 200; RIDL. Fl. Mal. Pen. 1 (1922) 332, fig.; KOCHUMMEN, Res. Pamphil. (For. Res. Inst. For. Dep. Mal.) 43 (1963) 6, 38. — *Dapania griffithii* KNUTH, Bot. Jahrb. 50 (1914) 234.

Tree, up to 42 m, 1 m σ (buttresses up to 4 m, 1 m out). Leaves trifoliolate, glabrous, pergamentaceous, often crisped when dry, venation rather inconspicuous, veinlets above finely reticulate; leaflets elliptic-oblong to -lanceolate, occasionally \pm obovate, tapering acuminate to caudate, base obtuse to acute, lateral ones 2-7 by ¾-2¾ cm, nerves 1-5 pairs; terminal leaflet 4-11½ by 1½-4 cm, nerves 4-6 pairs; petiole 5-12 by 1¼-2 mm, rachis 3-16 by ¾-1 mm; petiolules 3-7 by ¾-1¼ mm. Panicles shorter to \pm longer than the subtending leaf, stout, densely branched, ferruginous-puberulous, 2-10 cm; bracts small, ovate or linear, petioloid up to 2½ mm. Flowers pectinately clustered, subtended by minute bracts. Lower joint of pedicel 1-2½ mm, upper ½-1 mm. Calyx 2½-3 mm high, dark red, outside brown puberulous. Sepals 2-2¾ by 1½-2¼ mm, broadly ovate to -obovate, acute to emarginate. Petals \pm glossy, blackish red, whitish at base, 4½-8¼ by 2-2½ mm, obovate-lanceolate to -oblong, rounded to obtuse. Filaments in SF 4-4½ and 5-5½ mm, in LF 1½ and 2 mm; the longer sometimes without anther and club-shaped, red. Pistil in SF 1¼ mm, in LF 3-4 mm; puberulous; styles in SF ¾ mm, in LF 2-3 mm; ovary 1 by ¾-1 mm, subglobose. Fruit 18-32 by 10-23 mm, ellipsoid, glabrescent, greenish yellow at maturity, inside yellow, mesocarp glassy; rimae inconspicuous. Seeds 5-7½ by 2-4 mm; testa smooth; radicle 1¼ by ½ mm, cotyledons 5½ by 3½ mm.

Distr. Malesia: Sumatra, Malay Peninsula. Ecol. First storey of primary forest on flat to undulating sandy clay on dry to temporarily flooded land.

Vern. *As(s)am pupy* (or *pupoi*), *bélimbing (hutan)*, *kaju manau*, Lampong, *kukui*, Oesoe, *lain jénis, jinték-jinték, kupoyi, pandija*, N. Sumatra, *pokó pupoé, pupui, pupoi, pupoy*.

Notes. Leaves of seedlings are 1-foliolate. According to EDGEWORTH & HOOKER f. the leaves are irritable to the touch.

3. *Sarcotheca glomerula* VELDKAMP, Blumea 15 (1967) 532, f. 2i-j. — *Connaropsis macrophylla* KING, J. As. Soc. Beng. 62, ii (1893) 201, non *S. macrophylla* BL. 1850; RIDL. Fl. Mal. Pen.

1 (1922) 334. — *Dapania macrophylla* (KING) KNUTH, Bot. Jahrb. 50 (1914) 234. — *S. macrophylla* (non BL.) KNUTH, Pfl. R. Heft 95 (1930) 424, pro specim. malay., excl. specim. born. et syn. Miq.

Shrub or small tree, up to 9 m, 8 cm ø. Leaves unifoliate, (6-)11½–28 by (2¼-)4–9 cm, pergamentaceous to subcoriaceous, glabrous, oblong to lanceolate, margins ± parallel, contractedly acute to cuspidate, base broadly truncate to emarginate, not glaucous; nerves 8–13 pairs, branching off with wide angle (lower ± 65–90°), basals usually recurved; petiole 4–11½ by 1½–3 mm, petiolule 3–8 by 2–3 mm, glabrous. Panicles subterminal or axillary, 1-few together, ± erect, glabrous, stout, 4–19 cm; branches reduced, wart-like, up to 2½ mm. Flowers in few-flowered fascicles. Lower joint of pedicel ± absent, upper 1–3 by ¾ mm. Calyx 1½–2 mm high, glabrous outside except the ciliate margin. Sepals 1¼–1½ by 1¼–1½ mm, broadly ovate, rounded to obtuse. Petals 6–8½ by 1¾–2½ mm, lanceolate-oblong to obovate-lanceolate, rounded, red to crimson, tube lighter. Filaments in LF 1 and 1¾ mm, in SF 2½–3 and 3½–4 mm. Pistil sparsely puberulous, in SF 2 mm, in LF 4 mm; styles in SF ¾–1 mm, in LF 2½–3 mm; ovary 1 by ½–¾ mm, subglobose, pubescence mainly apically. Fruit 8–16 by 5–10 mm, ellipsoid to ovoid, acute to acuminate, recurved, glabrous, red; rimae inconspicuous, in the upper half, neither lighter nor papillose inside. Seeds 10 by 4 mm; testa transversely rugose; cotyledons 7¼ by 3 mm; radicle c. 1 mm long, stout.

Distr. *Malesia*: Malay Peninsula.

Ecol. Primary and secondary forest on flat to undulating land.

Vern. (*Asam*) (*sě-*)*tundok*, *bělimbing běsi*, *b. hutan*, *sěndok*, *tětındok*.

4. *Sarcotheca laxa* (RIDL.) KNUTH, Pfl. R. Heft 95 (1930) 422; VELDKAMP, Blumea 15 (1967) 533. — *Connaropsis laxa* RIDL. J. Str. Br. R. As. Soc. n. 75 (1917) 9; Fl. Mal. Pen. 1 (1922) 333. — *Connaropsis glabra* RIDL. J. Str. Br. R. As. Soc. n. 75 (1917) 9; Fl. Mal. Pen. 1 (1922) 332. — *S. glabra* KNUTH, Pfl. R. Heft 95 (1930) 422. — *Connaropsis sericea* RIDL. J. Fed. Mal. St. Mus. 10 (1920) 121; Fl. Mal. Pen. 1 (1922) 334. — *S. sericea* KNUTH, Pfl. R. Heft 95 (1930) 424. — *Connaropsis simplicifolia* RIDL. Fl. Mal. Pen. 1 (1922) 334. — *S. simplicifolia* KNUTH, Pfl. R. Heft 95 (1930) 424.

Shrub or tree, up to 23 m high, 45 cm ø. Branches glabrous or densely ferruginous-tomentose, glabrescent. Leaves unifoliate, (5-)8–23 by (2-)3–8½ cm, oblong to lanceolate, elliptic to obovate, acuminate to caudate, base broadly cuneate to truncate, above sparsely silky pubescent, mainly at base and on the midrib, beneath sometimes subglaucous, glabrous or pale to ferruginous pubescent; nerves 5–11 pairs, basals sometimes at 90°; petiole 5–25 by 1–3½ mm, petiolule 3–7 by 1–3 mm, glabrous or pubescent. Panicles 1–3 together, up to 30 cm, erect, pendent in fruit, glabrous, or finely pale puberulous, or ferruginous

velvety; branches patent to recurved in fruit, up to 14 mm, sometimes once forked near the top, subtended by a bract, a petioloid, or a small leaf. Lower and upper joints of pedicel subequal, ½–1 mm. Calyx 1¼–2 mm high, outside glabrous or very shortly pale puberulous or ferruginous puberulous. Sepals 1¼–2 by 1–2 mm, broadly ovate to spatulate, obtuse to emarginate. Petals 4–7 by 1¼–2 mm, obovate-lanceolate, rounded to emarginate, whitish to dark red. Filaments in SF 1–2½ and 2–3½ mm, in LF ½–1 and 1–1¾ mm. Pistil glabrous to appressed-strigose, in SF 1–1½ mm, in LF 3–4 mm long; styles in SF ½ mm, in LF 2–3 mm long; ovary ¾–1 by ½–¾ mm, ellipsoid. Fruit 6–13 by 4–9 mm, ovoid to ellipsoid, recurved, rounded to acuminate, glabrescent; rimae inconspicuous, closed not lighter nor glandular inside. Seeds 5–9 by 3–4 mm; testa smooth to transversely rugose; cotyledons 4–5 by 2–2½ mm, 3–4 times as long as the radicle measuring 1–1½ by ½ mm.

Distr. *Malesia*: Malay Peninsula, ? NE. Sumatra.

Ecol. Forest edges and swamps at low altitudes.

Note. A collection from Sumatra (Tenajan R., Upper Riouw, SOEPADMO 154) of which the leaves and also the fruit somewhat resemble the Bornean *S. rubrinervis*, but of which the panicle is like the Malayan *S. laxa* var. *sericea*, might be a new variety of *S. laxa*, but better material is needed to reach a definite conclusion whether this species occurs also in Sumatra.

a. var. *laxa*. VELDKAMP, Blumea 15 (1967) 535, f. 3a–b. — *S. laxa* (RIDL.) KNUTH. — *S. glabra* (RIDL.) KNUTH.

Nearly glabrous throughout. Nerves 5–9 pairs. Branches of panicle distinct, slender, 2–14 mm, near top once forked. Petals retuse to truncate, 4½–4¾ by 1¼–1½ mm, claw 0–½ mm, stout. Fruit 6–7 mm long. Seed 5 by 3 mm.

Distr. *Malesia*: NW. Malay Peninsula.

Vern. *Měšěkam*.

b. var. *sericea* (RIDL.) VELDKAMP, Blumea 15 (1967) 535, f. 3c–d. — *S. sericea* (RIDL.) KNUTH. — *S. simplicifolia* (RIDL.) KNUTH.

Leaves glabrous above, sparsely puberulous to glabrous beneath; nerves 8–11 pairs. Panicles densely, shortly puberulous; branches reduced, not forked, 1–6 mm. Petals obtuse to truncate, 5–7 by 1½–2 mm, claw slender, ¾–1 mm. Pistil mainly apically, sparsely strigose. Fruit 8–10 mm long. Seed 7½–8 by 3–4 mm.

Distr. *Malesia*: East coast of the Malay Peninsula.

Vern. *Bělimbing cherchek*, *b. hutan*, *gěrjij*, *měđang*, *sětundok*.

Uses. Roots for poulticing wounds externally (BURKILL & HANIFF SFN 17611).

c. var. *hirsuta* VELDKAMP, Blumea 15 (1967) 535, f. 3e–g.

Twigs ferruginous-tomentose, patchily glabrescent. Leaves beneath pale- to rusty-pubescent,

above sparsely and silky so, mainly at base and along the midrib; nerves 5–8 pairs. Panicle rusty-pubescent, branches reduced, stout, 1–3 mm. Petals obtuse, sometimes notched; claw $\frac{1}{2}$ –1 mm. Pistil densely appressed-strigose. Fruit 9–13 mm long. Seed 9 by 4 mm.

Distr. *Malesia*: Malay Peninsula (Johore).

Vern. *Bélimbing bési*, *b. burong*, *b. hutan*, *résak rambai daun*.

5. *Sarcotheca glauca* (HOOK. f.) HALL. f. Med. Rijksherb. Leiden 1 (1911) 2; KNUTH, Pfl. R. Heft 95 (1930) 421, f. 28f-n.; ANDERSON, Gard. Bull. Sing. 20 (1963) 162 (ecol.); VELDKAMP, Blumea 15 (1967) 535, f. 4a–c. — *Connaropsis glauca* HOOK. f. Trans. Linn. Soc. 23 (1860) 166. — Fig. 7a–h.

Shrub or tree, up to 21 m, 30 cm σ ; no buttresses. Leaves unifoliolate, $4\frac{1}{2}$ –11 by $1\frac{3}{4}$ – $4\frac{3}{4}$ cm (on sterile twigs larger, up to $13\frac{1}{2}$ by $6\frac{1}{2}$ cm), elliptic to oblong, acute to acuminate, base obtusely cuneate to emarginate, glabrous; beneath whitish green, dull, subglauous; nerves 5–7 pairs; petiole 10–27 by $\frac{1}{2}$ –1 mm, petiolule 3–6 by $\frac{3}{4}$ – $1\frac{1}{2}$ mm. Panicles 1–2 together, erect, $1\frac{1}{2}$ –13 cm, rusty-puberulous; branches up to 10 mm, usually many-flowered, rather closely placed. Pedicels pectinately clustered, lower joint 2–6 mm, upper $\frac{1}{4}$ – $\frac{1}{2}$ mm. Calyx rusty-puberulous outside, glabrescent in fruit except for margins and base, 2–3 mm high, crimson when dry. Sepals $1\frac{3}{4}$ –3 by $\frac{3}{4}$ – $1\frac{1}{4}$ mm, ovate to oblong. Petals red, darker at apex, $3\frac{3}{4}$ –6 by 1–2 mm, oblong to lanceolate, sometimes obovate. Filaments in SF 2– $2\frac{3}{4}$ and $2\frac{1}{2}$ – $3\frac{2}{3}$ mm, in LF $1\frac{1}{4}$ – $1\frac{1}{2}$ and $1\frac{1}{2}$ – $1\frac{3}{4}$ mm. Pistil in SF 1– $1\frac{1}{2}$ mm, in LF $3\frac{1}{4}$ – $3\frac{1}{2}$ mm, appressed rusty-strigose; styles in SF $\frac{1}{2}$ – $\frac{3}{4}$ mm, in LF $2\frac{1}{2}$ –3 mm; ovary $\frac{1}{2}$ –1 by $\frac{1}{2}$ – $\frac{2}{3}$ mm, ellipsoid. Fruit bright pink to dark red, 8–12 by 5–11 mm, subglobose to ellipsoid with obtuse to rounded apex, glabrescent; rimae open and conspicuous, inside lighter and papillose. Seeds 6 by $3\frac{1}{2}$ mm; testa shiny, smooth; cotyledons 5 by $2\frac{1}{2}$ mm, elliptic, radicle 1 mm.

Distr. *Malesia*: NW. Borneo (Sarawak, Brunei, Sabah).

Ecol. Rare to very rare in undisturbed forest, heath forest on well-drained humus podsols, ground-water podsols, peaty 'Hochmoors' and sand covered clay on terraces and sand stone. Occasionally in secondary forest (BRÜNING).

Vern. *Arémajuh*, Dajak, *asam daham*, *barus*, *bélimbing*, *b. daham*, *gitan gizu*, *kandis daham*, Brunei, *médang*, *piang*, Iban, *rangkas-rangkas*, Dusun Kinabatangan, *ségot*, Baju, *tampusi*, *temposi(s)*, Kedayan.

The vernacular epithet *daham* might point at the use of this plant against coughing.

Notes. This species is closely allied to *S. rubrinervis* HALL. f. and differs in having a less puberulous, when dry dark red to crimson calyx, a short compact panicle with very reduced primary branches, while the way of branching in the cyme is indistinct. The pistil in LF is $3\frac{1}{4}$ – $3\frac{1}{2}$ mm long, the filaments in SF 2– $2\frac{3}{4}$ and $2\frac{1}{2}$ – $3\frac{2}{3}$ mm. The

cotyledons are lanceolate.

6. *Sarcotheca monophylla* (PLANCH. ex HOOK. f.) HALL. f. Med. Rijksherb. Leiden 1 (1911) 2; KNUTH, Pfl. R. Heft 95 (1930) 422, f. 27; VELDKAMP, Blumea 15 (1967) 536, f. 2g–h. — *Connaropsis monophylla* PLANCH. ex HOOK. f. Trans. Linn. Soc. 23 (1860) 166; EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 440; KING, J. As. Soc. Beng. 62, ii (1893) 200; RIDL. Fl. Mal. Pen. 1 (1922) 332, f. 34. — *Dapania monophylla* KNUTH, Bot. Jahrb. 50 (1914) 648.

Shrub or tree, up to 30 m, 38 cm σ , bole occasionally buttressed and crooked. Leaves unifoliolate, 4–10 by $1\frac{1}{2}$ – $3\frac{1}{4}$ (–7) cm, elliptic to oblong, rarely suborbicular, acuminate to cuspidate, base rounded to cuneate, glabrous, dark when dry, subglauous beneath; nerves 5–7 pairs; petiole 6–31 by $\frac{1}{2}$ – $\frac{3}{4}$ mm, petiolule 3 by $\frac{2}{3}$ –1 mm. Panicles 1–2 together, erect, 1– $9\frac{1}{2}$ cm, rusty-puberulous, \pm dense; branches up to 4 mm long. Pedicels pectinately clustered, upper joint up to $\frac{1}{3}$ mm, lower 1–2 mm. Calyx $1\frac{3}{4}$ –2 mm high, outside rusty-puberulous, apically less so, reddish-brown when dry. Sepals $1\frac{1}{2}$ –2 by 1– $1\frac{1}{2}$ mm, ovate to rectangular, acute to emarginate. Petals deep red, 3–5 by $\frac{3}{4}$ – $1\frac{1}{2}$ mm, lanceolate, emarginate. Filaments in LF 1– $1\frac{1}{4}$ and $1\frac{1}{4}$ – $1\frac{1}{2}$ mm, in SF $1\frac{1}{2}$ and 2 mm. Pistil densely appressed rusty-strigose, in LF 3– $3\frac{1}{2}$, in SF 1 mm; styles in LF 2– $2\frac{1}{2}$ mm, in SF $\frac{1}{2}$ mm long; ovary $\frac{1}{2}$ –1 by $\frac{1}{2}$ – $\frac{2}{3}$ mm, ellipsoid. Fruit up to 13 by 13 mm, pale to bright red, subglobose to ovoid, rounded to acute; rimae conspicuous, open, lighter and papillose inside. Seeds $7\frac{1}{2}$ by 3 mm; testa smooth; cotyledons 4 by $2\frac{1}{4}$ mm, radicle $1\frac{1}{4}$ by $\frac{1}{3}$ mm.

Distr. *Malesia*: W. and Central Malay Peninsula.

Ecol. Secondary forest, open jungle on flat to undulating land on rich soil at low altitude.

Vern. (*Asam*) *pupoy*, *bélimbing akar*, *b. bésih*, *b. bulat*, *b. burong*, *b. hutan*, *b. kérés*, *b. k(è)ra*, *b. pénjuru*, *b. pipit (pépít, pipét)*, *bibit* (Sakai), *kúlat pipit*, *sétundok*.

Note. The type (CUMING 2324) came from Malaya, not from the Philippines as KNUTH supposed.

7. *Sarcotheca celebica* VELDKAMP, Blumea 15 (1967) 537, f. 4f–m.

Shrub or tree, up to 35 m, 17 cm σ . Leaves unifoliolate, ($3\frac{1}{2}$ –)6– $13\frac{1}{2}$ by 2–5 cm, elliptic to lanceolate, acute-cuneate, base cuneate to \pm truncate, above with prominent, rather coarse venation, glabrous, subglauous, sparsely puberulous; nerves 5–6 pairs; petiole 6–21 by $\frac{1}{2}$ –1 mm, petiolule 2–5 by $\frac{1}{2}$ – $1\frac{1}{4}$ mm, sparsely strigose. Panicles 1–2 together, 1–7 cm, erect, slender, rusty-puberulous; branches up to 2 (–7) mm, distant. Pedicels few, close together with equal upper and lower joints, up to $1\frac{1}{2}$ mm. Calyx 2– $2\frac{1}{4}$ mm high, rusty-puberulous outside, reddish-brown when dry. Sepals $1\frac{1}{2}$ –2 by 1– $1\frac{1}{2}$ mm, ovate to rectangular, acute to truncate. Petals red, 4– $4\frac{1}{4}$ by 1– $1\frac{1}{2}$ mm, lanceolate, rounded to

retuse. *Filaments* in SF 1-2 and 2-2¼ mm, in LF ¾ and 1 mm. *Pistil* appressed-strigose, in SF 1 mm, in LF 2½ mm; styles in SF ¼ mm, in LF 2 mm; ovary ½-¾ by ½-¾ mm, subglobose to ellipsoid. *Fruit* 8-13 by 6-9 mm, ellipsoid rounded to acutish, glabrescent, red; rimae open from the top to below the middle, ± conspicuously, lighter and papillose inside. *Seeds* 4-5 by 3 mm; testa slightly transversely rugose to ± smooth; cotyledons 3 by 2¾ mm, radicle 1 mm.

Distr. *Malesia*: Central Celebes (Malili) and Kabaena I. (S of SE. Celebes).

Ecol. Rather open country, primary forest on stony to clayish, flat to undulating land at low altitude.

Vern. *Ko(e)ngilu ((mo-)puté)*, To Bela, To Padoë, To També.

Note. This new species is best distinguished by its lax, narrow panicles with thin rachis and the coarser and more prominent venation on the upper side of the leaf as compared with its nearest allies *S. glauca* and *S. monophylla*.

8. *Sarcotheca ferruginea* MERR. Pap. Mich. Ac. Sc. 19 (1933) 160, fig.; VELDKAMP, *Blumea* 15 (1967) 538, f. 3h-i.

Tree. Twigs velvety rusty-pubescent, later patchily glabrescent and dark. *Leaves* shiny golden pubescent when young, upper surface soon glabrous or with a few appressed, pale hairs at the basis and along the midrib, beneath densely ferrugineous-pubescent, not glaucous, (3½-)5-11¼ by (1-)2-3½ cm, oblong to oblanceolate, acute to caudate, base broadly cuneate to rounded, margins usually paler; nerves 5-7 pairs; petiole 4-6½ by ½-1 mm, petiolule 2-4 by ¾-1½ mm, rusty-velvety, glabrescent. *Panicles* 1-2 together, short, slender, up to 7½ cm, velvety; branches distant, ½-2 mm. Pedicels with unequal lower joint, one per cyme elongated, 3-4 mm, others c. 1 mm; upper joint ½-1 mm. *Calyx* 2-3¾ mm high, rusty-puberulous outside. *Sepals* 1¾-3½ by ½-1 mm, ovate-lanceolate, acute. *Petals* red, 4-6 by 1½-2 mm, obovate-elliptic to lanceolate, rounded to obtuse. *Filaments* in LF 1 and 1½ mm. *Pistil* in LF 3-3½ mm, appressed-strigose; styles in LF 2-2½ mm; ovary 1 by 1 mm, subglobose. *Fruit* 7-14 by 6-12 mm, ovoid to subglobose, rounded, somewhat shiny, reddish; rimae inconspicuous, not glandular or lighter inside. *Seeds* 7 by 4½ mm; testa transversely rugose; cotyledons 5 by 3 mm, radicle 1 mm.

Distr. *Malesia*: N. Sumatra (West and West Coast Res.), apparently local and rare.

Vern. *Kaju kandis*.

Note. I have not seen the short-styled form.

9. *Sarcotheca rubrinervis* HALL. f. Beih. Bot. Centralbl. 34, ii (1917) 29; KNUTH, Pfl. R. Heft 95 (1930) 425; VELDKAMP, *Blumea* 15 (1967) 539, f. 4d-e. — *S. oblongifolia* MERR. Univ. Cal. Publ. Bot. 15 (1929) 111; KNUTH, Pfl. R. Heft 95 (1930) 421.

Shrub or tree, up to 19 m, bole up to 10 m, 30 cm ø. *Leaves* unifoliolate, 5-18½ by 1¾-7 cm,

oblong to lanceolate, glabrous, acute to caudate, base obtuse to rounded, beneath not or slightly glaucous; nerves 4-11 pairs, often with reddish tinge; petiole 6-20 by 1-2 mm, petiolule 2-4 by 1-2 mm. *Panicles* 1-2 together, elongated, lax, pendulous, rusty-puberulous, 7-38½ cm; branches elongated, slender, patent, ± monochasially branched, up to 8(-21) mm. Pedicels with unequal lower joint, usually one per cyme elongated to 5 mm, others up to 3 mm; upper joint ¼-1 mm. *Calyx* 2-3 mm high, rusty-puberulous, at least at base. *Sepals* 1½-2¾ by 1-1½ mm, ovate to lanceolate, acute to emarginate. *Petals* 3¾-5½ by 1-1½ mm, lanceolate, rounded to emarginate, pale red to red, occasionally white, apex usually darker, claw ⅔-1 mm. *Filaments* in SF 1½-2 and 2½-3 mm, in LF ½-⅔ and 1-1¼ mm long. *Pistil* in SF 1-1¼ mm, in LF 2¼-2⅔ mm; styles in SF ½ mm, in LF 1¾-1⅞ mm; appressed-puberulous; ovary ½-¾ by ½-⅔ mm, subglobose, densely appressed-strigose. *Fruit* 6-10 by 5-10 mm, subglobose, rounded, glabrescent, glaucous to glossy, pink to bright red; rimae not always conspicuous, lighter and papillose inside. *Seeds* up to 6¾ by 5 mm; testa smooth to ± transversely rugose; cotyledons elliptic, 4¾ by 1½ mm, radicle 1 by ⅞ mm.

Distr. *Malesia*: E. Borneo (from Tawao to Balikpapan).

Ecol. Primary and secondary forest near rivers on loam, flat to undulating land.

Vern. *Asém-asém*, Dusun Kinabatangan, *iba talon*, Bajau, *ira prumpuan*, Suluk, *kajo badjuk*, Kajam-Dajak, *kandis daham*, Brunei, *lampyos*, Dusun Penompang, *pinggoh*, *pinguh*, Klabakan, *pingo*, Tidon, *ténggoh*, Kutai.

Note. Sometimes difficult to distinguish from *S. glauca* (see there).

10. *Sarcotheca ochracea* HALL. f. Beih. Bot. Centralbl. 34, ii (1917) 28; KNUTH, Pfl. R. Heft 95 (1930) 424; VELDKAMP, *Blumea* 15 (1967) 541, f. 5c-e.

Treelet, up to 9 m, 10 cm ø. Twigs velvety, glabrescent. *Leaves* unifoliolate, 7½-23½ by 3½-10¼ cm, elliptic to oblong, abruptly acuminate to cuspidate, base obtuse to truncate, above glabrous, beneath rusty-pubescent to -velvety, sometimes subglaucous; nerves 6-11 pairs; petiole 5-24 by 1½-3 mm, petiolule 3-7 by 1½-3 mm. *Panicles* 1-2 together, 7-70 cm, erect to pendulous, rusty-velvety, compact to elongated. Branches very short to elongated, often distant, pectinately branched, many-flowered, patent to recurved, up to 30 mm long, rusty-velvety. Lower joint of pedicel 4-8 mm, upper ½-1 mm. *Calyx* (2¼-)3-3½ mm high, rusty-puberulous outside. *Sepals* suborbicular to obovate, rounded to retuse, 2¼-3 by 1½-3 mm. *Petals* crimson, apically darker, (4¼-)6-8 by (1-)1½-1¾ mm, obovate-lanceolate to lanceolate, obtuse to rounded. *Filaments* in SF 2½ and 3-3¾ mm, in LF 1½-2 and 2-2½ mm. *Pistil* densely rusty-strigose, in SF 1¾-2, in LF 3-4 mm; styles red, in SF ½-¾ mm, in LF 2-2½ mm long; ovary 1-1½ by 1 mm,

subglobose. *Fruit* 8–15 by 6–15 mm, subglobose to oblong, rounded, glabrescent, bright red; rimae conspicuous, lighter and/or papillose inside. *Seed* 1–2 per fruit, 5¼–7 by 3¼–4½ mm; testa transversely rugose. Mature embryo not seen.

Distr. *Malesia*: Borneo (Sarawak: Bintulu).

Ecol. Along streams in forest on clay.

Vern. *Ikor mata*, Iban, *pechi mata*.

11. *Sarcotheca macrophylla* BLUME, Mus. Bot. Lugd. Bat. 1 (1850) 242; MIQ. Fl. Arch. Ind. III. (1870) 70, t. 30; BAILLON, Adansonia 10 (1873) 364; Hist. Pl. 5 (1874) 26, 47; HALL. f. Beih. Bot. Centralbl. 34, ii (1917) 29; KNUTH, Pfl. R. Heft 95 (1930) 424, *pro spec. Born.*; VELDKAMP, Blumea 15 (1967) 541, f. 5a–b. — *Roucheria macrophylla* MIQ. Fl. Ind. Bat. 1, 2 (1858) 136; Suppl. 1 (1860) 162.

Shrub or tree, up to 15 m, 10 cm ø. *Leaves* unifoliolate, (5–)16–28 by 6–10 cm, oblong to oblanceolate, margins ± parallel, abruptly acuminate to cuspidate, base truncate to emarginate, subcoriaceous, above glabrous, beneath puberulous on the veins, sometimes subglaucous; nerves 6–13 pairs; petiole 5–12(–25) by 1½–3 mm, petiolule 3–9 by 1–3 mm. *Panicles* 1–4 together, slender, lax, 12–85 cm, pendulous, brown-puberulous; branches elongated, 6–25(–50) mm, often flattened. Lower joint of pedicel up to 2 mm, upper ¼–1 mm. *Calyx* 1½–3 mm high, ferruginous-puberulous outside. *Sepals* 1¼–2½ by 1–1¾ mm, obovate to ovate, rounded to obtuse. *Petals* dark red, 3¼–5 by 1–1¾ mm, obovate-oblong to lanceolate, obtuse to emarginate, claw ¼–½ mm. *Filaments* in SF 1–2 and 1¾–3 mm, in LF ¾–1¼ mm and 1½–1¾ mm. *Pistil* appressed-strigose, in LF 2–3 mm, in SF 1¼–1¾ mm; styles in SF ¼–¾ mm, in LF 1–2 mm; ovary ½–1 by ½–¾ mm, subglobose to ellipsoid. *Fruit* 6–11 by 5–8 mm, subglobose, rounded, glabrescent, shiny, dark red; rimae inside lighter, papillose, conspicuous. *Seeds* up to 9 by 4 mm; testa transversely rugose; cotyledons 4 by 2½ mm, radicle 1 mm.

Distr. *Malesia*: Borneo (Indonesian Borneo; Sarawak: Marop).

Ecol. Primary and secondary forest on sand.

Vern. *Bëlimbing manik*, Bakumpai-Dajak, *kaju kim*, *krumbai merah*, *mim*, *pengu*, Dusun, *ram(b)-ajan*.

Notes. BLUME cited this species also to occur in Sumatra, but this seems to be erroneous.

It has been confused with *Connaropsis macrophylla* KING = *S. glomerula*.

Dubious

Sarcotheca philippica (F.-VILL.) HALL. f. Med. Rijksherb. Leiden 1 (1910) 2. — *Connaropsis philippica* F.-VILL. Novis. App. (1880) 33; MERR. Sp. Blanc. (1918) 19, 195; KNUTH, Pfl. R. Heft 95 (1930) 417.

Subscandent. Innovations dark purple. *Leaves* imparipinnate, 1–4-jugate; leaflets 6–10 by 2–3 cm, oblique-ovate, acute, subcoriaceous, pubescent when young, later glabrous. *Panicle* axillary and terminal, shorter than the subtending leaf. *Sepals* 2–4 mm long. *Petals* twice as long, connate at base when young, later free. *Filaments* alternately shorter (*'alterna breviora'*), often without anthers; styles 5, erect, adpressed; stigmas oblong, apiculate; ovary ovate, pilose, 5-locular, ovules 2 per cell. *Fruit* 2–3 by ½–1 cm, orange-red, pilose, 5-angular, 5-locular. *Seed* 1 per cell, ovate, with white aril (translated from type description).

Distr. *Malesia*: Philippines (Bugney near Igarás, Iloilo).

Vern. *Balabangquillin*, *malabangquillin*.

Note. MERRILL noted that he has seen no representative of this genus in the Philippines and none is known to me. Although he is very critical of F.-VILLAR's work (*cf. l.c.* 14–18), he thinks it to be '... apparently a true ... *Sarcotheca* ...'. KNUTH referred it to *Averrhoa carambola* L., with which the description agrees for the greater part, differing, however, by the subscandent habit, the subcoriaceous leaflets, the 2 ovules per cell, and the rather small, orange-red, pilose fruit. F.-VILLAR stated he has seen the plant alive, so presumably his remarks pertaining to habit and fruit are correct; the more so as in his work this species follows the description of *Averrhoa carambola*. As long as no representative is found the status of this species will remain in doubt.

Excluded

Connaropsis rubescens RIDL. J. Bot. 62 (1924) 295 = *Rourea minor* (GAERTN.) LEENHOUTS, Blumea 12 (1963) 20 (*Connaraceae*).

Sarcotheca paniculata RIDL. Trans. Linn. Soc. III, 2 (1893) 282 = *Rourea minor* (GAERTN.) LEENHOUTS, Fl. Mal. I, 5 (1958) 515a (*Connaraceae*).

Sarcotheca pinnata MERR. J. Str. Br. R. As. Soc. n. 86 (1922) 314 = *Rourea pinnata* (MERR.) VELDKAMP, Blumea 15 (1967) 543 (*Connaraceae*).

Sarcotheca varians (CRAIB) KNUTH, Pfl. R. Heft 95 (1930) 425. — *Connaropsis varians* CRAIB, Kew Bull. (1926) 158 = *Rourea minor* (GAERTN.) LEENHOUTS, Fl. Mal. I, 5 (1958) 515b (*Connaraceae*).

5. AVERRHOA

LINNÉ, Gen. Pl. ed. 5 (1754) 196; Sp. Pl. (1753) 428; ENDL. Gen. Pl. (1839) 1173, *incl. sect. Bilimbi et sect. Carambola* ENDL.; KNUTH, Pfl. R. Heft 95 (1930) 417; BACK. & BAKH. f. Fl. Java 1 (1963) 247. — *Averrhoaceae* HUTCHINSON, Fam. Fl. Pl. ed. 2, 1 (1959) 356. — Fig. 9.

Evergreen shrubs or trees. Innovations pubescent, glabrescent. *Leaves* spirally arranged to terminally clustered, estipulate, imparipinnate, herbaceous; leaflets entire, subopposite, sessile, terminal largest. *Panicles* axillary or cauliflorous. *Flowers* in scattered, stalked, loose cymes, heterodi- or -tristylous. Bracts small, caducous. *Sepals* quincuncial or paratact, shortly connate at base. *Petals* contort or paratact, free or coherent above the claw, creamy to dark red with white markings. *Ovary* appressed-strigose; ovules (2-)3-7 per cell, pendulous. *Fruit* large, yellowish green and semitransparent *in vivo*, red when dry; rimae small, reduced to absent (?). *Seeds* elliptic, flattened; aril present in one species, attached to the entire adaxial raphe, bilabiate, enveloping the seed, fleshy, with oily drops; endosperm present; cotyledons 6-8 times as long as the oblique and stout radicle.

Distr. 2 spp., probably native in *Malesia*, cultivated pantropically at low altitude for their fruit trees, often escaping.

It is often assumed that *Averrhoa* is possibly of American origin. Both species are mentioned in pre-Linnean literature always from Indo-Malesia (BAUHIN, 1623, being the oldest). The closest relatives are Malesian-Malagasian. Though I can not forward proof, for or against, an Indo-Malesian origin seems most probable.

Ecol. Irritability of the leaves has been noted as early as 1785 by BRUCE (Phil. Trans. 356), while DARWIN made a detailed study of it (*A. bilimbi* L.) in his 'The Movements of Plants' (1880) 330, 447.

Uses. Mainly for the fruit; see under the species.

Syst. The two species are remarkably different in important characters which are almost of the same value as those separating the allied genera *Sarcotheca* and *Dapania* as appears from the key to the species. One is tempted to raise them to the status of sections, as ENDLICHER proposed (Gen. Pl. 1839, 1173). At the same time this shows the intimate relationship of the three genera. This defeats HUTCHINSON's rigorous attempt to assign *Averrhoa* to a separate family *Averrhoaceae*, even accommodating it to another order (Fam. Fl. Pl. ed. 2, 1, 1959, 356). The reason for this rests on the supposed presence of a disk and horizontal ovules; the first I can not find and the ovules are pendulous.

KEY TO THE SPECIES

- 1. Leaves 3-6-jugate. Panicles axillary, rarely some ramiflorous. Petals up to 8 mm, minutely puberulous inside, coherent above the claw. Shorter stamens without anther. Ovules 3-5 per cell. Fruit stellate in σ . Seed arillate. 1. *A. carambola*
- 1. Leaves 7-19-jugate. Panicles cauliflorous, rarely some axillary. Petals 10-20 mm, glabrous inside, not coherent above the claw. All stamens antheriferous. Ovules 4-7 per cell. Fruit terete, slightly lobed. Seed exarillate. 2. *A. bilimbi*

1. *Averrhoa carambola* LINNÉ, Sp. Pl. (1753) 428; CAV. Diss. 7 (1789) 374, f. 220; DC. Prod. 1 (1824) 689; BL. Bijdr. (1825) 242; W. & A. Prod. (1834) 141; BLANCO, Fl. Filip. (1837) 391; MIQ. Fl. Ind. Bat. 1, 1 (1859) 133; EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 439; PROGEL, Fl. Bras. 12, 2 (1877) 520, incl. var. *angustisepala*; TRIMEN, J. Linn. Soc. Bot. 24 (1887) 129 (typification); NINGRAT, Teysmannia 3 (1892) 754; K. & V. Bijdr. 9 (1903) 106; BACK., Fl. Bat. (1907) 229; KOORD. Atlas 4 (1918) 603; MERR. Sp. Blanc. (1918) 194; RIDL. Fl. Mal. Pen. 1 (1922) 332; HEYNE, Nutt. Pl. (1927) 853; KNUTH, Pfl. R. Heft 95 (1930) 417; OCHSE & BAKH. Vrucht. (1931) 91, tab. col.; BURK. Dict. (1935) 271; QUIS. Med. Pl. Philip. (1951) 439; BACK. & BAKH. f. Fl. Java 1 (1963) 247; VELDK., Fl. Thail. 2 (1970) 21. — *A. acutangula* STOKES, Bot. Mat. Med. 2 (1812) 543. — *A. pentandra* BLANCO, Fl. Filip. (1837) 392. — *Tamara tonga* RHEEDE, Hort. Mal. 3 (1682) 51, f. 43, 44. — *Prunum*

stellatum RUMPH. Herb. Amb. 1 (1750) 115, f. 35. — Fig. 9.

Tree, up to 14 m by 30 cm. Branches often drooping. Innovations yellowish to reddish pubescent, glabrescent. *Leaves* 3-6-jugate, not crowded terminally; rachis up to 20 cm; leaflets up to 10 by 4 cm, variable in shape, lowest not reflexed, acute to acuminate, glaucous beneath; nerves 4-10 pairs. *Panicles* axillary, rarely ramiflorous, 1-few together, ascending, up to 7 cm long. *Flowers* heterodistylous (LF, MF), said to be scentless, melliferous. Pedicels 3-6 mm, articulated 1-2 mm below the flower. *Sepals* up to 4 by 2 mm, bright red, yellowish brown with pale margins when dry, obovate-oblong to triangular, acute to obliquely emarginate, subglabrous. *Petals* up to 8 by 2 mm, obovate to lanceolate, coherent, claw c. 1½ mm, glabrous, but inside with minute septate-glandular hairs. Shorter stamens anantheriferous, filaments subulate with often swollen base, up to 1¼ mm, longer ones in LF

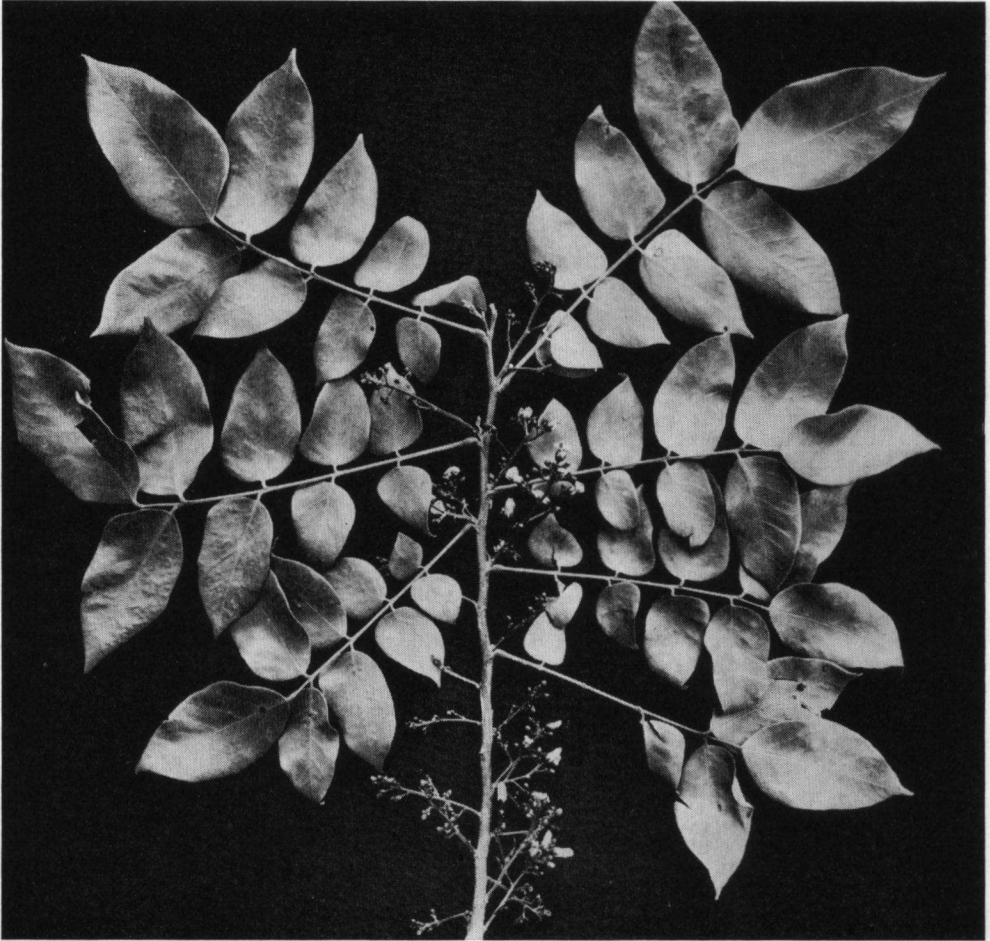


Fig. 9. *Averrhoa carambola* L. (Courtesy T. B. WORTHINGTON).

up to 3 mm, in MF up to 4½ mm. Ovary elliptic, up to 2½ mm long, appressed-puberulous, mainly on the ribs; styles in LF up to 2 mm, in MF ½ mm; ovules 3–5 per cell. Fruit up to 12½ by 6 cm, ovoid to ellipsoid, stellate in ♂, lobed at both ends, apically with minute rimae on the ribs. Seeds up to 10, 12 by 5 mm; aril fleshy, bilabiate, enclosing the seed, lobed at base; cotyledons up to 6½ by 3½ mm, elliptic.

Distr. Native country unknown, possibly Central and East Java, but escaping freely, often a relict of former cultivation.

Ecol. At low altitude, up to 1000 m, along rivers, in ravines, primary and secondary forest.

Dispersal. Fruits eaten by bats, mice and *Calotes* spp. (Agamidae). Cf. NINGRAT (1892).

Vern. Variations on *bélimbing*. Sumatra: *asom djobing*, Bat., *balimbing manis*, *b. segi*, *b. sajur*, *b. batu*, *kémbola*, *b. bési*, *b. kérés*, Mal., *kembang bua*, *kaping*, Palemb., *b. manih*; Java:

balimbing amis, *tjalingtjing amis*, S., *b. légi*, *b. lènger*, *b. lingir*, *b. manes*, Mad., *libi melai*, Sawu; Borneo: *b. pèségi*, *b. pénjura*, Kuching, *b. amamas*, Sabah; Celebes: *lumpias mamis*, Bentenan, *rumpiasa*, Bantik, *lompiat morominit*, Mongodow, *dumpias tariis*, *lopias emé*, Tonsawang, *lumpias tombal*, Tontembuan, Tonsawang, *lèmbètuè lombiata*, Goronta, *lombituko gula*, Buol, *takulè*, Barèe, *bainang sulapa*, Makass., *kulirang taning*, *pulirang taning*, N. Salajar, *baknil pasaki*; Sepa, S. Ceram, *ifèl emroro*, Masareta, Buru, *malibi tofuo*, Weda, S. Halm., *balibi totofuko*, Galelas, Tobelor, *totofuko*, *t. lèmo*, Ternate, *tufuo*, Tidore; Philip.: *dalgán*, Ilk., *dalihan*, *galurán*, Ibn., *galangan*, P. Bis., *garáhan*, Bis., *malimbin*, S. L. Bis., *sirinate*, Ting.; E. New Guinea: *ibeid*, Tehid, *painayangara*, Tumbunke.

Uses. The fruit is eaten fresh or pickled. Leaves and fruits are said to be good against fevers, aptha, angina, chickenpox, ringworm, headaches,

scurvy, dysentery, piles and affections of skin and eyes; they excite the appetite, but may cause vomiting. It is antiphlogistic and a sialogogue. The fruit removes stains from laundry, hands and weapons. See NINGRAT (1893), KOORDERS & VALETON (1903), HEYNE (1927), OCHSE (1931), BURKILL (1935), and QUISUMBING (1951).

Phytochem. DE PERALTA (Philip. Agr. 17, 1928, 334) has shown the presence of HCN in leaves, roots and stems; BATE-SMITH (J. Linn. Soc. Lond. Bot. 58, 1962, 134) the presence of cyanidin, p-cumaric acid and traces of sinapic acid, and (*ibid.* 55, 1957, 687) tannin, leucoanthocyanin and leucocyanidin.

Syst. This species is widely cultivated for a long time and many cultivars are extant (*cf.* NINGRAT, 1893), differing in taste and size of the fruit. *A. f. acida* and *f. dulcis* have been described by KOORDERS & VALETON, and material bearing these names has been examined, but no characters could be found to distinguish them. PROGEL's *var. angustispala* from S. America seems not to warrant distinction, as the shape and pubescence of the sepals in Malesia is very variable. This variety has possibly been the reason for an assumed American origin of the genus time and again found in literature.

2. *Avverrhoa bilimbi* LINNÉ, Sp. Pl. (1753) 428; CAV. DISS. 7 (1789) 373, f. 219; DC. Prod. 1 (1824) 689; ROXB. Fl. Ind. ed. Carey 2 (1832) 451; W. & A. Prod. (1834) 142; BLANCO, Fl. Filip. (1837) 391; ENDL. Gen. Pl. (1839) 1173; MIQ. Fl. Ind. Bat. 1, 1 (1859) 139; EDGEW. & HOOK. f. Fl. Br. Ind. 1 (1874) 439; PROGEL, Fl. Bras. 12, 2 (1877) 520; TRIMEN, J. Linn. Soc. Bot. 24 (1887) 129 (typification); K. & V. Bijdr. 9 (1903) 111; KOORD. Atlas 4 (1918) 601, 602; MERR. Sp. Blanc. (1918) 195; En. Born. (1921) 311; RIDL. Fl. Mal. Pen. 1 (1922) 331; HEYNE, Nutt. Pl. (1927) 852; KNUTH, Pfl. R. Heft 95 (1930) 418, *incl. f. papuana* KNUTH; OCHSE & BAKH. Ind. Groenten (1931) 546; BENTHALL, Trees of Calcutta (1933) 70; BURK. Dict. (1935) 270; SORGDRAGER, Pharm. Tijd. 1 (1941) repr. 4 pp. (anat., uses); QUIS. Med. Pl. Philip. (1951) 438; BACK. & BAKH. f. Fl. Java 1 (1963) 247; VELDK., Fl. Thail. 2 (1970) 22. — *A. obtusangula* STOKES, Bot. Mat. Med. 2 (1812) 542. — *Bilimbi* RHEEDE, Hort. Mal. 3 (1682) 55, f. 45, 46. — *Blimbingun teres*, *Blimbing bula* RUMPH. Herb. Amb. 1 (1750) 118.

Shrub or tree, up to 15 m, 30 cm ø. Branches erect. Innovations and green parts long-persisting pale yellowish to rusty velvety. Leaves 7–19-jugate, usually terminally tufted; rachis 17–57 cm; leaflets up to 12 by 4 cm, variable in pubescence, size and shape, lower reflexed, acute to acuminate, not glaucous beneath; nerves 6–14 pairs. Panicles cauliflorous on tubercles, nearly down to ground-level, fasciculate and pendulous up to 20 cm, rarely axillary, solitary and erect. Flowers heterotristylous, usually MF. Pedicels 4–17 mm, articulated near or below the middle. Sepals 3–8 by 1½–3 mm, yellowish red to purplish, sparsely

appressed-puberulous outside mainly at base, inside glabrous or subglabrous, elliptic to lanceolate or spatulate, acute to rounded. Petals free, 10–20 by 3–4 mm, lanceolate-spatulate, inside glabrous, claw 3–6 mm. Stamens all fertile, in SF 3½–4 and 7 mm, in MF 2–5 and 9–12 mm, in LF 5 and 7½ mm, bases not thickened. Ovary densely appressed pale strigose and with short, septate-glandular hairs, in SF 2–2½ by 1 mm, in MF 3–4 by 1–1½ mm, in LF 4 by 1 mm, elliptic; styles in SF ½–¾ mm, in MF 2–4 mm, in LF 6½–9 mm; ovules 4–7 per cell. Fruit terete-obtusangular, up to 10 by 5 cm, elliptic to obovate, obtuse, rimae present (?), base tapering. Seeds up to 14, 6–7 by 4–6 mm, exarillate; cotyledons 4–6 by 3½–5 mm, orbicular, cordate.

Distr. Native country unknown, widely cultivated, escaping freely, often a relict of former cultivation, for instance in East Malesia.

Ecol. Along rivers, lowland primary and secondary forest.

Vern. *Bëlimbing* and many variations; Sumatra: *limëng*, *sëlimëng*, *thlimëng*, Atjeh, *asom*, Batak; Mal. Pen.: *b. asam*, *b. bësi*, *b. botol*, *b. buloh*, *b. këris*, *b. masam*; Borneo: *bëliwit*, Dajak Busang, *iba*, Bajan, *blimbing puchung*, Kedayan; Java: *tjalingtjing*, *t. wulët*, S; *limbi*, Bima; *libi*, *Sawu*; *bëlerang*, S; *lumpias*, Bentenan, Ponosakan, Tombulu, Tontembuan, *rumpëasa dureng*, Bantik, *lompiat litod*, Mongodow, *dumpias*, *d. tuwama*, Tonsawang, *wuli(n)dan*, Tontembuan, *lëmbëtüë*, Gorontalo, *lombituko*, Buol, *sanggulëra*, Parigi, *tangkurera*, Barëë, *batnang*, Makassar, *kulirang*, *pulirang*, N. Salajar, *tjalënë*, Bugin.; *niniloe daë lok*, Roti, *kerbol*, Timor, *baknil*, Kai, *ahurëla*, Atamano, W. Ceram, *haurëla*, Amahai, S. Ceram, *taulela*, Nuauulu, *takurëla*, Ambon, *tahurëla*, Sapurua, Ulias, *taprera*, Kajeli, Buru, *ifël milo*, Masarete, Buru, *malibi*, Weda, S. Halm., *balibi*, N. Halm., Ternate; Philip.: *iba*, Tag., Sul., P. Bis., *ibag*, Mbo., *kalamids*, *kalanuas*, *kamids*, *kolonanas*, *kolonauas*, Tag., *kalingua*, Bis., *kiling-iba*, Bik., *ibe*, Yak., *piäs*, Ilk., *puis*, Ig.; New Guinea: *miri-miri*, Kapur, *utëké*, Mimika & Atuka R., *ololoh*, Sentani.

Uses. In the Malay Peninsula the leaves are used as a paste against itches, eaten against syphilis and a decoction is drunk after childbirth. In Java the leaves are used against mumps, rheumatism and pimples, against piles; a decoction of the flowers is used against cough and thrush. The fruit juice is generally used against fevers, scurvy, beri-beri, biliousness, coughs and piles; it also removes stains from laundry, hands and weapons. See KOORDERS & VALETON (1903), HEYNE (1927), OCHSE & BAKHUIZEN (1931), BURKILL (1935), and QUISUMBING (1951). Fruits and flowers are edible but more acid than those of *A. carambola*.

Syst. The species has always been regarded as possessing only an MF flower. Short-styled or SF (ELMER 15122) and long-styled or LF (HALLIER *f. s.n.*) forms occur but very rarely so. It is doubtful whether *f. papuana* KNUTH merits distinction; his definition reads: "In omnibus partibus fere duplo major". Material showing these sizes is

found on most islands throughout its range in
Malesia.

Excluded

Averrhoa acida LINNÉ, Sp. Pl. (1753) 428 =
Phyllanthus acida (L.) SKEELS, Bull. U.S. Dep.
Agr. Bur. Pl. Ind. 148 (1909) 17 (*Euphorbiaceae*).
Averrhoa frondosa SALISBURY, Prod. (1796) 318
= *Phyllanthus acida* (L.) SKEELS, Bull. U.S. Dep.
Agr. Bur. Pl. Ind. 148 (1909) 17 (*Euphorbiaceae*).
Averrhoa microphylla TARDIEU-BLOT, Not. Syst.

11 (1943) 133; Fl. Gén. I.-C. 1, Suppl. (1945) 547,
f. 66, is according to LEENHOUTS = *Rourea*
harmandiana PIERRE (*Connaraceae*).

Averrhoa minima PERROTTET, Mém. Soc. Linn.
Paris 3 (1824) 101. "Espèce nouvelle venue de la
Chine, qui s'éleve à 1 mètre (3 pieds) au plus
(Mascareigne)". Type-material could not be
found in the Paris Herbarium. Probably it does
not belong to *Oxalidaceae*, but to *Euphorbiaceae*?

Averrhoa sinica HANCE in Walp. Ann. 2 (1852)
241 = *Rourea minor* (GAERTN.) LEENHOUTS, Fl.
Mal. I, 5 (1958) 514 (*Connaraceae*).