Gardens' Bulletin Singapore **52** *(2000) 11–87.*

Key to the *Macaranga* Thou. and *Mallotus* Lour. Species (Euphorbiaceae) of East Kalimantan, Indonesia

J.W.F. SLIK[1], PRIYONO[2] AND P.C. VAN WELZEN[1]

[1]Nationaal Herbarium Nederland, Universiteit Leiden Branch, P.O. Box 9514, 2300 RA Leiden, The Netherlands
[2]Wanariset Herbarium, P.O. Box 319, Balikpapan 76100, Indonesia

Abstract

A key to all *Macaranga* (27 taxa) and *Mallotus* (19 taxa) species known to occur in East Kalimantan (Indonesia) is provided in this paper. The key is mainly based on vegetative characters proven useful in the field. Some reproductive characters are included if identification is otherwise impossible. The taxa are described briefly by their diagnostic characters. Drawings are provided for most of the treated species.

Introduction

Species of the genera *Macaranga* Thou. and *Mallotus* Lour. (Euphorbiaceae) often form a characteristic part of secondary vegetation in Southeast Asia, and many species are among the first colonisers of disturbed vegetation. A considerable number can also be found in late secondary vegetation and the understorey of primary forest. The wide ecological range of both genera with the more or less well-defined ecological preferences of the various species, makes them potentially very useful for recognising the disturbance history of a forest.

However, a key to the species is still much in need, especially one based on vegetative characters in order to identify sterile specimens. Keys presently available for East Kalimantan are either outdated (Pax and Hoffmann, 1914), do not cover all the species (Keßler & Sidiyasa., 1994), or are partly based on the availability of both flowering and fruiting material (Airy Shaw, 1975; Whitmore, 1975).

The key presented here is based on collections from East Kalimantan, which are present in the Nationaal Herbarium Nederland, Universiteit Leiden Branch (L) and the Wanariset Herbarium, East Kalimantan (WAN). Reproductive characters have only been added when identification is otherwise impossible. It is important to note that this key is made specifically for East Kalimantan specimens. Identification of plants from outside this area may not work, even if the species are included in this key. Some species show strong dimorphism between their juvenile and adult states. These are treated briefly in the species descriptions but not in the key.

which is based on (sub-)adult individuals. In general, the key will work well for individuals that are taller than 0.5 m. An overview and keys for several seedlings can be found in Bodegom *et al.* (1999). Short descriptions of ecology, distribution and habit of the species are given, based on information on the labels of East Kalimantan specimens and literature references (Airy Shaw, 1975; Argent *et al.*, 1998; Keßler & Sidiyasa, 1994; Keßler *et al.*, 1995; Sidiyasa *et al.*, 1999; Whitmore, 1975).

Key to the Genera

1a. Glabrous or indumentum simple. Twigs solid to hollow (ant inhabited). Leaves alternate, often peltate, often lobed, sometimes with few basal macular glands on upper surface. Inflorescences mostly branched. Staminate flowers usually completely surrounded by bracts. Bracts sometimes fimbriate. Stamens up to c. 30, anthers clearly (3—)4 celled, apicifixed, theca opening apically. Styles partly connate, stigmas free. Fruits 2—6 locular, usually smooth, sometimes spiny ..... **Macaranga**

1b. Glabrous or indumentum simple to tufted to stellate. Twigs solid. Leaves alternate to opposite, when opposite usually unequal in size or shape, sometimes peltate, rarely lobed, usually with few basal macular glands on upper surface. Inflorescences usually unbranched. Staminate flowers not completely surrounded by bracts. Bracts with entire margins. Stamens up to c. 150, anthers 2 celled, basi- to dorsi-fixed, theca opening extrorse. Styles completely fused, apically splitting into (2)-3-(4) stigmas. Fruits (2)-3-(4)-locular, usually spiny ..... **Mallotus**

Macaranga Thou.

Shrubs to trees up to 35 m tall, dioecious. Glabrous or indumentum simple. *Bark* sometimes prominently hooped (rings surrounding the stem). *Wood* soft. *Twigs* sometimes hollow and ant-inhabited (small openings), sometimes whitish-glaucous. *Stipules* small and narrowly triangular, to very large and ovate to rounded, sometimes recurved and forming an enclosed hollow inhabited by ants. *Leaves* alternate to spirally arranged, small to very large; blades often peltate, often 3(—5)-lobed, pinnate to basally tripliveined to palmativeined, upper surface sometimes with basal macular glands, lower surface often gland-dotted. *Inflorescences* axillary to rarely sub-terminal. *Staminate inflorescences* mostly branched; bracts large, usually surrounding the flowers, sometimes fimbriate; flowers 2—150 per node, sepals 2—4, stamens 1—30, anthers (3- or) 4-celled, apicifixed, disc absent, pistil absent. *Pistillate inflorescences* usually branched; bracts persistent to caducous;

flowers 1 to several per node, calyx short, ovary 1—6-locular, styles long to short, partly connate, stigmas free. *Fruit* a leathery to berry-like capsule, smooth to spiny to horned, sometimes with conspicuous glandular patches, dehiscing into bivalved parts. *Seeds* often with red to pink aril.

Key to the *Macaranga* Taxa

1a. Twigs solid 2
1b. Twigs hollow (often ant-inhabited) 26

2a. Leaves penniveined 3
2b. Leaves basally tripliveined to palmativeined 10

3a. Plants completely glabrous on vegetative parts 4
3b. Plants hairy on twigs, petioles, and/or leaf undersides 5

4a. Leaves whitish glaucous on under surface. Basal veins of equal length or longer than the upper veins ..... **5. M. conifera**
4b. Leaves not whitish glaucous on under surface. Basal veins shorter than at the centre of the lamina ..... **18. M. lowii var. kostermansii**

5a. Vegetative parts with hairs longer than 1 mm 6
5b. Vegetative parts with hairs shorter than 1 mm 7

6a. Leaf lamina 5—7 cm long, upper surface with conspicuous secondary veins. Pedicels up to 1 cm long ..... **9. M. fulva**
6b. Leaf lamina 7—17 cm long, upper surface with inconspicuous secondary veins. Pedicels 1.5—3 cm long ..... **4. Macaranga repando-dentata**

7a. Basal veins shorter than at the centre of the lamina 8
7b. Basal veins of equal length or longer than higher on the lamina 9

8a. Twigs and petioles densely hairy. Petioles usually shorter than 2 cm ..... **4. M. brevipetiolata**
8b. Twigs and petioles mostly sparsely hairy. Petioles usually longer than 2 cm ..... **17. M. lowii var. lowii**

9a. Lower surface of leaves conspicuously whitish glaucous, velvety hairy, with secondary veins not prominent ..... **5. M. conifera**
9b. Lower surface of leaves not glaucous, not velvety hairy, with prominent secondary veins ..... **6. M. costulata**

10a. Leaves peltate 11
10b. Leaves not peltate 20

11a. Leaves not lobed 12
11b. Leaves lobed 18

12a. Petiole insertion more than 1.4 cm from blade base. Upper surface of leaves usually without basal macular glands (when present then more than 2) 13
12b. Petiole insertion less than 1.4 cm from blade base. Upper surface of leaves sometimes with 2 basal macular glands 16

13a. Under surface of leaves densely hairy on whole surface, few to numerously gland dotted ..... **25. M. tanarius**
13b. Under surface of leaves glabrous to sparsely hairy on main veins, numerously gland dotted 14

14a. Leaves never more than 11 cm wide. Capsules berry-like .... **22. M. puncticulata**
14b. Leaves rarely less than 11 cm wide. Capsules dry 15

15a. Stipules tough (leathery when dried). Leaves leathery when dried, under surface glaucous, secondary veins not prominent .... **23. M. recurvata**
15b. Stipules thin (papery when dried). Leaves papery when dried, under surface not glaucous, secondary veins prominent ..... **25. M. tanarius**

16a. Leaf under surface conspicuously glaucous, velvety hairy, secondary veins not prominent ..... **5. M. conifera**
16b. Leaf under surface not glaucous, hairy but not velvety, secondary veins prominent 17

17a. Leaf upper surface with two basal macular glands ..... **6. M. costulata**
17b. Leaf upper surface without basal macular glands ..... **8. M. endertii**

18a. Stipules up to 4 cm long, ovate, apex acute, persistent, usually dead and dry on living plant. Leaf lamina usually longer than 30 cm .... **10.M. gigantea**
18b. Stipules up to 1.5 cm long, broadly ovate to ovate, apex rounded to acuminate to acute, persistent to caducous, alive on living plant. Leaf lamina shorter than 30 cm 19

19a. Twigs hairy, not glaucous. Stipules ovate, apex acute. Petioles hairy. Leaf base rounded to truncate, blade shallowly 3 (to 5)-lobed, under surface hairy ..... **7. M. depressa var. strigosa**
19b. Twigs usually glabrous, often glaucous. Stipules broadly ovate, apex rounded to acuminate (to acute). Petioles rarely hairy. Leaf base often emarginate, blade deeply 3-lobed, under surface glabrous to hairy.... 24

20a. Leaves not lobed 21
20b. Leaves lobed 23

21a. Leaf upper surface completely hairy ..... **26. M. trichocarpa**
21b. Leaf upper surface glabrous or rarely sparsely hairy on veins 22

22a. Vegetative parts glabrous or with few to numerous hairs. Leaves below conspicuously whitish glaucous, velvety hairy, secondary veins not prominent ..... **5. M. conifera**
22b. Vegetative parts with few to numerous hairs. Leaves below not glaucous, not velvety hairy, secondary veins prominent .... **6. M. costulata**

23a. Leaves shallowly 3-lobed (cusped), upper surface completely hairy, base acute to rounded to slightly cordate ..... **26. M. trichocarpa**
23b. Leaves deeply 3-lobed, upper surface not completely hairy, base deeply cordate 24

24a. Stipules persistent (present on all the leaves !). Leaf under surface glabrous ..... **12. M. hosei**
24b. Stipules caducous (if persistent then leaf under surface velvety hairy). Leaf under surface glabrous to velvety hairy 25

25a. Twigs conspicuously glaucous, often with ant openings. Stipules ovate, apex acuminate to acute. Leaf base often with large protruding glands along the margin, leaf under surface mostly glabrous or with sparse hairs, rarely velvety ..... **20. M. pearsonii**
25b. Twigs usually not glaucous, without ant openings. Stipules broadly ovate, apex rounded to acuminate. Leaf base without large protruding glands along the margin, leaf under surface velvety hairy .... **21. M. pruinosa**

26a. Leaves not peltate 27
26b. Leaves peltate 28

27a. Stipules persistent (present on all the leaves!), apex rounded ..... **12. M. hosei**
27b. Stipules caducous, apex acute ..... **20. M. pearsonii**

28a. Leaves not lobed 29
28b. Leaves lobed 34

29a. Stipules recurved, forming a hollow between twig and stipule 30
29b. Stipules erect, not forming a hollow 32

30a. Stipules longer than wide (like a pair of horns), 1.5 —2.5 cm long .... **16. M. lamellata**
30b. Stipules shorter than wide, up to 1.5 cm long (mostly between 0.5 and 1 cm long) 31

31a. Internodes often slightly swollen, sometimes hairy. Stipules caducous to persistent, green (to red). Leaves ovate to lanceolate (always clearly longer than wide), under surface glabrous or with sparse hairs, usually not gland dotted. Plants often growing in swamps and along river sides ..... **13. M. hullettii**
31b. Internodes usually not to sometimes slightly swollen, glabrous. Stipules often persistent, red. Leaves broadly ovate (equal or only slightly longer than wide), under surface often velvety hairy (to glabrous), gland dotted. Plants mostly growing in dry places .... **2. M. bancana** (formerly **M. triloba**)

32a. Twigs conspicuously swollen, ant openings large (c. 2 mm diameter). Stipules early caducous ..... **22. M. puncticulata**
32b. Twigs not conspicuously swollen, ant openings absent or small (mostly c. 1 mm diameter). Stipules caducous to persistent 33

33a. Twigs without ant openings. Stipules caducous to persistent. Leaves leathery when dry, under surface densely gland dotted, slightly glaucous. Fruits larger than 3 mm diam ..... **23. M. recurvata**
33b. Twigs usually with ant openings. Stipules persistent (present with all the leaves !). Leaves papery when dry, below sparsely gland dotted, not glaucous. Fruits small, c. 3 mm diam ..... **27. M. winkleri**

34a. Stipules recurved, forming a hollow between stem and stipule 35
34b. Stipules erect, not forming a hollow between stem and stipule 42

35a. Leaf base with conspicuously large glands along margin (larger than

those towards the apex) 36
35b. Leaf with large glands of equal size along the whole margin .....
..... 37

36a. Glands along leaf margin with a clearly visible opening. Calyx caducous
..... **1. M. aëtheadenia**
36b. Glands along leaf margin without an opening. Calyx persistent .....
..... **11. M. glandibracteolata**

37a. Stipules longer than wide, 1.5—2.5 cm long, resembling a pair of horns
..... **16. M. lamellata**
37b. Stipules shorter than wide, up to 1.5 cm long (mostly 0.5 to 1 cm long)
..... 38

38a. Stipules not surrounding the stem. Leaves clearly 3 to 5-lobed 39
38b. Stipules completely surrounding the stem. Leaves often shallowly 3-lobed (cusped) 40

39a. Leaf under surface glabrous ..... **19. M. motleyana**
39b. Leaf under surface velvety hairy ..... **11. M. glandibracteolata**

40a. Stipules green, rarely red. Leaves conspicuously longer than wide, usually less than 14 cm wide, shallowly lobed (cusped), lower surface glabrous or with sparse hairs, usually not gland dotted. Plants often growing in swamps and along rivers ..... **13. M. hullettii**
40b. Stipules usually red. Leaves slightly longer than wide, often more than 14 cm wide, shallowly to deeply lobed, lower surface glabrous to densely (velvety) hairy, usually gland dotted. Plants usually growing in dry places 41

41a. Twigs glabrous ..... **2. M. bancana** (formerly **M. triloba**)
41b. Twigs hairy ..... **15. M. indistincta**

42a. Stipules narrowly triangular, c. 3—5 mm wide, not surrounding the stem 43
42b. Stipules broadly ovate to rounded, more than 5 mm wide, nearly to completely surrounding the stem 44

43a. Leaves with central lobe 3.5—5 times longer than wide, base of central lobe not overlapping lateral lobes, under surface inconspicuously glaucous ..... **3. M. beccariana**
43b. Leaves with central lobe 1.3—2 times longer than wide, base of central

lobe usually overlapping lateral lobes, under surface conspicuously glaucous (pure white) ..... **14. M. hypoleuca**

44a. Stipules persistent (present with all the leaves !), apex rounded .... **12. M. hosei**
44b. Stipules caducous, apex acute ..... **20. M. pearsonii**

1. Macaranga aëtheadenia Airy Shaw (Fig. 1)

Diagnostic characters: Trees up to 20 m tall, dbh up to 20 cm. Bark hooped, glaucous, latex red. Twigs hollow, glaucous, usually with ant openings. Stipules recurved, half to completely surrounding the twig, red. Leaves peltate, 3(-5)-lobed, base with very large hollow glands along the margin. Staminate inflorescences branched. Fruits more than 2-locular, with glandular bands, without spines.

Habitat & Ecology: Up to 300 m altitude. In disturbed places in primary forest (gaps) and in secondary (logged) forests, often along roads or skid trails. Usually inhabited by ants.

Distribution: Endemic to Borneo. In East Kalimantan found north of the Mahakam river in Kutai and Berau.

2. Macaranga bancana (Miq.) Müll.Arg. (Fig. 2)

Diagnostic characters: Small trees up to 16 m tall, dbh up to 20 cm. Bark smooth, hooped. Twigs hollow, transversely ribbed, usually with ant openings, glabrous. Stipules recurved, completely surrounding the twigs, usually red. Leaves peltate, 3-lobed, in young specimens sometimes very deeply lobed, in adults trees usually very shallowly lobed, (seedlings not lobed) under surface glabrous to densely velvety hairy, usually conspicuously gland dotted. Staminate inflorescences branched. Fruits more than 2-locular, without spines.

Habitat & Ecology: Up to 400 m altitude. In disturbed places in primary forest (gaps) and in secondary forest. Mostly found in dry places but occasionally also in swampy areas. On sandy loam. Usually inhabited by ants.

Distribution: From Thailand southward into Peninsular Malaysia, Sumatra, and Borneo. Found throughout East Kalimantan.

Note: Often mentioned for this area as *M. triloba* (Blume) Müll.Arg. However, recent insights have made it clear that this species does not occur in Borneo, and that the correct name for the species found in this area should be *M. bancana* (T.C. Whitmore & S.J. Davies, *pers. comm.*).

3. Macaranga beccariana Merr. (Fig. 3)

Diagnostic characters: Trees up to 15 m tall, dbh up to 15 cm. Bole straight. Bark smooth, hooped, glaucous, latex clear to red. Twigs hollow, glaucous, usually with ant openings. Stipules erect, apex pointed (they look spine-like on living individuals), same colour as stem or twigs. Leaves peltate, deeply 3-lobed, central lobe 3.5 to 5 times longer than wide, not overlapping with lateral lobes, undersurface glaucous, glabrous. Staminate inflorescences branched. Fruits more than 2-locular, without spines.

Habitat & ecology: Up to 900 m altitude. In disturbed places in primary forest (gaps) and in secondary forests, often along roads. Usually inhabited by ants.

Distribution: Endemic to Borneo. In East Kalimantan only found in the northern part (Berau).

4. Macaranga brevipetiolata Airy Shaw (Fig. 4)

Diagnostic characters: Trees up to 14 m tall. Twigs solid, densely short hairy apically. Stipules needle like, erect, caducous. Petioles usually not more than 2 cm long, densely short hairy. Leaves not peltate, not lobed, penniveined, usually obovate, base without or with indistinct basal macular glands. Staminate inflorescences unbranched. Fruits 2-locular, with spines.

Habitat & ecology: Up to 300 m altitude. Primary forest understorey species, also present in selectively logged forest. On sandy loam, sandy clay or dry sandstone soils.

Distribution: Endemic to Borneo. In East Kalimantan found in Kutai.

5. Macaranga conifera (Zoll.) Müll.Arg. (Fig. 5)

Diagnostic characters: Trees up to 30 m tall, dbh up to 60 cm. Bole straight. Bark hooped, dippled, latex red. Inner bark red. Wood white. Twigs solid, usually glabrous, rarely hairy apically. Stipules erect, caducous. Leaves not peltate to sub-peltate in adults, but peltate in seedlings and saplings!, not

lobed, tripliveined in adults, ovate, upper surface usually without basal macular glands, under surface conspicuously glaucous, usually glabrous, densely gland dotted (good visible in young individuals, inconspicuous in adults), rarely hairy. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Up to 1100 m altitude. In disturbed places in primary forest (gaps) and in secondary forest, including scrub vegetation. Along streams, roads, skid trails. Dry to periodically inundated to marshy terrain. Loam, sandy, and limestone soils.

Distribution: Peninsular Malaysia, Sumatra, Borneo and Sulawesi. Found throughout East Kalimantan.

Note: This species has a very strong dimorphy between the juveniles and the adults. The juveniles have bright red petioles, clearly peltate leaves and conspicuously large green persistent stipules.

6. Macaranga costulata Pax & K.Hoffm. (Fig. 6)

Diagnostic characters: Trees up to 30 m tall, dbh up to 60 cm. Latex red. Twigs solid, sometimes with flaky yellow-orange indumentum on young parts. Stipules caducous, erect. Leaves not peltate (tripliveined) to peltate, not lobed, broadly ovate to ovate, young leaves with or without flaky yellow-orange indumentum, upper surface usually with 2 basal macular glands, under surface gland dotted. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Up to 1800 m altitude. In primary and secondary forest, including scrub. On clay, dark brown, limestone and sandstone soils.

Distribution: Endemic to Borneo. In East Kalimantan only found north of the Mahakam river.

7. Macaranga depressa (Müll.Arg.) Müll.Arg. forma strigosa Whitmore (Fig. 7)

Diagnostic characters: Shrubs to small tree up to 7 m tall, dbh up to 7 cm. Bark hooped, latex clear, turning pink to red. Twigs solid, long hairy. Stipules erect, semi-persistent, green-brownish. Leaves peltate, 3—5-lobed (seedlings not lobed), upper and lower surface long hairy. Staminate inflorescences branched. Fruits more than 2-locular, often with horn like

appendages, not spiny.

Habitat & ecology: Up to 1200 m altitude. In primary and secondary forests, also in swamp forest. Along roads, streams, forest edges. On sandstone to red clayey loam.

Distribution: Endemic to Borneo. Present throughout East Kalimantan.

8. Macaranga endertii Whitmore

Diagnostic characters: Trees up to 15 m tall. Twigs solid. Stipules erect, caducous. Leaves peltate, not lobed, upper surface without basal macular glands, lower surface hairy. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Up to 700 m altitude. In primary forest or on exposed places. Mostly found on limestone.

Distribution: Endemic to Borneo. In East Kalimantan found north of the Mahakam river.

9. Macaranga fulva Airy Shaw

Diagnostic characters: Bush of 4 m tall. Twigs solid, long hairy. Stipules erect, spine-like, caducous. Leaves not peltate, not lobed, penniveined, elliptic, lamina not longer than 7 cm, upper and under surface long hairy. Staminate inflorescences unbranched. Pistillate inflorescences with very large, leaf-like bracts. Fruits 2-locular, spiny.

Habitat & ecology: Lowland. In primary forest understorey. Sandy soil.

Distribution: Endemic to Borneo. Known from only one collection from northern East Kalimantan (Bulungan district).

10. Macaranga gigantea (Rchb.f. & Zoll.) Müll.Arg. (Fig. 8)

Diagnostic characters: Trees up to 30 m tall, dbh up to 50 cm. Bole straight. Bark hooped, lenticelled, latex pink to red. Twigs solid, apically hairy. Stipules erect, persistent but dying on stem (brown colour), large, up to 4.5 cm long, hairy. Leaves peltate (but deeply cordate in seedlings), shallowly to deeply 3-lobed, very large, up to 50 by 50 cm, under surface conspicuously hairy. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Up to 1400 m altitude, but usually lower. In disturbed places in primary forest (gaps) and secondary forests, especially common after fire, also present in scrub to grass lands. On sandy clay to sandy soils.

Distribution: From Thailand southward into Peninsular Malaysia, Sumatra, and Borneo. Found throughout East Kalimantan.

11. Macaranga glandibracteolata S.J.Davies (Fig. 9)

Diagnostic characters: Trees up to 25 m tall, dbh up to 30 cm. Bark hooped, latex red. Twigs hollow, glaucous, usually with ant openings. Stipules recurved, not surrounding the twigs. Leaves peltate, 3-lobed, base sometimes with very large glands along the margin, under surface velvety hairy, sometimes glaucous. Staminate inflorescences branched. Fruits more than 2-locular, not spiny.

Habitat & ecology: Lowland. In primary forest in disturbed sites (gaps) and in secondary forest, often along roads. Usually ant inhabited.

Distribution: Endemic to Borneo. Found in the northern part of East Kalimantan (Berau).

12. Macaranga hosei King ex Hook.f. (Fig. 10)

Diagnostic characters: Trees up to 25 m tall, dbh up to 45 cm. Bark hoop marked. Twigs solid to hollow, sometimes glaucous, with or without ant openings, glabrous. Stipules erect, persistent, surrounding the twigs, apex rounded. Leaves deeply cordate to peltate, 3-lobed, under surface sometimes glaucous. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Lowland. In disturbed sites in primary forest (gaps) and in secondary forests. Dry and swampy soils. Sandy and sandstone soils. Can be ant inhabited.

Distribution: From Thailand southward into Peninsular Malaysia and Borneo. Found in northern part of East Kalimantan, north of the Sangkulirang limestone mountain range.

13. Macaranga hullettii King ex Hook.f. (Fig. 11)

Diagnostic characters: Small trees up to 12 m tall, dbh up to 11 cm. Bark smooth, hooped, sometimes dippled, latex red. Twigs hollow, transversely ribbed, sometimes hairy, usually with ant openings. Stipules recurved,

usually green, sometimes tinged red to dark red, completely surrounding the twig. Leaves peltate, usually not lobed, sometimes slightly 3-lobed (cusped), always much longer than wide, under surface usually not gland dotted. Staminate inflorescences branched. Fruits more than 2-locular, not spiny but with horn-like apical appendages.

Habitat & ecology: Up to 1230 m altitude. Primary to lightly disturbed secondary forests, often in swamps or along streams, also along roads and in open places. On sandstone to sandy loam. Usually ant inhabited.

Distribution: Peninsular Malaysia, Sumatra, Borneo. Found throughout East Kalimantan.

14. Macaranga hypoleuca (Rchb.f. & Zoll.) Müll.Arg. (Fig. 12)

Diagnostic characters: Trees up to 30 m tall, dbh up to 50 cm. Bole straight. Bark smooth, hooped, glaucous, latex red. Twigs hollow, glaucous, usually with ant openings. Stipules erect, persistent, spine-like, glaucous. Leaves peltate, deeply 3-lobed (seedlings not lobed), central lobe usually overlapping the lateral lobes, under surface conspicuously glaucous (bright white). Staminate inflorescences branched. Fruits more than 2-locular, not spiny, glaucous, seeds with conspicuous red aril.

Habitat & ecology: Up to 2400 m altitude, but usually below 1000 m. In primary forest (gaps) and secondary forests, also in scrub, along roads, streams, sometimes on alluvial places. On clayey to sandy clay soils. Usually ant inhabited.

Distribution: From Thailand southward into Peninsular Malaysia, Sumatra, Borneo. Found throughout East Kalimantan.

15. Macaranga indistincta Whitmore

Diagnostic characters: Trees up to 15 m tall, dbh up to 15 cm. Twigs hollow, hairy, usually with ant openings. Stipules recurved, completely surrounding the twigs. Leaves peltate, shallowly 3-lobed, under surface hairy, conspicuously gland dotted. Staminate inflorescences branched. Fruits more than 2-locular, not spiny.

Habitat & ecology: Up to 900 m altitude. In primary forest? Usually ant inhabited.

Distribution: Endemic to Borneo. In East Kalimantan only known from Kutai.

16. Macaranga lamellata Whitmore (Fig. 13)

Diagnostic characters: Small trees up to 10 m tall, dbh up to 8 cm. Bole straight. Bark smooth, hooped, latex red. Twigs hollow, usually with ant openings. Stipules recurved, very long and horn-like, up to 2.5 cm long, completely surrounding the twigs. Leaves peltate, not lobed to shallowly 3-lobed (cusped), under surface glaucous or not. Staminate inflorescences branched. Fruits more than 2-locular, not spiny, but glandular banded, seeds with conspicuous bright red aril.

Habitat & ecology: Lowland. In primary forest. Usually ant inhabited.

Distribution: Endemic to Borneo. Found south of the Mahakam river in East Kalimantan.

17. Macaranga lowii King ex Hook.f. var. lowii (Fig. 14)

Diagnostic characters: Trees up to 20 m tall, dbh up to 16 cm. Bole straight. Bark smooth, shallowly cracked, latex red. Inner bark thin, dark red. Twigs solid, apically short hairy. Stipules erect, spine-like, usually crowded at twig apex. Leaves not peltate, not lobed, penniveined, elliptic to obovate, upper surface basely with two conspicuous macular glands, under surface usually short hairy. Staminate inflorescences unbranched. Pistillate inflorescences with large leaf-like bracts. Fruits 2-locular, spiny, sometimes with long red stigmas.

Habitat & ecology: Up to 1350 m altitude. Mainly in the understorey of primary forests but also in secondary forests. On well drained, clay-rich and sandy loam soils.

Distribution: Southeast Asia, Sumatra, Borneo and the Philippines. Found throughout East Kalimantan.

18. Macaranga lowii King ex Hook.f. var. kostermansii Airy Shaw (Fig. 15)

Diagnostic characters: Trees up to 15 m tall, dbh up to 15 cm. Bark smooth, latex red. Twigs solid, glabrous. Stipules erect, spine-like, apically crowded on twig, red. Leaves not peltate, not lobed, penniveined, elliptic to obovate, upper surface with basally two dark red macular glands, under surface

glabrous. Staminate inflorescences unbranched. Fruits 2-locular, spiny.

Habitat & ecology: Up to 150 m altitude. In the understorey of primary forest but also in secondary forest. On slopes or ridges, along skid trails. On sandy loam.

Distribution: Endemic to Borneo. Found throughout East Kalimantan.

19. Macaranga motleyana (Müll.Arg.) Müll.Arg. (Fig. 16)

Diagnostic characters: Trees up to 25 m tall, dbh up to 30 cm. Bole straight. Bark smooth, hooped, glaucous, latex clear turning red. Twigs hollow, glaucous, usually with ant openings. Stipules recurved, not completely surrounding the twigs, green or red. Leaves peltate, deeply 3-lobed (unlobed in seedlings), under surface usually slightly glaucous, glabrous. Staminate inflorescences branched. Fruits more than 2-locular, not spiny, glaucous, with glandular bands.

Habitat & ecology: Up to 400 m altitude. In primary forest in disturbed sites (gaps) and in secondary forest, along river banks and roads. On dry to swampy places. On limestone to red loamy clay. Usually ant inhabited.

Distribution: From Thailand and Indo-China southward into Peninsular Malaysia, Sumatra and Borneo. Found throughout East Kalimantan.

20. Macaranga pearsonii Merr. (Fig. 17)

Diagnostic characters: Trees up to 35 m tall, dbh up to 65 cm. Bole straight. Bark slightly fissured, hooped, lenticelled, latex red. Twigs solid to hollow, glaucous, glabrous to hairy (when young). Stipules erect, caducous, apex acute, green to reddish. Leaves deeply cordate to peltate, deeply 3-lobed (unlobed in seedlings), base with conspicuous large glands along the margin, under surface usually slightly glaucous, sometimes hairy. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Up to 1200 m altitude. In primary forest in disturbed sites (gaps) and secondary forest to scrub, along roads. Sometimes in periodically flooded areas, usually on dry places. Quite often inhabited by ants.

Distribution: Endemic to Borneo. Found throughout East Kalimantan.

21. Macaranga pruinosa (Miq.) Müll.Arg. (Fig. 18)

Diagnostic characters: Trees up to 20 m tall, dbh up to 25 cm. Bark smooth, hooped, latex red. Twigs solid, sometimes hairy. Stipules erect, semi-persistent, apex rounded. Leaves deeply cordate to peltate, deeply 3-lobed, base without conspicuously large glands along the margin, lower surface velvety hairy. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Lowland. Primary and secondary forests, usually in swamps or along streams, rarely also on dry ground.

Distribution: Peninsular Malaysia, Sumatra, and Borneo. Found throughout East Kalimantan.

22. Macaranga puncticulata Gage. (Fig. 19)

Diagnostic characters: Small trees up to 10 m tall. Twigs solid to hollow, when hollow often with very large ant openings (up to 2 mm) and the swollen internodes strongly constricted at the nodes. Stipules erect, caducous. Leaves peltate, not lobed, small, not wider than 11 cm but usually much narrower, under surface glaucous, densely gland dotted. Staminate inflorescences branched. Fruits more than 2-locular, not spiny.

Habitat & ecology: Lowland. In swamp forest. Sometimes ant inhabited.

Distribution: Peninsular Malaysia, Sumatra and Borneo. Found south of the Mahakam river in East Kalimantan.

23. Macaranga recurvata Gage. (Fig. 20)

Diagnostic characters: Trees up to 30 m tall, dbh up to 45 cm. Twigs usually solid, rarely hollow, glabrous. Stipules erect, caducous. Leaves peltate, not lobed, under surface glaucous, densely gland dotted, glabrous. Staminate inflorescences branched. Fruits 2-locular, not spiny.

Habitat & ecology: Up to 500 m altitude. In primary (*Agathis*) and secondary forest. In swampy places. On acid, sandy soil.

Distribution: Peninsular Malaysia and Borneo. Found throughout East Kalimantan.

24. Macaranga repando-dentata Airy Shaw (Fig. 21)

Diagnostic characters: Shrubs to small trees up to 7 m tall. Twigs solid, long hairy. Stipules erect, caducous, spine like. Leaves not peltate, not lobed, penniveined, lamina longer than 7 cm, long hairy. Staminate inflorescences unbranched. Pistillate inflorescences with bracts very large and leaf like. Fruits 2-locular, spiny.

Habitat & ecology: Up to 300 m altitude. In the understorey of primary forest. On sandy soils.

Distribution: Endemic to Borneo. In East Kalimantan only found in Kutai.

25. Macaranga tanarius (L.) Müll.Arg. (Fig. 22)

Diagnostic characters: Shrubs to trees up to 15 m tall, dbh up to 20 cm. Bole straight. Bark smooth, hooped, latex red. Twigs solid. Stipules erect, persistent, green to reddish. Leaves peltate, not lobed, upper surface basally sometimes with several macular glands, under surface glabrous to velvety hairy, thinly to densely gland dotted. Staminate inflorescences branched. Fruits 2-locular, with few curling spines, glaucous.

Habitat & ecology: Up to 2100 m altitude. Usually in very disturbed vegetation like scrub or abandoned shifting cultivation areas, often along roads, or along streams. On clay loam, sandy, and sandstone soils.

Distribution: From India and southern China to Australia and New Guinea. Found throughout East Kalimantan.

26. Macaranga trichocarpa (Rchb.f. & Zoll.) Müll.Arg. (Fig. 23)

Diagnostic characters: Shrubs to 6 m tall, dbh up to 10 cm. Bark smooth, orange brown, latex clear turning red. Twigs solid, hairy apically. Stipules erect, caducous. Leaves not peltate, not lobed to sometimes slightly 3-lobed (cusped), base cordate to attenuate, upper surface basally with two conspicuous macular glands, densely short hairy (slightly sandpaper-like), under surface densely short hairy. Staminate inflorescences unbranched. Fruits 2-locular, spiny.

Habitat & ecology: Up to 500 m altitude. Usually in very disturbed secondary forest, especially scrub or abandoned shifting cultivation areas, but also present in gaps in primary forest. Often along forest edges and road sides

where it can form pure stands. On sandy loam, sandy clay and red-yellow podsolic soils.

Distribution: From Myanmar and Indo-China, south into Peninsular Malaysia, Sumatra and Borneo. Found throughout East Kalimantan.

27. Macaranga winkleri Pax & K.Hoffm. (Fig. 24)

Diagnostic characters: Shrubs to small trees up to 15 m tall, dbh up to 18 cm. Bole straight. Bark smooth, hooped, latex clear turning red. Twigs hollow, strongly angular when young, usually with ant openings, red when young. Stipules erect, conspicuously longer than wide, red. Leaves peltate, not lobed, basal veins usually at a 90 or more degrees angle with the midrib. Staminate inflorescences branched. Fruits 2-locular, very small (c. 3 mm diameter), not spiny.

Habitat & ecology: Up to 1800 m altitude. In disturbed sites (gaps) in primary forest and in secondary forests, including very disturbed forest (after fires). Often along forest edges, road sides, river sides, in land slips. On yellow sandy loam. Usually ant inhabited.

Distribution: Endemic to Borneo. Found throughout East Kalimantan.

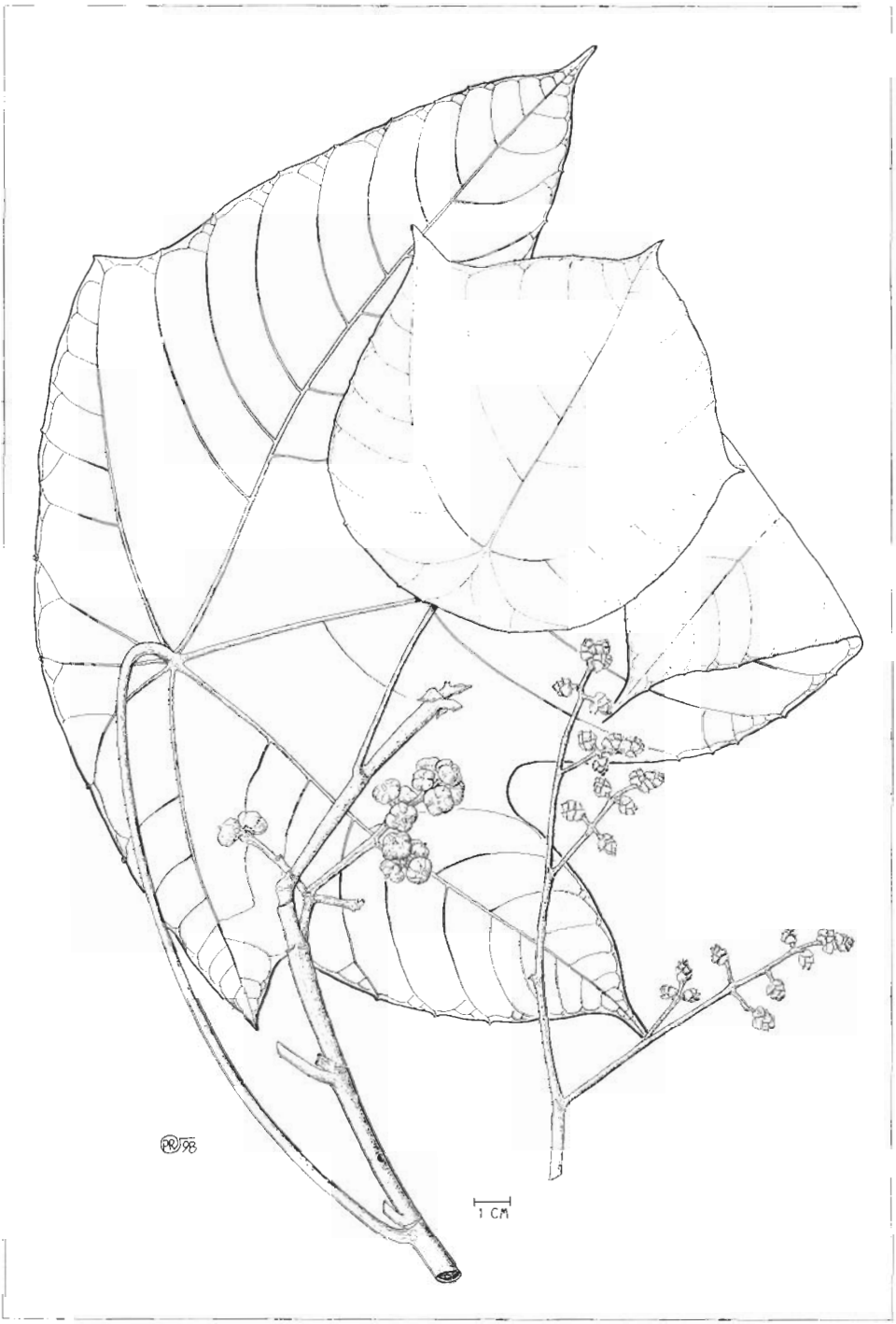

Figure 1. *Macaranga aëtheadenia* Airy Shaw. Habitus of pistillate plant and detail of staminate inflorescence.

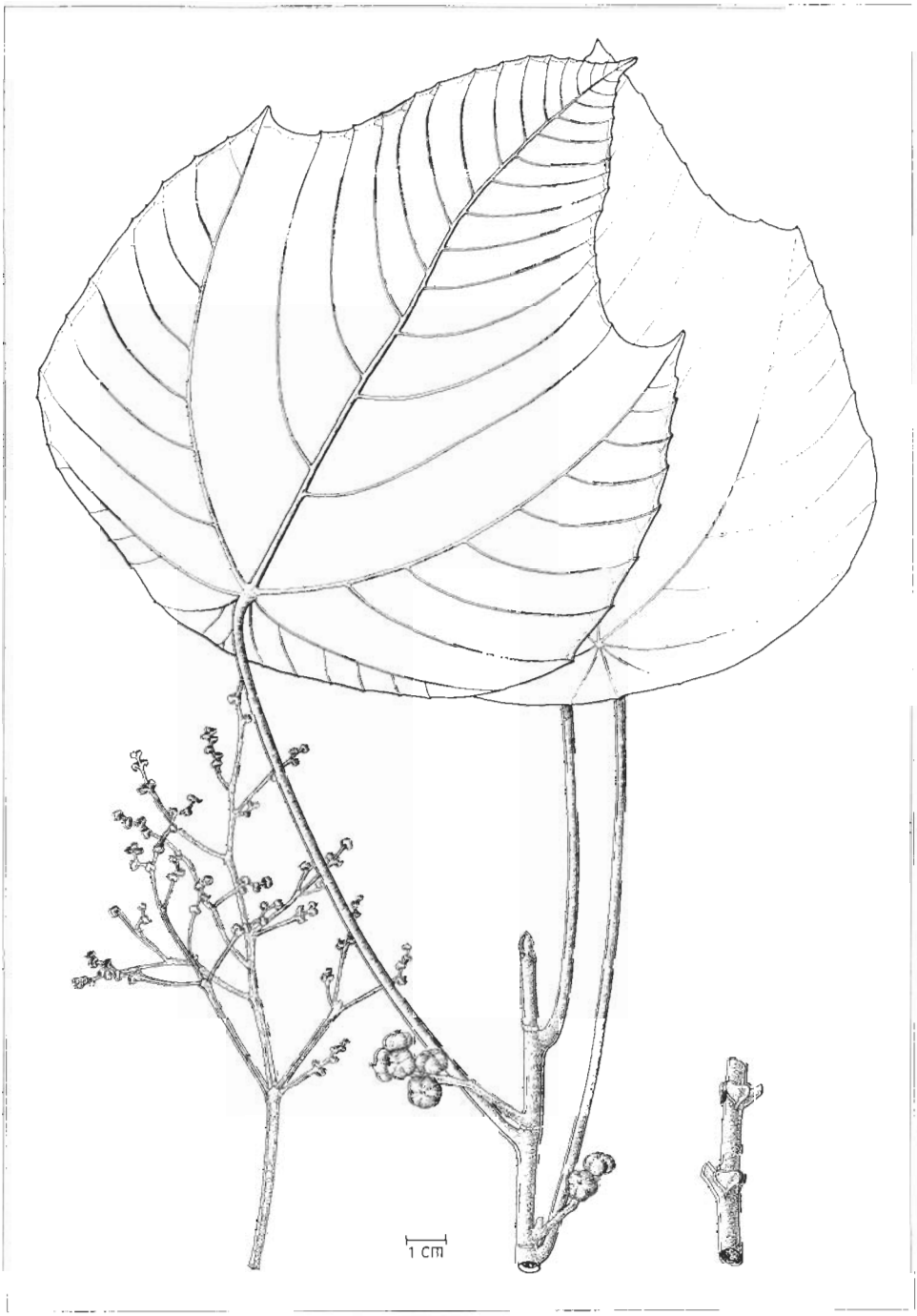

Figure 2. *Macaranga bancana* (Miq.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence. The plant shown here has shallowly lobed leaves, but in the field the leaves can also be very deeply lobed.

Figure 3. *Macaranga beccariana* Merr. Habitus plus details of pistillate and staminate inflorescences.

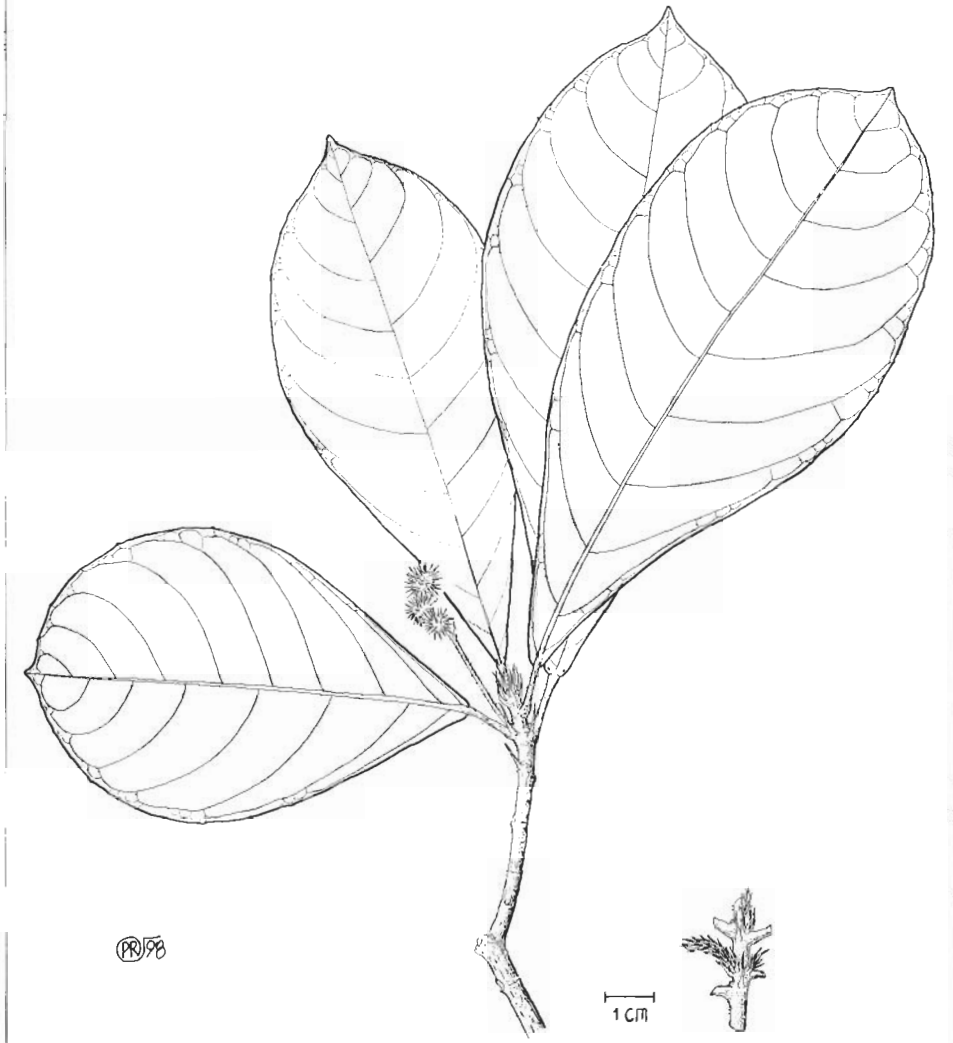

Figure 4. *Macaranga brevipetiolata* Airy Shaw. Habitus of pistillate plant and detail of young staminate inflorescence.

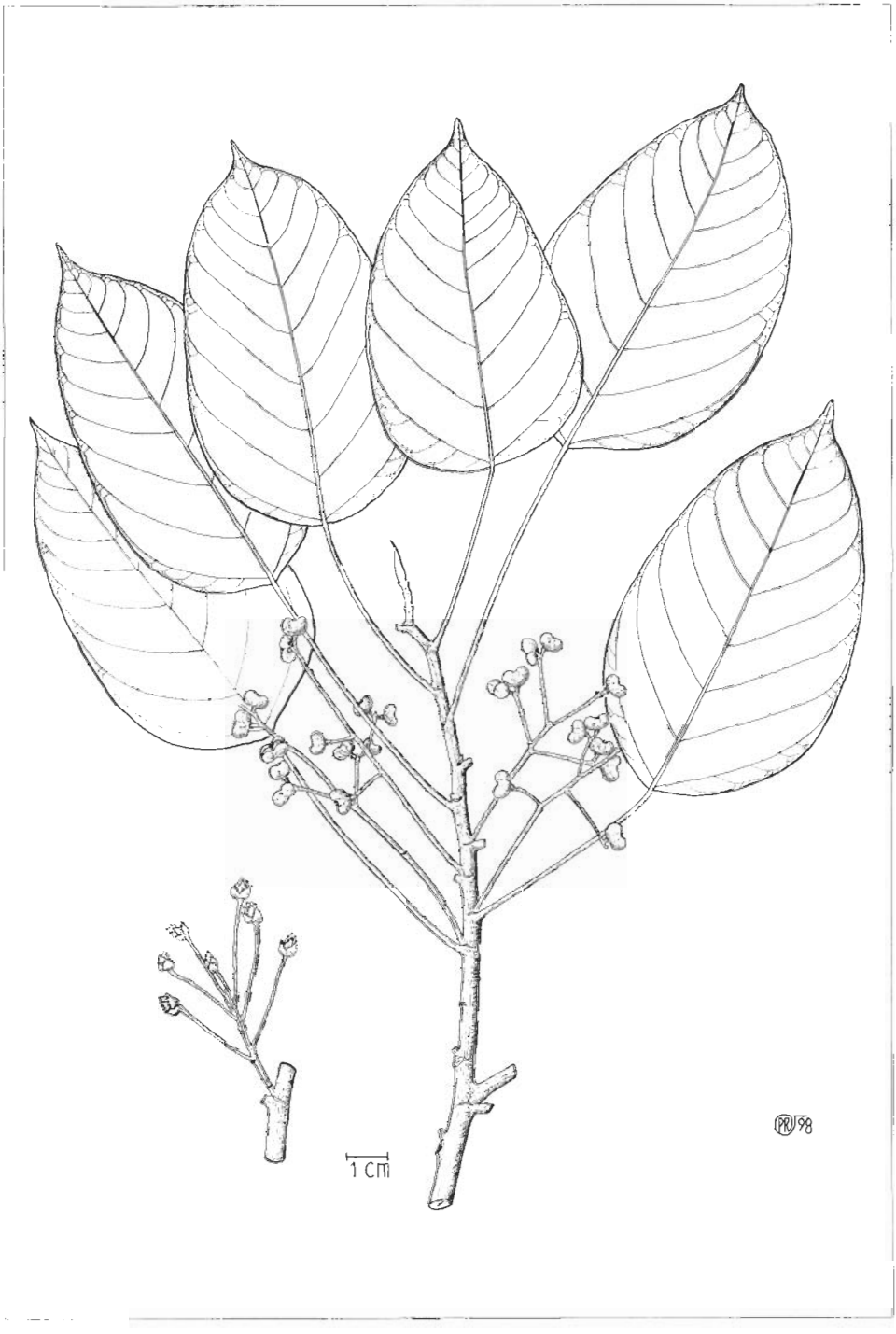

Figure 5. *Macaranga conifera* (Zoll.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

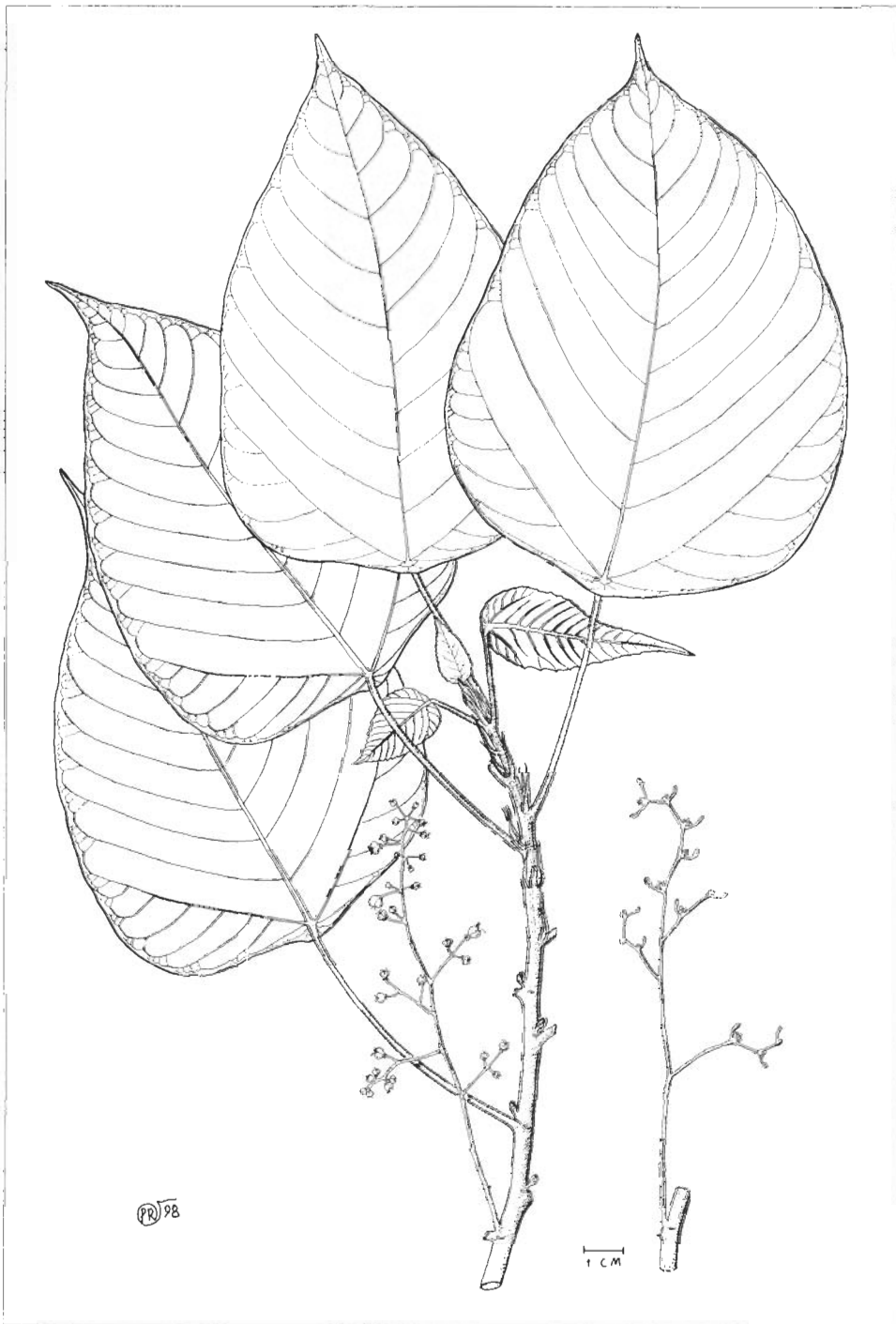

Figure 6. *Macaranga costulata* Pax & K.Hoffm. Habitus of pistillate plant and detail of staminate inflorescence.

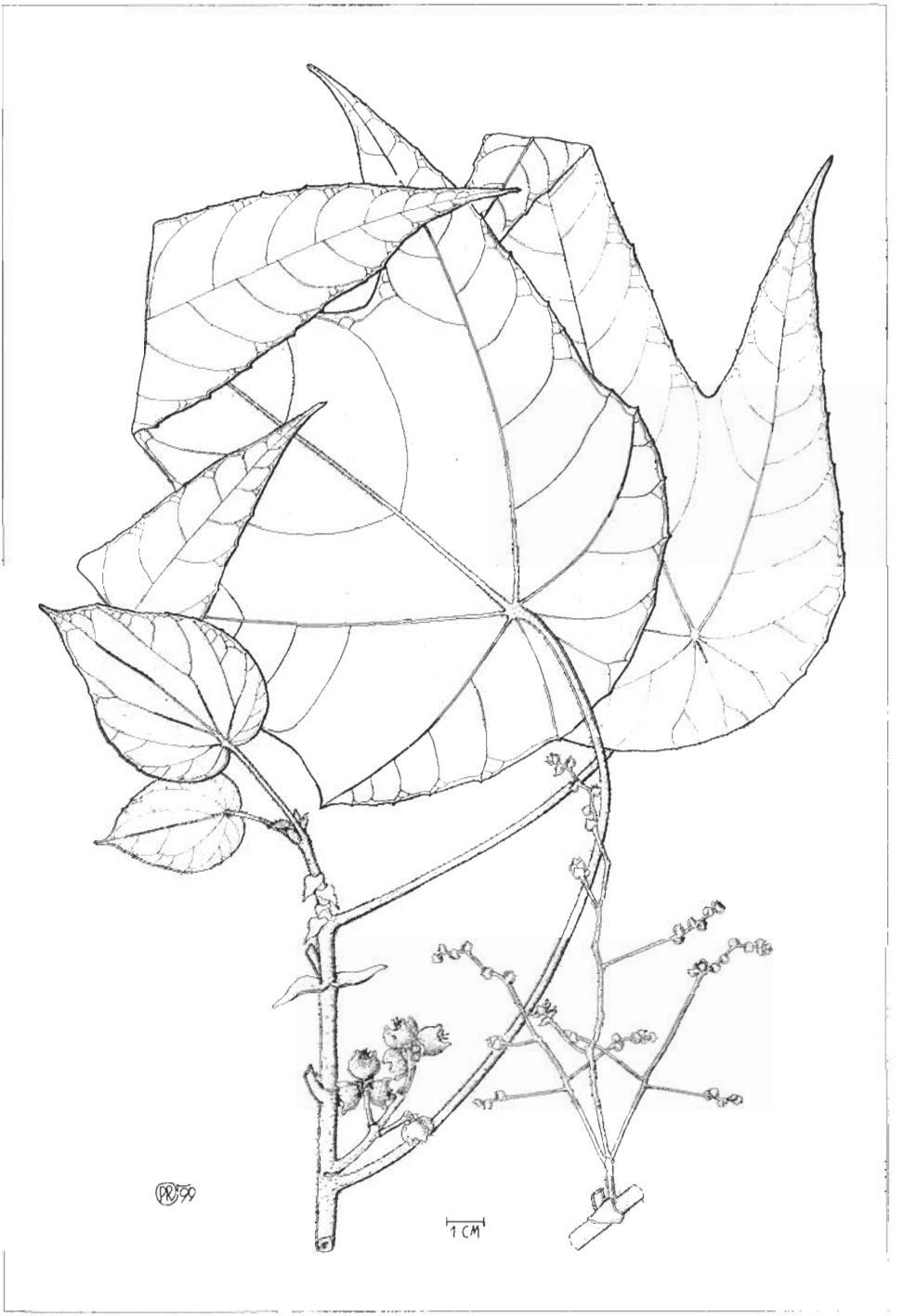

Figure 7. *Macaranga depressa* (Müll.Arg.) Müll.Arg. forma *strigosa* Whitmore. Habitus of pistillate plant and detail of staminate inflorescence.

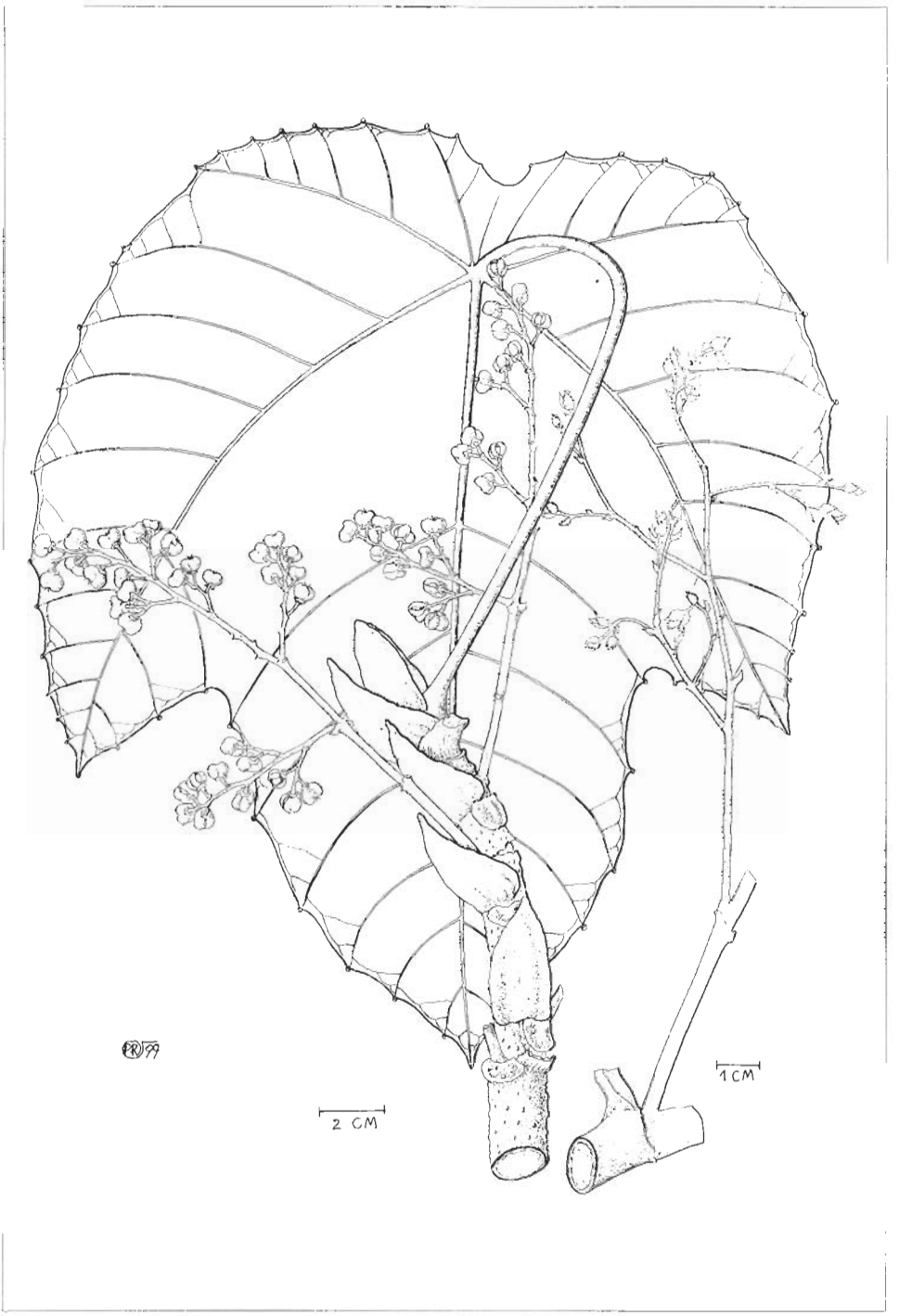

Figure 8. *Macaranga gigantea* (Rchb.f. & Zoll.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

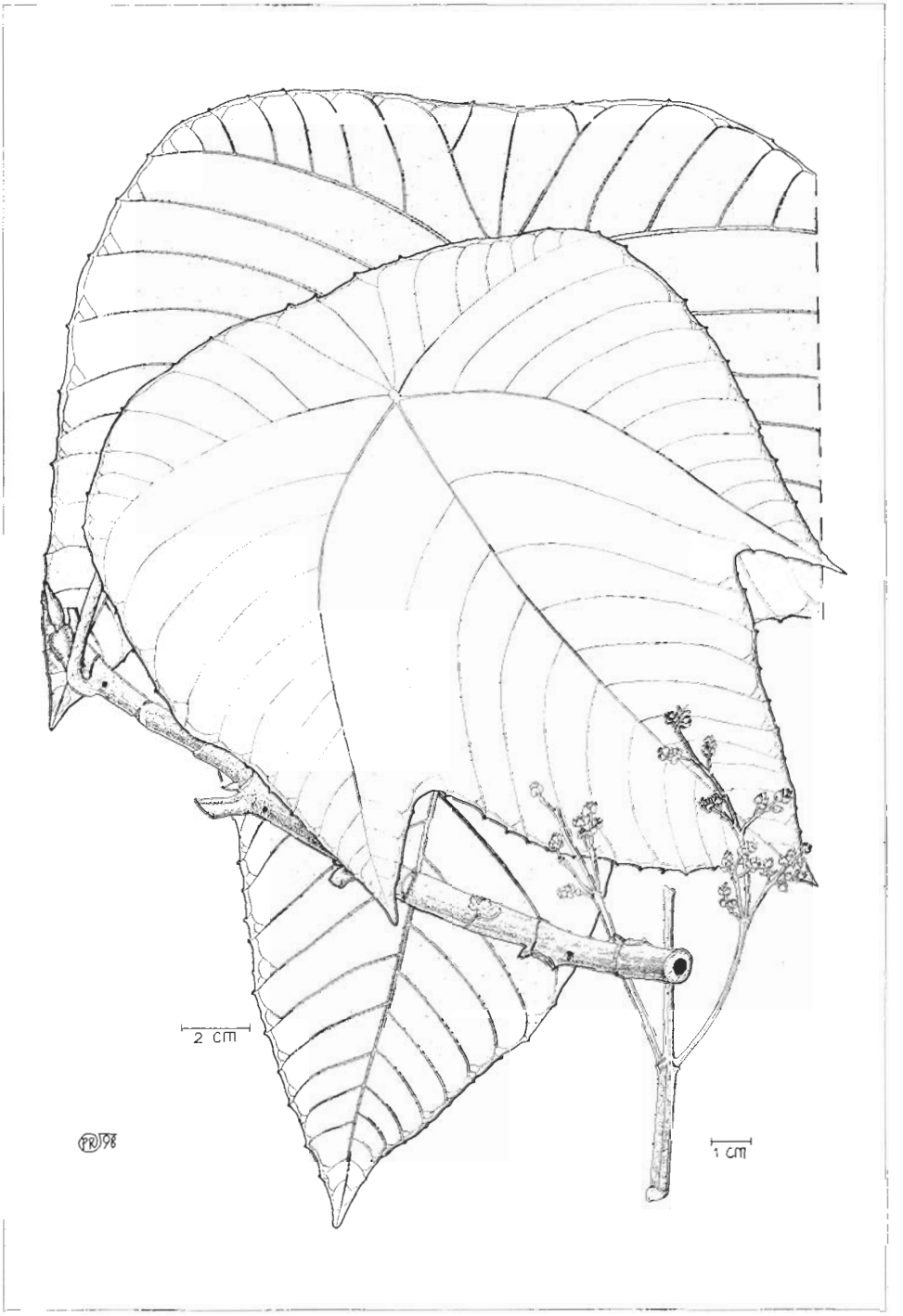

Figure 9. *Macaranga glandibracteolata* S.J.Davies. Habitus and detail of staminate inflorescence.

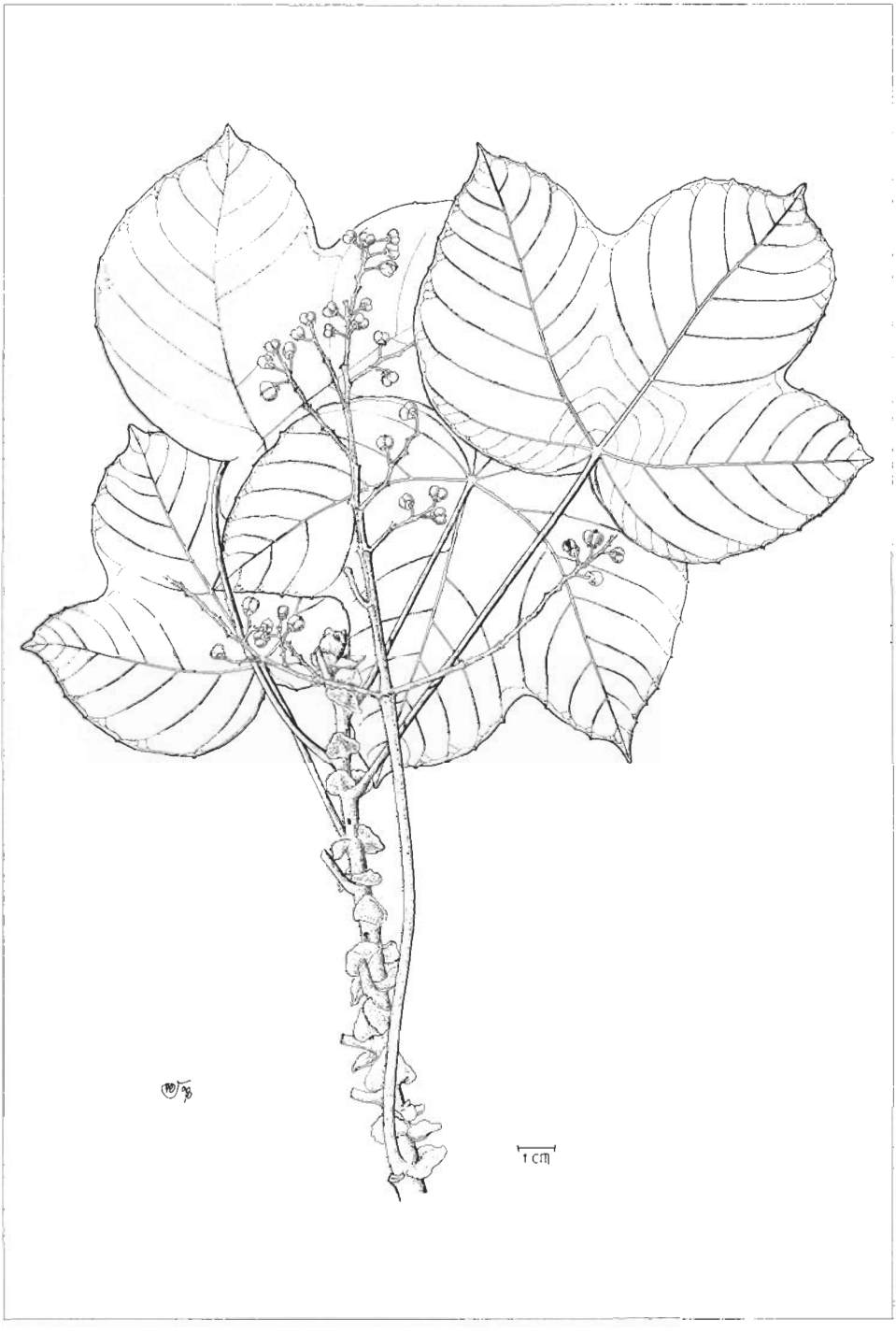

Figure 10. *Macaranga hosei* King ex Hook.f. Habitus of pistillate plant.

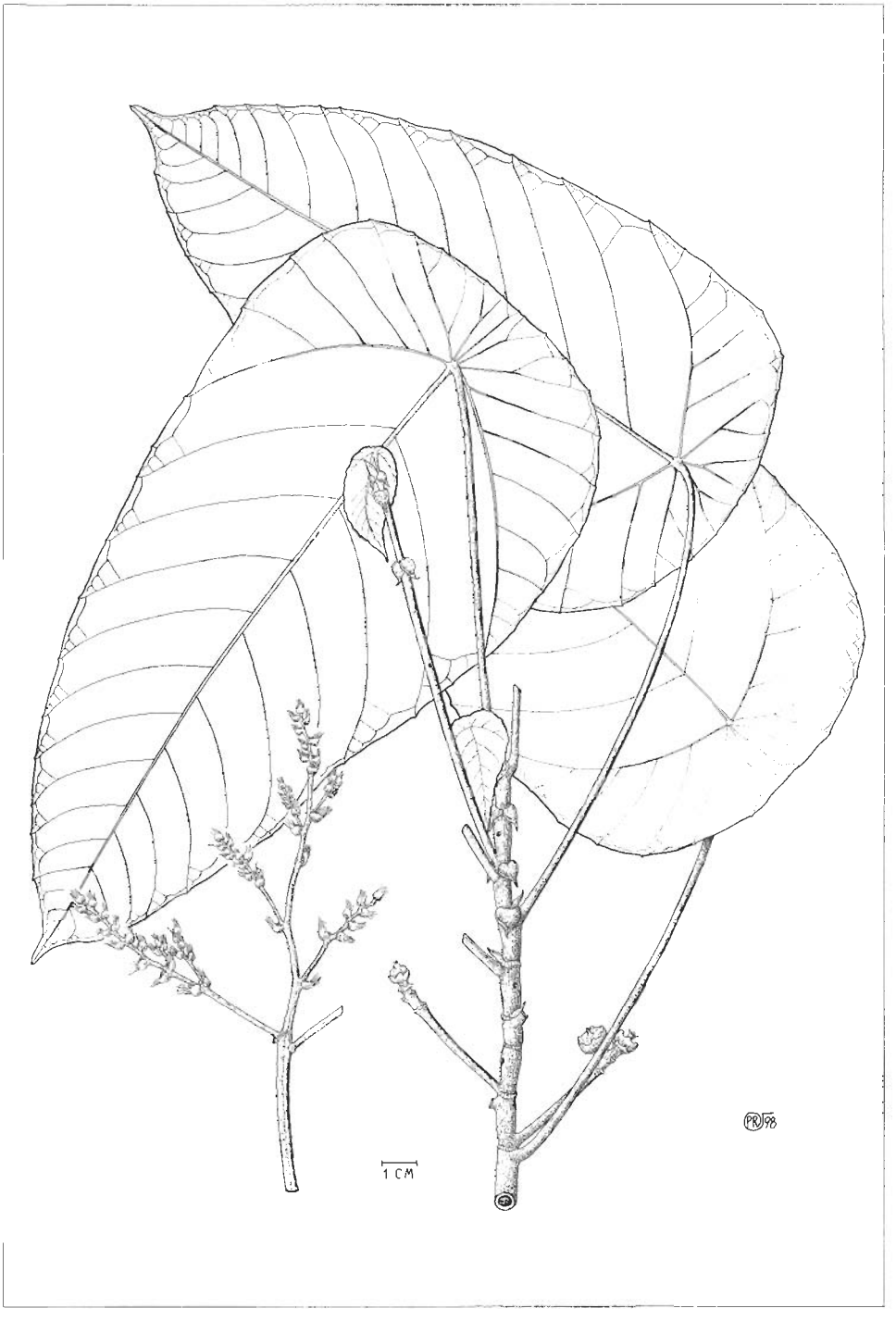

Figure 11. *Macaranga hullettii* King ex Hook.f. Habitus of pistillate plant and detail of staminate inflorescence.

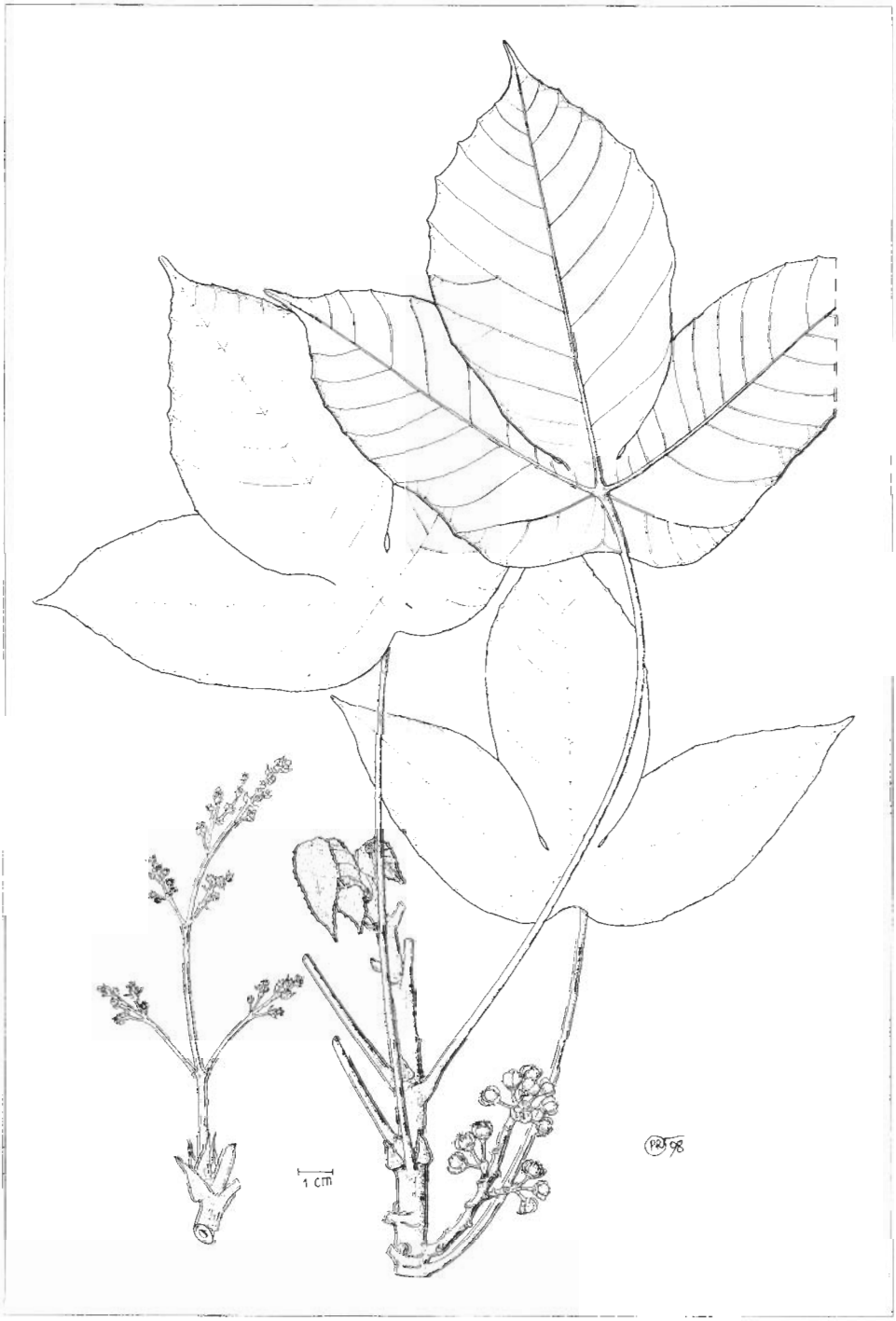

Figure 12. *Macaranga hypoleuca* (Rchb.f. & Zoll.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

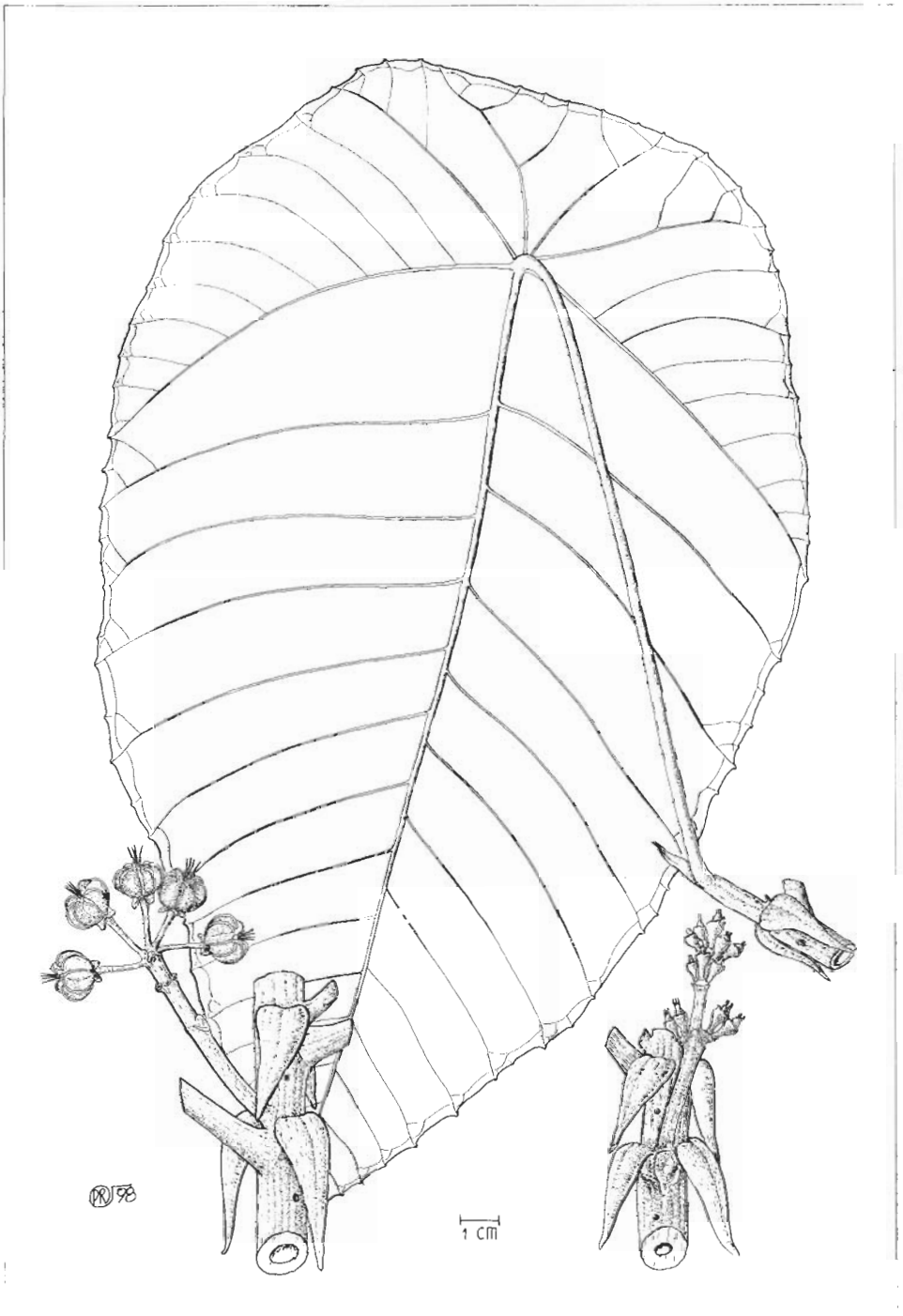

Figure 13. *Macaranga lamellata* Whitmore. Habitus and details of full grown and young pistillate inflorescences.

Figure 14. *Macaranga lowii* King ex Hook.f. var. *lowii*. Habitus of pistillate plant and detail of staminate inflorescence.

Figure 15. *Macaranga lowii* King ex Hook.f. var. *kostermansii* Airy Shaw. Habitus of pistillate plant and detail of fruit and staminate inflorescence.

Figure 16. *Macaranga motleyana* (Müll.Arg.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

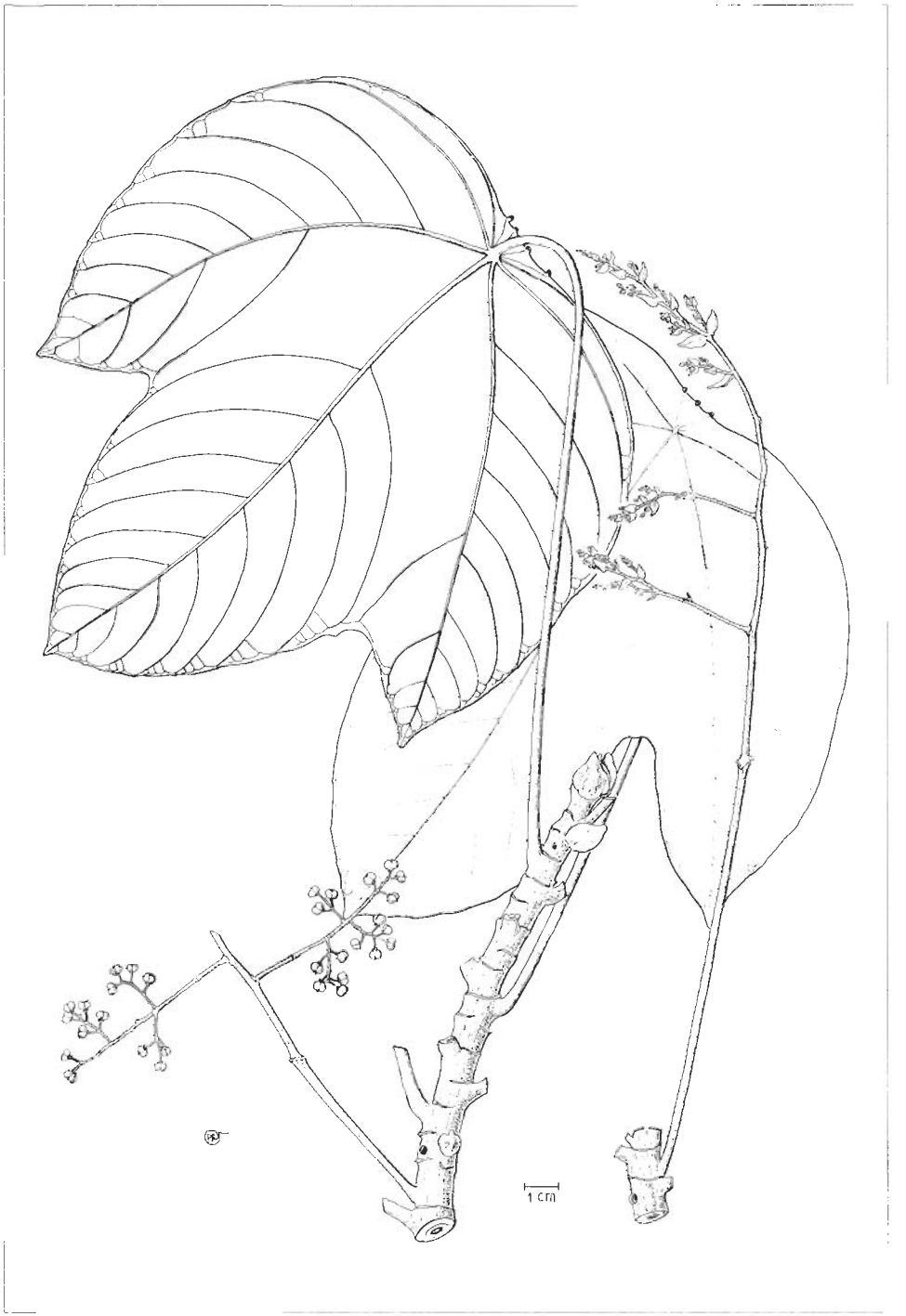

Figure 17. *Macaranga pearsonii* Merr. Habitus of pistillate plant and detail of staminate inflorescence.

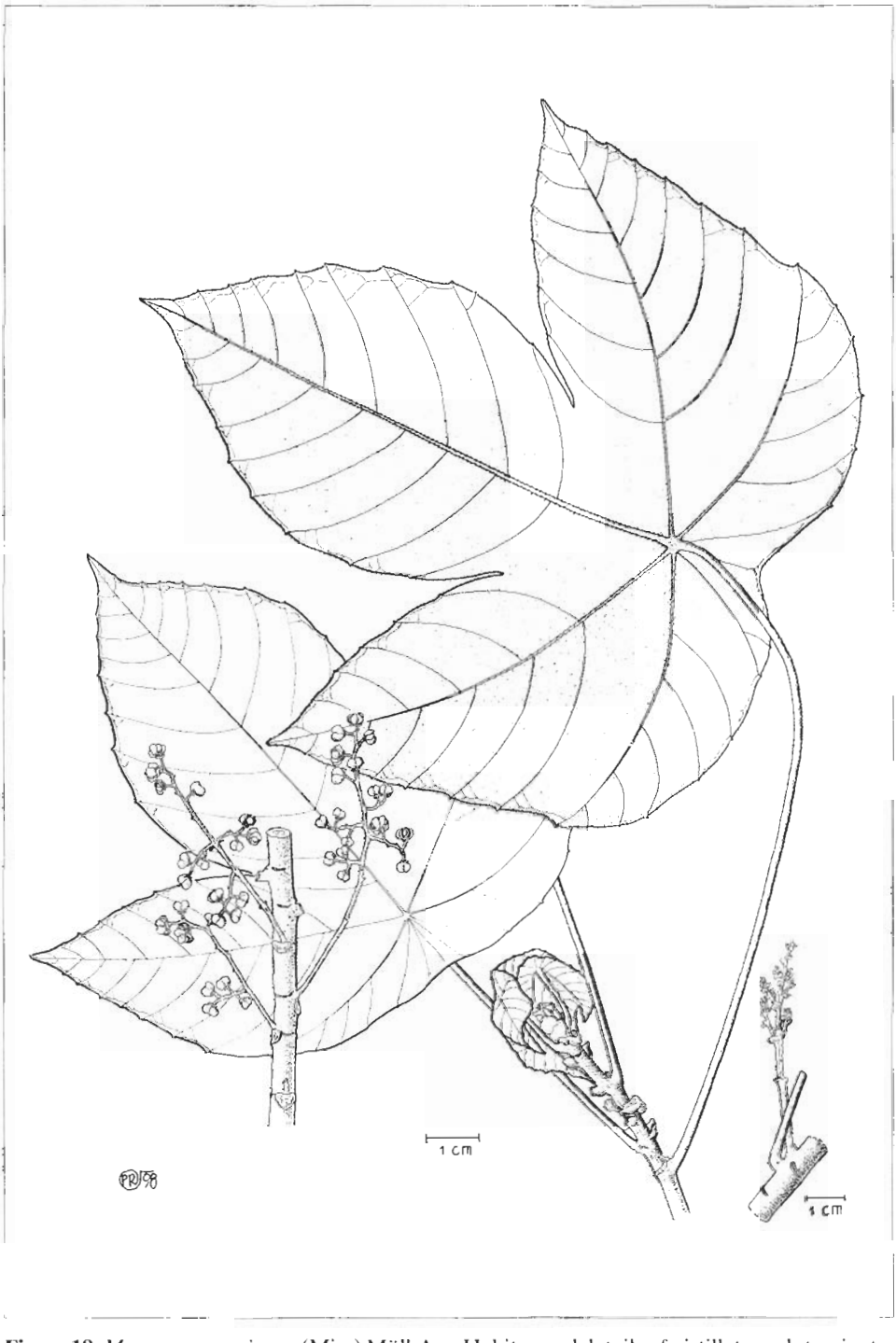

Figure 18. *Macaranga pruinosa* (Miq.) Müll.Arg. Habitus and details of pistillate and staminate inflorescences.

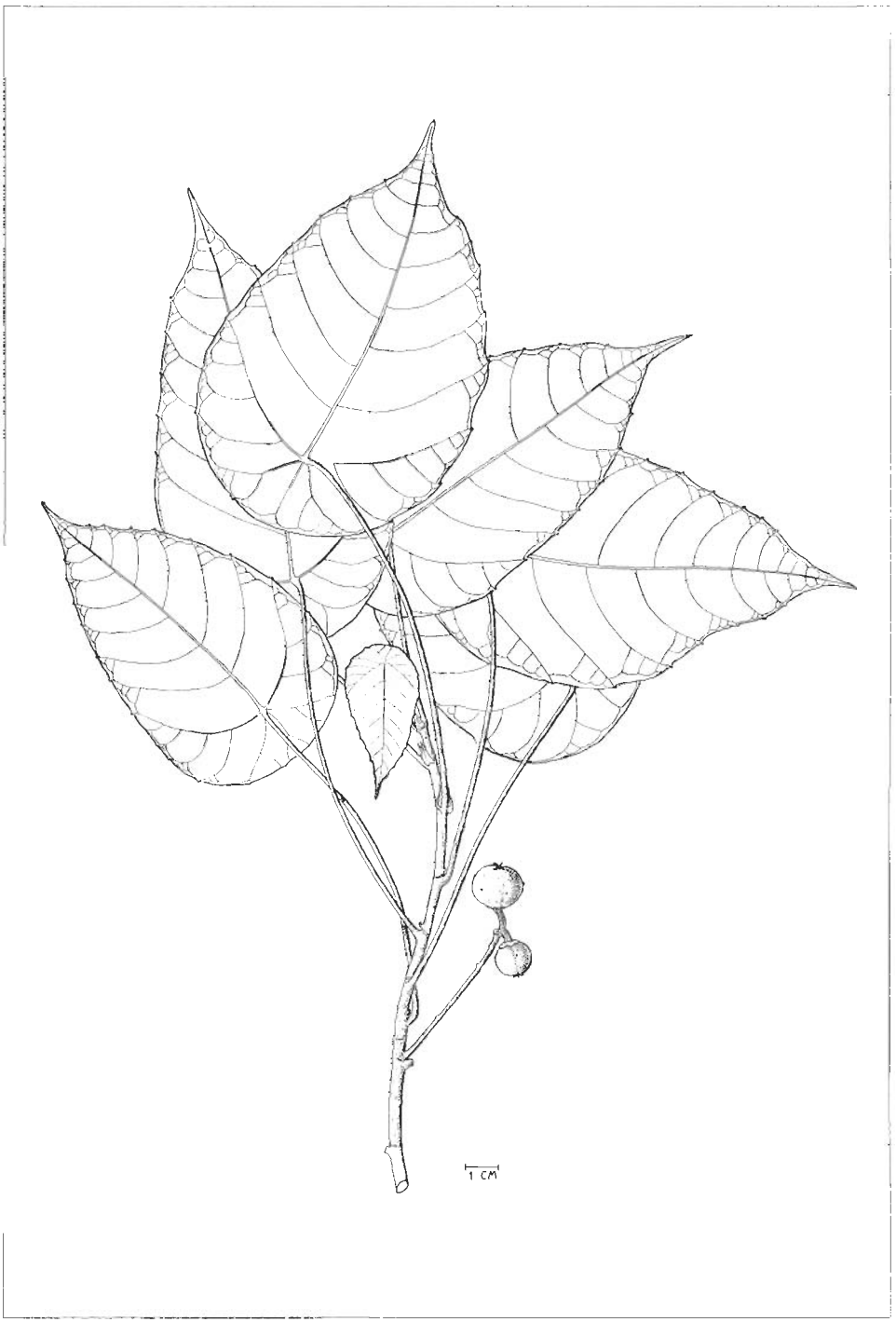

Figure 19. *Macaranga puncticulata* Gage. Habitus of pistillate plant. This is a specimen with solid stem. They can also have ant inhabited hollow stems with large openings (c. 2 mm across).

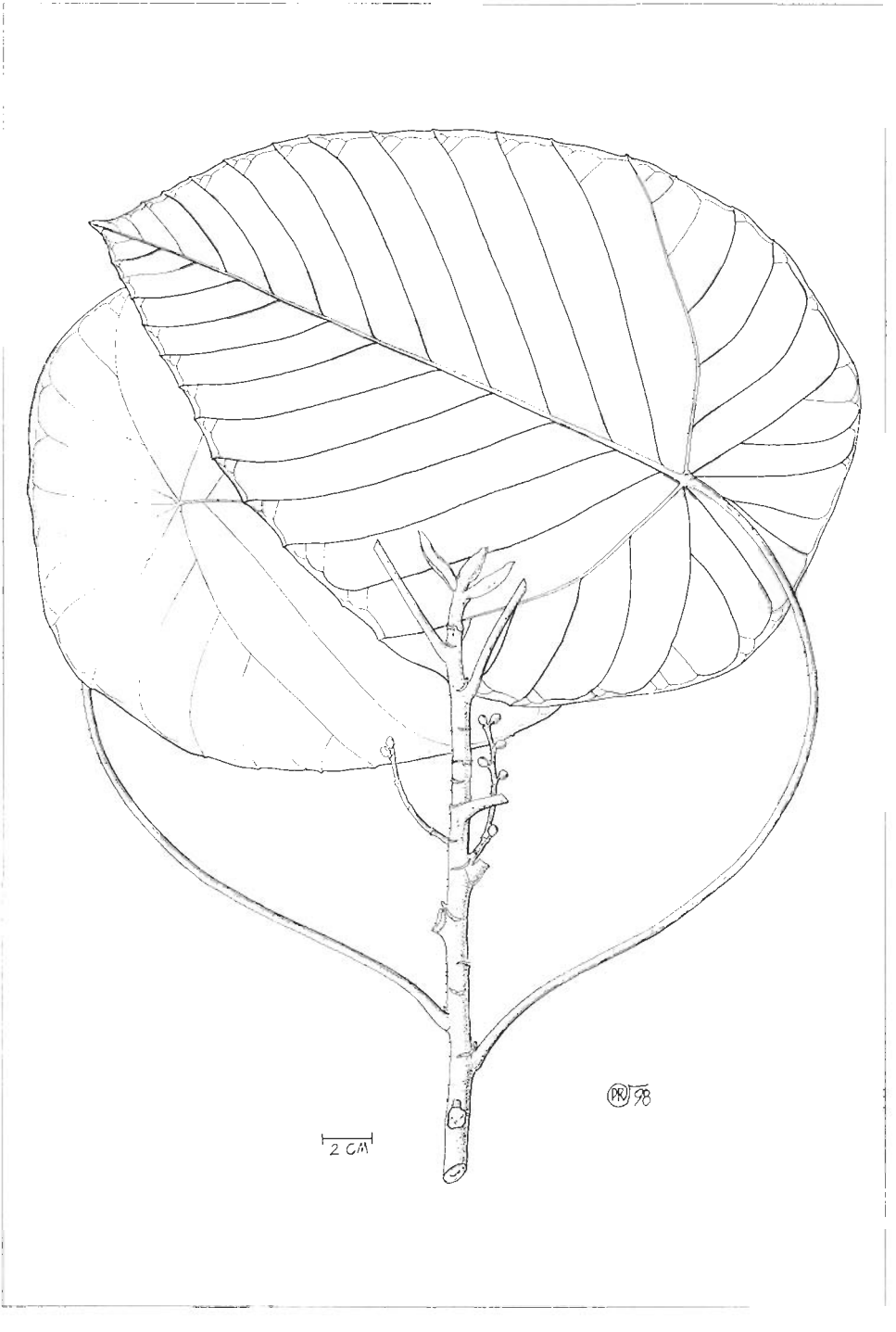

Figure 20. *Macaranga recurvata* Gage. Habitus of pistillate plant, with young fruits.

Figure 21. *Macaranga repando-dentata* Airy Shaw. Habitus of pistillate plant.

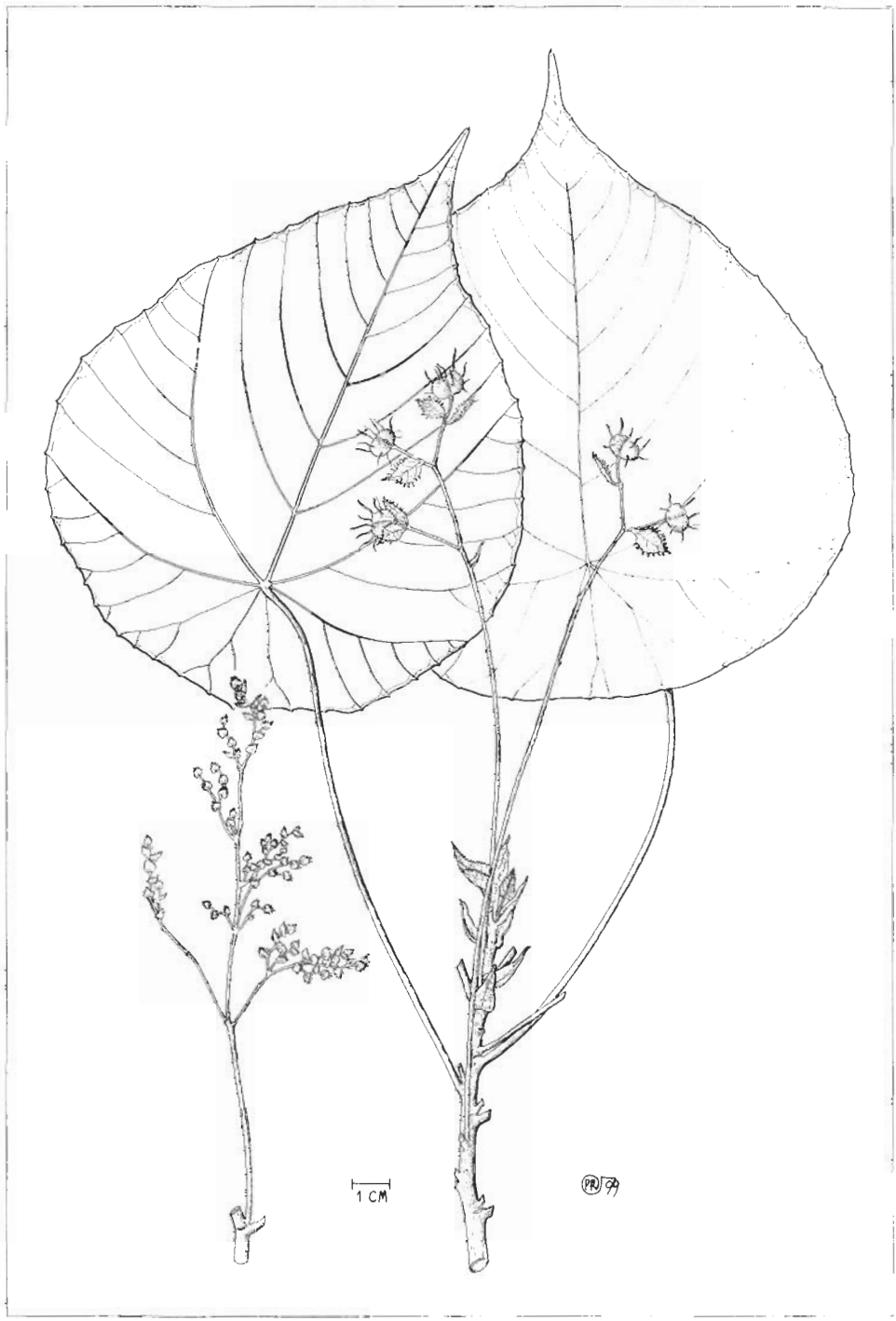

Figure 22. *Macaranga tanarius* (L.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

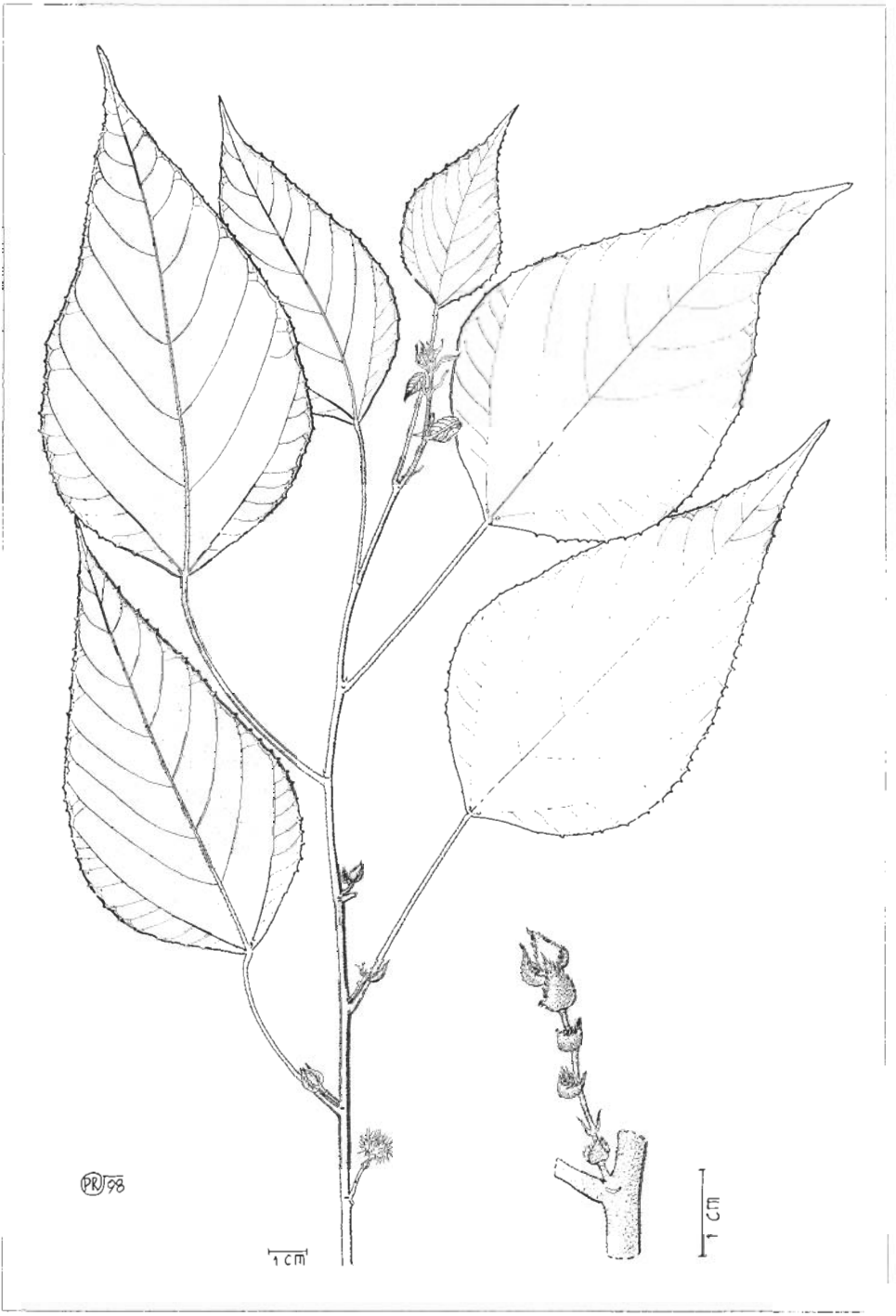

Figure 23. *Macaranga trichocarpa* (Rchb.f. & Zoll.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

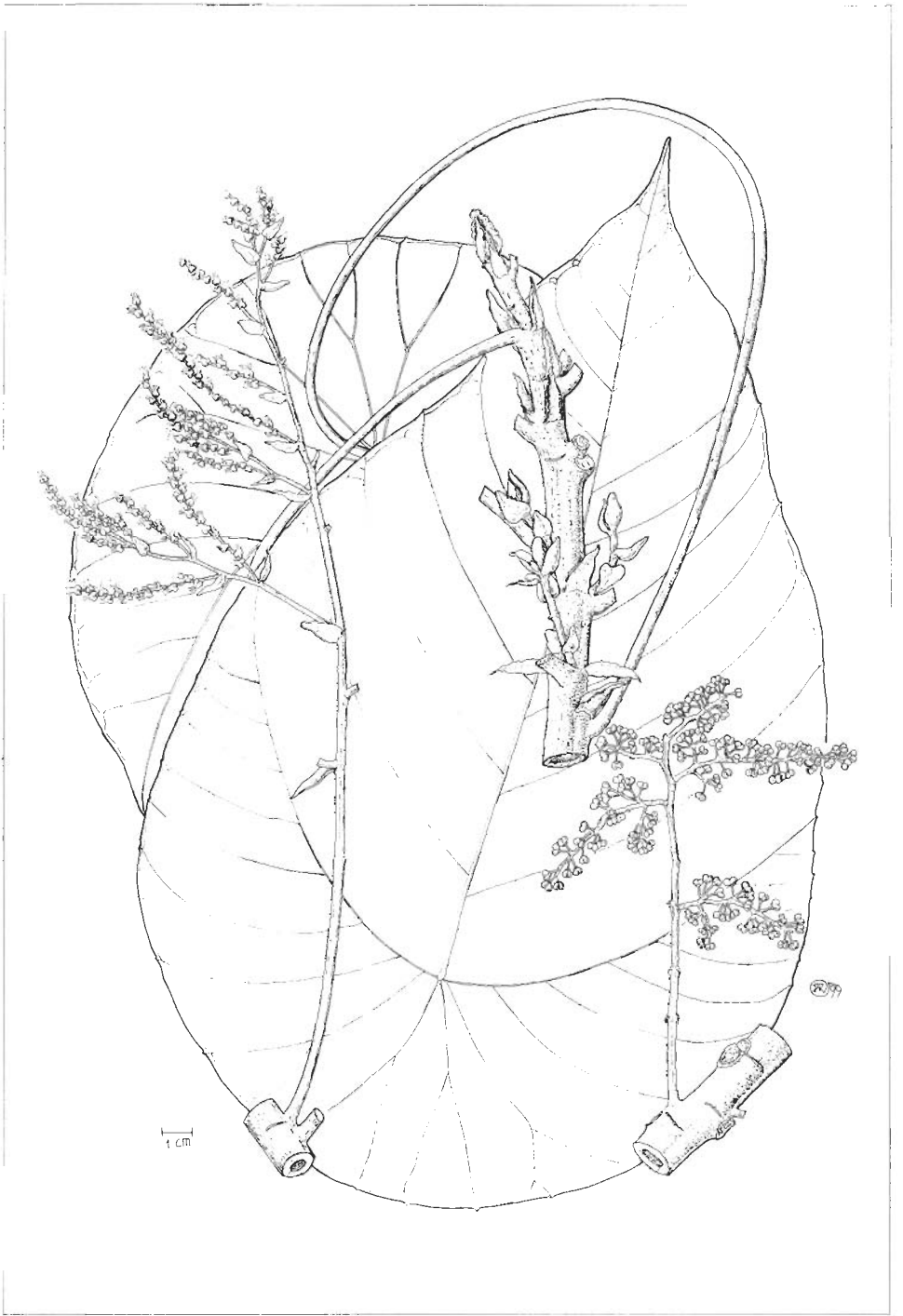

Figure 24. *Macaranga winkleri* Pax & K.Hoffm. Habitus and details of staminate and pistillate inflorescences.

Mallotus Lour.

Shrubs to trees up to 35 m tall, usually dioecious. Indumentum simple to tufted to stellate. *Bark* sometimes prominently hooped (rings around stem). *Wood* soft to hard. *Stipules* mostly small, often caducous. *Leaves* alternate to opposite (when opposite often unequal in size or shape), mostly small; blades sometimes peltate, usually not lobed (sometimes 3-cusped), penniveined to tripliveined to palmativeined, sometimes with hairy domatia, usually with basal macular glands on leaf uppersides, often gland dotted on leaf undersides, sometimes gland dotted on leaf uppersides. *Inflorescences* axillary to terminal, racemes to thyrses to panicles. *Staminate inflorescences* mostly unbranched thyrsoid racemes; bracts small, often caducous; flowers 1—9 per node, sepals 3 or 4, disc rarely present, stamens 15 to 150, anthers 2-celled, basi- to dorsi-fixed, connective often widened, pistil absent. *Pistillate inflorescences* mostly unbranched racemes; bracts small, often caducous; flowers 1, rarely 2 per node, sepals 2—9, ovary (2–)3(–4) locular, style long to short, apically splitting into (2–)3(–4) stigmas, papillae plumose. *Fruit* a capsule, smooth to spiny to winged, usually dehiscent into bivalved parts.

Key to the *Mallotus* Taxa

1a. Leaves peltate 2
1b. Leaves not peltate 4

2a. Petiole insertion usually more than 5 mm from lamina base. Plants often smelling of fenugreek when dried. Inflorescences never branched 3
2b. Petiole insertion usually less than 5 mm from lamina base. Plants never smelling of fenugreek when dried. Staminate inflorescences branched 13

3a. Vegetative parts glabrous. Leaf under surface with conspicuous hair tufts in axils of basal nerves ..... **3. M. floribundus**
3b. Vegetative parts extremely hairy. Leaf under surface without conspicuous hair tufts in axils of basal nerves ..... **6. M. lackeyi**

4a. Leaves opposite, unequal, one of each pair extremely small (less than 1 cm) and stipule-like (check carefully because the leaves look alternate at first glance !) 5
4b. Leaves alternate to opposite, if opposite and unequal, then the smaller

leaf cordate or the same shape as the larger leaf, never stipule-like .. 9

5a. Petioles of large leaves less than 1 cm long 6
5b. Petioles of large leaves longer than 1 cm 7

6a. Vegetative parts hairy ..... **2. M. eucaustus**
6b. Vegetative parts glabrous ..... **15. M. penangensis**

7a. Twigs, petioles and leaf under surface hairy ..... **17. M. stipularis**
7b. Twigs and petioles glabrous; leaf under surface glabrous to sparsely hairy 8

8a. Petioles usually more than 1 mm thick, up to 5(—8) cm long. Leaves ovate to rarely elliptic. Staminate inflorescences conspicuously branched, both pistillate and staminate inflorescences with numerous reddish-orange glands producing a sticky yellow exudate ..... **4. M. griffithianus**
8b. Petioles usually less than 1 mm thick, up to 2(—3) cm long. Leaves elliptic to obovate. Inflorescences never branched, without sticky yellow exudate ..... **15. M. penangensis**

9a. Majority of leaves alternate, sometimes apically on twigs also opposite 10
9b. Majority of leaves opposite 15

10a. Leaves penniveined ..... **14. M. peltatus**
10b. Leaves basally tripliveined 11

11a. All vegetative parts densely hairy. Twigs, petioles and leaf under surfaces mostly creamish brown, contrasting sharply with green upper surface 12
11b. All vegetative parts more or less glabrous (except sometimes petioles). Twigs, petioles and leaf under surfaces greenish, never creamish brown. (Note: The three species in section *Polyadenii* can only be distinguished with certainty if pistillate inflorescences are present) 18

12a. Leaf base with more than 2 macular glands ..... **16. M. repandus**
12b. Leaf base without or with 2 macular glands 13

13a. Leaves sometimes 3-cusped, base (cordate to) cuneate to attenuate, upper surface basally always with 2 conspicuous macular glands,

without a blackish area around them. Fruits not woolly, with few robust spine-like appendages ..... **13. M. paniculatus**

13b. Leaves rarely 3-cusped, base rounded to truncate to cordate, rarely attenuate, upper surface basally often with 2 inconspicuous macular glands with a blackish area around them. Fruits woolly, smooth or with numerous soft, spine-like appendages. 14

14a. Latex colourless, not turning black. Fruits without spine-like appendages ..... **8. M. macrostachyus**

14b. Latex turning black. Fruits with numerous soft, spiny appendages .... **10. M. mollissimus**

15a. Leaves opposite, strongly unequal in size. Small leaves clearly differing in shape compared with the large leaves. Petioles of the small leaves 1—3(—5) mm long 16

15b. Leaves all opposite or majority of leaves opposite, (slightly) unequal in size. Small leaves more or less the same shape as the large leaves. Petioles of the small leaves longer than 5 mm 17

16a. Petioles of large leaves always longer than 10 mm. Large leaves basally tripliveined to rarely penniveined ..... **1. M. dispar**

16b. Petioles of large leaves 1—7 mm long. Large leaves penniveined..... ..... **9. M. miquelianus**

17a. Vegetative parts usually glabrous (except sometimes petioles). Stipules early caducous. Majority of leaves opposite, leaves not to slightly differing in size or petiole length, upper surface usually densely gland dotted (Note: The three species in section *Polyadenii* can only be distinguished with certainty if pistillate inflorescences are present) 18

17b. Vegetative parts glabrous to densely hairy. Stipules persistent to caducous. Leaves opposite, conspicuously differing in size and petiole length, upper surface not densely gland dotted 20

18a. Petioles glabrous or with only a few scattered hairs. Pistillate pedicels 1.5—2.5(—4) cm long. Fruits with rounded carpels .... **7. M. leucodermis**

18b. Petioles glabrous to hairy. Pistillate pedicels c. 0.5 cm long. Fruits with large wings or angular carpels 19

19a. Petioles glabrous or with only a few scattered hairs. Fruits with angular carpels, spine-like wings absent ..... **12. M. muticus**

19b. Petioles (glabrous to) short hairy. Fruits with spine-like wings, 1.5—3 cm long ..... **18. M. sumatranus**

20a. Leaf base with two conspicuous macular glands placed on the first pair of veins ..... **19. M. wrayi**
20b. Leaf base with several (more than 2) sometimes inconspicuous macular glands placed on the lamina, between the veins 21

21a. Leaves with second pair of veins originating c. half way up or higher on the lamina ..... **5. M. korthalsii**
21b. Leaves with second pair of veins originating clearly less than half way up the lamina ..... **11. M. moritzianus**

1. Mallotus dispar (Blume) Müll.Arg. (Fig. 25)

Diagnostic characters: Shrubs or small trees up to 15 m tall, dbh up to 10 cm. Most parts usually hairy (stellate or tufted). Leaves opposite (alternate when young), strongly unequal in size and shape; petioles of small leaves less than 5 mm long, of large leaves more than 1 cm long; small leaves cordate; large leaves triplivcined to penniveined, upper surfaces usually without or with inconspicuous basal macular glands. Staminate inflorescence unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, fruits spiny.

Habitat & ecology: Lowland up to 750 m altitude. In the understorey of primary forest or in lightly disturbed secondary forest (selectively logged). Sandy loam and limestone soils.

Distribution: From Thailand southward into Peninsular Malaysia, Sumatra, Java, Borneo and the Philippines. Found throughout East Kalimantan.

2. Mallotus eucaustus Airy Shaw (Fig. 26)

Diagnostic characters: Trees up to 25 m tall, dbh up to 25 cm. Bole straight. Bark smooth, hooped. Most parts densely short simple-haired. Leaves distichous, opposite, strongly unequal in size and shape, small leaves reduced to stipule-like structures without petioles; large leaves penniveined, upper surface without basal macular glands. Staminate inflorescences unbranched, one flower per node. Pistillate inflorescences with several fruits developing, fruits short spiny.

Habitat & ecology: Lowland up to 300 m altitude. In primary forest understorey or in lightly disturbed secondary forest (selectively logged). On sandy, and clayey loam soils.

Distribution: Endemic to Borneo. In East Kalimantan found north of the Mahakam river.

3. Mallotus floribundus (Blume) Müll.Arg. (Fig. 27)

Diagnostic characters: Shrubs to trees up to 20 m tall, dbh up to 15 cm. Strongly smelling of fenugreek when dried. More or less glabrous with some scattered simple to stellate to tufted hairs. Leaves alternate to apically pseudo-opposite, peltate, upper surface with several basal macular glands, under surface with conspicuous hairy domatia at petiole insertion, often glaucous, usually densely gland dotted. Staminate inflorescences unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, fruits with long spines.

Habitat & ecology: In disturbed sites in primary forest (gaps) and in secondary forest. Often along rivers or in swampy areas but also on dry places. On sandy to sandstone soils.

Distribution: From Thailand and Indo-China to the Solomon Islands. In East Kalimantan found north of the Mahakam river.

4. Mallotus griffithianus (Müll.Arg.) Hook.f. (Fig. 28)

Diagnostic characters: Trees up to 15 m tall, dbh up to 15 cm. Bole straight. Bark smooth, hooped. Mostly glabrous with some scattered simple hairs. Leaves opposite, strongly unequal in size and shape; small leaves reduced to stipule-like structures without petioles; petioles of large leaves strongly kneed distally, blade penniveined, upper surface without basal macular glands. Staminate inflorescences branched, densely gland-dotted, glands excreting yellow sticky fluid, one flower per node. Pistillate inflorescences with several fruits developing, densely gland dotted, glands excreting yellow sticky fluid, pedicels very long, up to 2 cm, fruits long spiny, each spine with a terminal gland.

Habitat & ecology: Up to 360 m altitude. In understorey of primary forest or in lightly disturbed secondary forest (selectively logged). On sandy, loamy or tuff soils.

Distribution: Peninsular Malaysia and Borneo. Found throughout East Kalimantan.

5. Mallotus korthalsii Müll.Arg. (Fig. 29)

Diagnostic characters: Shrubs to trees up to 15 m tall, dbh up to 15 cm. Bark smooth. More or less glabrous to simple to stellate to tufted hairy. Leaves opposite (alternate when young), unequal in size, tripliveined, second pair of veins arising in the upper half of the lamina, upper leaf surface with several basal macular glands on the lamina between the secondary veins. Staminate inflorescences unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, spiny.

Habitat & ecology: Up to 2000 m altitude, usually much lower. In the understorey of primary forest and in secondary forest. On sandy clay, sandy loam, and limestone soils.

Distribution: Peninsular Malaysia, Borneo, and the Philippines. Found throughout East Kalimantan.

6. Mallotus lackeyi Elmer (Fig. 30)

Diagnostic characters: Shrubs to small trees up to 10 m tall, dbh up to 10 cm. Plants smelling strongly of fenugreek when dried. Most parts densely tufted to stellate haired. Bole crooked. Bark smooth to knobby to flaky. Leaves alternate to apically pseudo-opposite, peltate, upper surface with several basal macular glands, usually gland dotted, under surface densely hairy, gland dotted. Staminate inflorescences unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, fruits short spiny.

Habitat & ecology: Up to 1200 m altitude. In the understorey of primary forest to secondary forest. Often along streams and rivers, on inundated terrain but also on dry slopes. On sandy loam, clay and limestone soils.

Distribution: Borneo and the Philippines. Found throughout East Kalimantan.

7. Mallotus leucodermis Hook.f. (Fig. 31)

Diagnostic characters: Trees up to 35 m tall, dbh up to 55 cm. More or less glabrous with some scattered simple to stellate hairs. Steep buttresses

present to absent. Bole straight. Bark rough to smooth, dippled, brittle, with small flakes. Wood hard. Leaves alternate to rarely opposite, when opposite then only slightly unequal in size, tripliveined, upper surface usually with several basal macular glands, usually densely gland-dotted. Staminate inflorescences unbranched, with several flowers per node. Pistillate inflorescences with several fruits developing, pedicels very long (up to 4.5 cm), fruits smooth, globose carpels.

Habitat & ecology: Up to 1440 m altitude. In primary forest, sometimes in secondary forest as a primary forest remnant species. On swampy as well as dry places. On loamy soils, sometimes mixed with limestone.

Distribution: Peninsular Malaysia to New Guinea. Found throughout East Kalimantan.

8. Mallotus macrostachyus (Miq.) Müll.Arg. (Fig. 32)

Diagnostic characters: Shrubs to trees up to 12 m tall, dbh up to 15 cm. All parts densely flaky brown-creamish hairy. Bole not straight. Bark smooth, lenticelled. Leaves alternate, often slightly peltate (up to 5 mm free base) to cordate, upper surface usually with two inconspicuous basal macular glands surrounded by blackish coloured stain when dried, green upper surface contrasting sharply with brown-creamish hairy under surface. Staminate inflorescences branched, with several flowers per node. Pistillate inflorescences with several fruits developing, fruits smooth, brown-creamish woolly.

Habitat & ecology: Up to 900 m altitude. Mainly in severely disturbed secondary forest (after fire and shifting-cultivation), rarely in primary forest. On sandy and sandy loam soils.

Distribution: From Thailand southward into Peninsular Malaysia, Sumatra, and Borneo. Found throughout East Kalimantan.

9. Mallotus miquelianus (Scheff.) Boerl. (Fig. 33)

Diagnostic characters: Shrubs up to 5 m tall, dbh up to 5 cm. Almost glabrous to densley simple to stellate to tufted hairy. Forming sprouts along root-stalks. Leaves opposite, strongly unequal in size and shape; petiole of small leaves up to 5 mm long, blade cordate, tripliveined, upper surface with two to several large basal macular glands; petiole of large leaves up to 7 mm long, blade obovate, penniveined, upper surface with

several large basal macular glands. Staminate inflorescences unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, fruits short spiny.

Habitat & ecology: Up to 600 m altitude. In the understorey of primary forest and in secondary forests (selectively logged). Often in swampy places but also on well drained soils. On sandy and limestone soils.

Distribution: From Thailand southward into Peninsular Malaysia, Sumatra, Borneo and the Philippines. Found throughout East Kalimantan.

10. Mallotus mollissimus (Geisel.) Airy Shaw (Fig. 34)

Diagnostic characters: Shrubs to trees up to 15 m tall, 15 cm diameter. Latex clear, turning black. All parts densely flaky brown-creamish hairy. Leaves alternate, often slightly peltate (up to 5 mm free base) to cordate, upper surface usually with two inconspicuous basal macular glands surrounded by blackish coloured stain when dried, green upper surface contrasting sharply with brown-creamish hairy under surface. Staminate inflorescences branched, with several flowers per node. Pistillate inflorescences with several fruits developing, fruits with numerous soft spines, brown-creamish woolly.

Habitat & ecology: Up to 1500 m altitude. Mainly in secondary forest (logged, burnt), rare in primary forest. Along roads, streams and rivers. On sandy loam soils.

Distribution: From Myanmar and Indo-China to New Guinea and Australia. Found throughout East Kalimantan.

11. Mallotus moritzianus Müll.Arg. (Fig. 35)

Diagnostic characters: Shrubs to trees up to 10 m tall, dbh up to 10 cm. Bark smooth. Usually simple to stellate to tufted hairy. Leaves opposite (alternate when young), unequal in size, tripli- to penni-veined, second pair of veins arising in the lower half of the lamina, upper leaf surface with several basal macular glands on the lamina between the secondary veins. Staminate inflorescences unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, spiny.

Habitat & ecology: Up to 1000 m altitude. Primary and secondary forest. On stream banks, periodically inundated land, but also well drained land.

On sandstone, clayey loam and sandstone soils.

Distribution: Peninsular Malaysia, Sumatra, Java, Lesser Sunda Islands, and Borneo. Found north of the Mahakam river in East Kalimantan.

12. Mallotus muticus (Müll.Arg.) Airy Shaw (Fig. 36)

Diagnostic characters: Trees up to 35 m tall, dbh up to 70 cm. More or less glabrous with some scattered simple to stellate hairs. Buttresses up to 7 m tall, 1 m wide at base. Bole straight, slightly fluted. Bark smooth, flaky. Wood hard. Leaves alternate to rarely opposite, when opposite then only slightly unequal in size, tripliveined, upper surface usually with several basal macular glands, usually densely gland dotted, under surface often with hairy domatia. Staminate inflorescences unbranched, with several flowers per node. Pistillate inflorescences with several fruits developing, pedicels short (up to c. 5 mm long), fruits smooth, indehiscent, angular carpels.

Habitat & ecology: Up to 500 m altitude. In primary forest, swamp forest and in secondary forest as a primary forest remnant. Often on periodically inundated or swampy terrain, but also on dry terrain. On clay rich to sandy soils.

Distribution: Peninsular Malaysia, Sumatra and Borneo. Found throughout East Kalimantan.

13. Mallotus paniculatus (Lam.) Müll.Arg. (Fig. 37)

Diagnostic characters: Shrubs to trees, up to 25 m tall, dbh up to 25 cm. Bole straight. Bark cracked, lenticellate, latex red. All parts densely flaky brown-creamish hairy. Leaves alternate, rarely slightly peltate (up to 5 mm free base), usually tripliveined, base attenuate to obtuse, upper surface usually with two conspicuous basal macular glands, not surrounded by blackish coloured stain when dried, green upper surface contrasting sharply with brown-creamish hairy under surface. Staminate inflorescences branched, with several flowers per node. Pistillate inflorescences with several fruits developing, fruits with few spine-like appendages, short brown-creamish hairy.

Habitat & ecology: Up to 1500 m altitude. Mainly in heavily disturbed secondary forest (after fire, abandoned shifting-cultivation), rarely in primary forest. Along roads, streams, on land slides. On sandy clay soils.

Distribution: From south China to New Guinea and Australia. Found throughout East Kalimantan.

14. Mallotus peltatus (Geisel.) Müll.Arg. (Fig. 38)

Diagnostic characters: Shrubs to trees up to 12 m tall, dbh up to 10 cm. Strongly smelling of fenugreek when dried. More or less glabrous with some scattered simple to stellate to tufted hairs. Leaves alternate to apically pseudo-opposite, not peltate (outside Kalimantan often also peltate), penniveined, upper surface with several basal macular glands, under surface with conspicuous hairy domatia along the midrib. Staminate inflorescences unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, fruits with long spines.

Habitat & ecology: Up to 450 m altitude. In primary and secondary forests. Often along streams and rivers, along roads, and inundated terrains. On sandy loam, and limestone soils.

Distribution: From east India and south China to New Guinea. Found throughout East Kalimantan.

15. Mallotus penangensis Müll.Arg. (Figs 39 and 40)

Diagnostic characters: Trees up to 25 m tall, dbh up to 30 cm. Bole straight. Bark smooth, hooped. More or less glabrous with some scattered short simple hairs. Leaves opposite, strongly unequal in size and shape, small leaves reduced to stipule-like structures without petioles; petioles of large leaves very variable in length (from 1 to 4.5 cm long), blade penniveined, upper surface without basal macular glands, under surface sometimes with hairy domatia. Staminate inflorescences unbranched, one flower per node. Pistillate inflorescences usually with only terminal fruit developing, fruits long spiny.

Habitat & ecology: Up to 1200 m altitude. In the understorey of primary forest and in lightly disturbed secondary forest (selectively logged). On sandy loam or (red) clay soils, also found on limestone.

Distribution: From Thailand to New Guinea. Found throughout East Kalimantan.

16. Mallotus repandus (Willd.) Müll.Arg.

Diagnostic characters: Shrubs up to 3 m tall. Most parts densely brown-creamish simple to stellate hairy. Leaves alternate, tripliveined, upper surface with several basal macular glands, under surface densely gland dotted. Staminate inflorescences branched, several flowers per node. Pistillate inflorescences with several fruits developing, fruits 2-locular, smooth.

Habitat & ecology: Up to 420 m altitude. Mainly in secondary forest and scrub.

Distribution: India and Sri Lanka to New Guinea and Australia. Found north of the Sankulirang limestone mountain range in East Kalimantan (Berau).

17. Mallotus stipularis Airy Shaw (Fig. 41)

Diagnostic characters: Trees up to 20 m tall, dbh up to 20 cm. Bole straight. Bark smooth, hooped. Most parts with long simple hairs. Stipules large, margins with long simple hairs, apex usually round. Leaves opposite, strongly unequal in size and shape, small leaves reduced to stipule-like structures without petioles; blade penniveined, upper surface without basal macular glands, under surface usually with hairy domatia. Staminate inflorescences unbranched, one flower per node. Pistillate inflorescences with several fruits developing, fruits short spiny.

Habitat & ecology: Up to 950 m altitude. In the understorey of primary forest and in lightly disturbed secondary forest (selectively logged). On clay rich soils.

Distribution: Thailand, Sumatra and Borneo. Only found north of the Sankulirang limestone mountain range in East Kalimantan.

18. Mallotus sumatranus (Miq.) Airy Shaw (Fig. 42)

Diagnostic characters: Trees up to 12 m tall, dbh up to 20 cm. More or less glabrous to simple to stellate hairy on petioles. Leaves usually opposite, only slightly unequal in size, tripliveined, upper surface usually with several basal macular glands, usually densely gland dotted, under surface often with hairy domatia. Staminate inflorescences unbranched, with several flowers per node. Pistillate inflorescences with several fruits developing,

pedicels short (up to c. 5 mm long), fruits smooth, indehiscent, with long pointed wings up to 3 cm long.

Habitat & ecology: Up to 50 m altitude. In primary forest, often in swamp forest.

Distribution: Sumatra and Borneo. Found along the Mahakam river in East Kalimantan (Kutai).

19. Mallotus wrayi King ex Hook.f. (Fig. 43)

Diagnostic characters: Shrubs to trees up to 19 m tall, dbh up to 15 cm. Bole sometimes crooked, branching midway up. Bark smooth. From almost glabrous to densely simple to stellate to tufted hairy. Leaves opposite (alternate when young), unequal in size, tripliveined, second pair of veins arising in the lower half of the lamina, upper leaf surface with two conspicuous basal macular glands on the first secondary veins. Staminate inflorescences unbranched, several flowers per node. Pistillate inflorescences with several fruits developing, spiny.

Habitat & ecology: Up to 1200 m altitude. In primary and slightly disturbed secondary forest (selectively logged). However, the species sprouts after fire and can thus also be present in burnt forest. On swampy to well drained, sandy to loamy to clayey soils.

Distribution: Peninsular Malaysia, Sumatra and Borneo. Found throughout East Kalimantan.

Figure 25. *Mallotus dispar* (Blume) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

Figure 26. *Mallotus eucaustus* Airy Shaw. Habitus of pistillate plant and detail of staminate inflorescence.

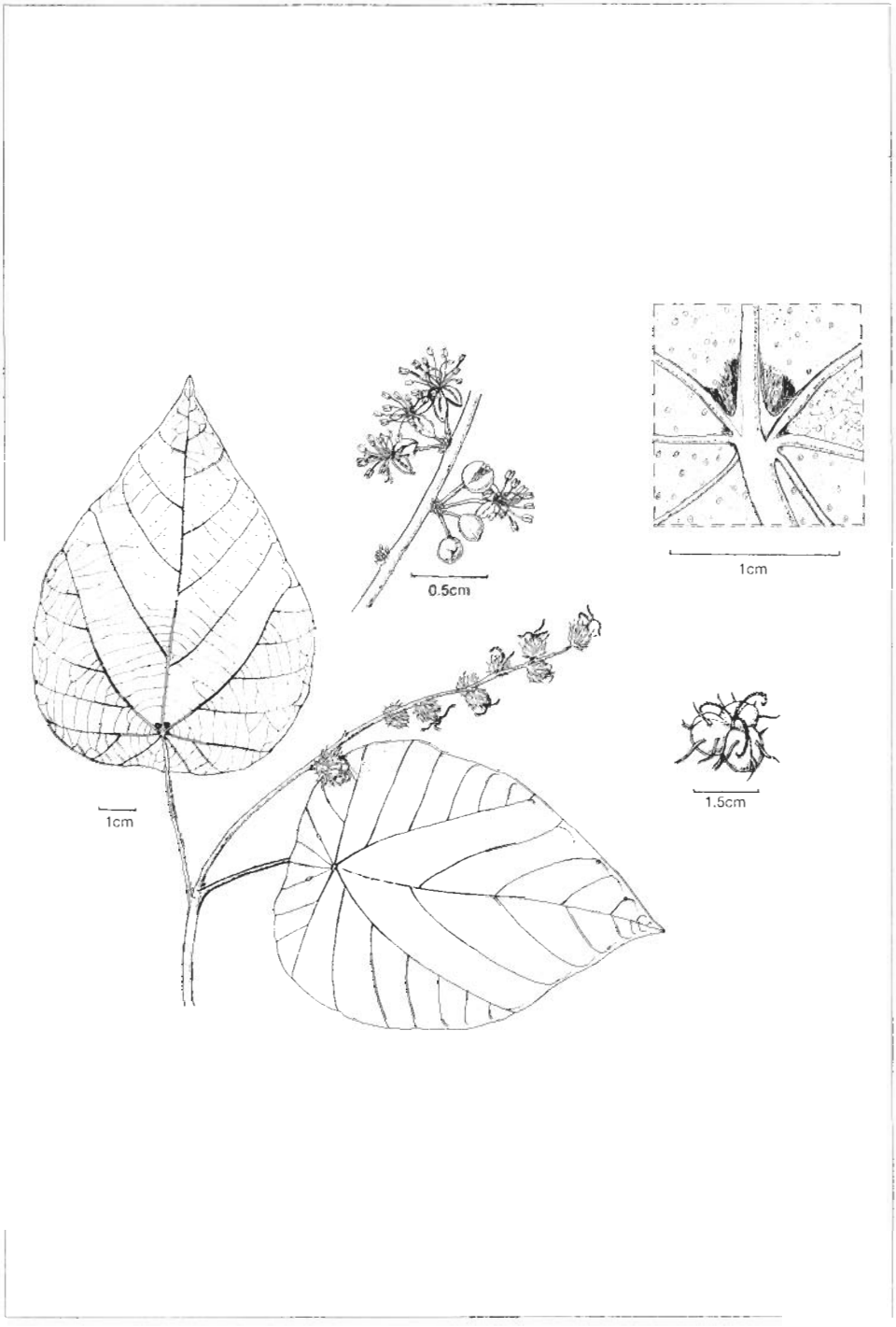

Figure 27. *Mallotus floribundus* (Blume) Müll.Arg. Habitus of pistillate plant and details of staminate flowers, a fruit and the domatia at the petiole on the leaf underside.

Figure 28. *Mallotus griffithianus* (Müll.Arg.) Hook.f. Habitus of pistillate plant and detail of staminate inflorescence.

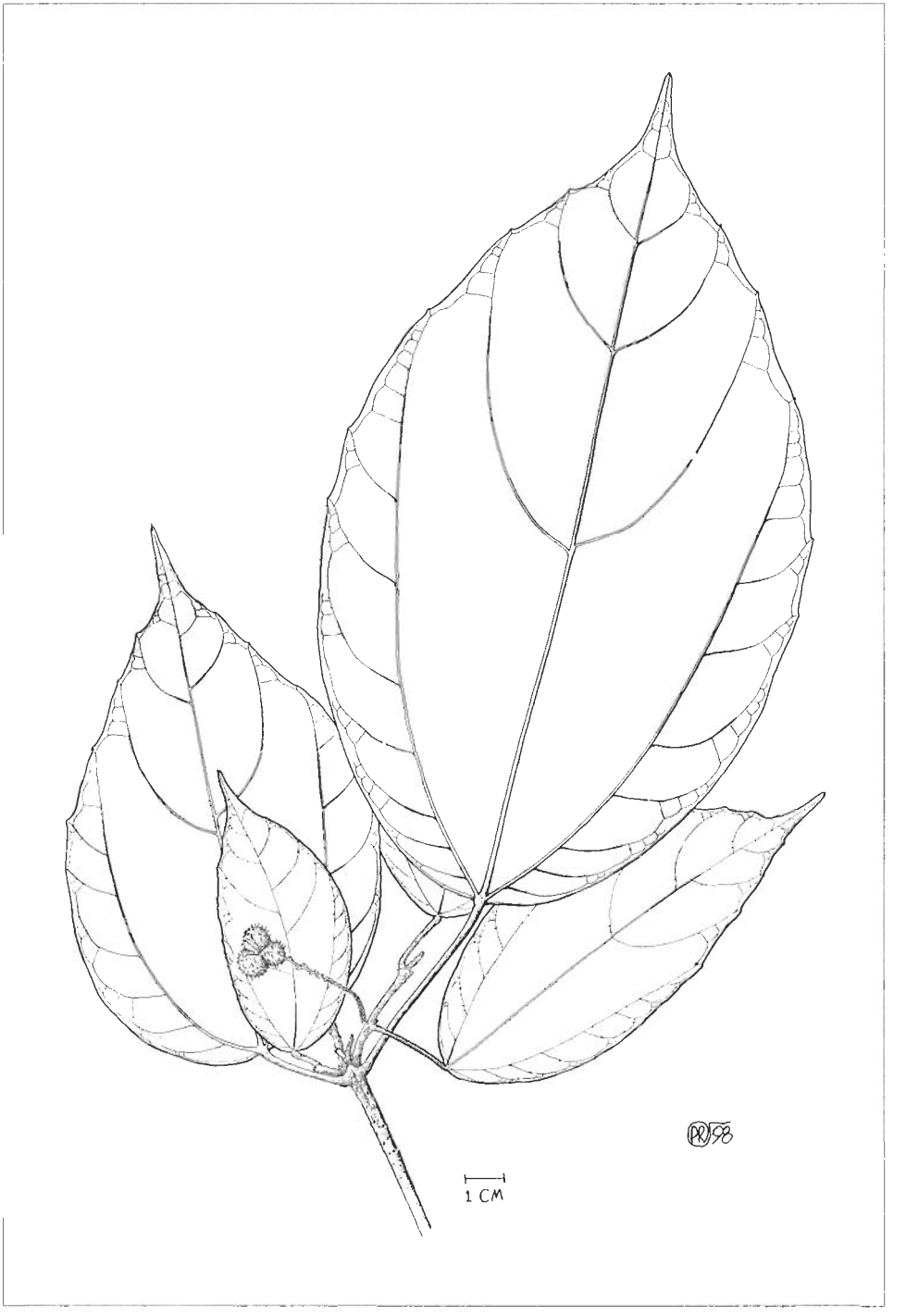

Figure 29. *Mallotus korthalsii* Müll.Arg. Habitus of pistillate plant.

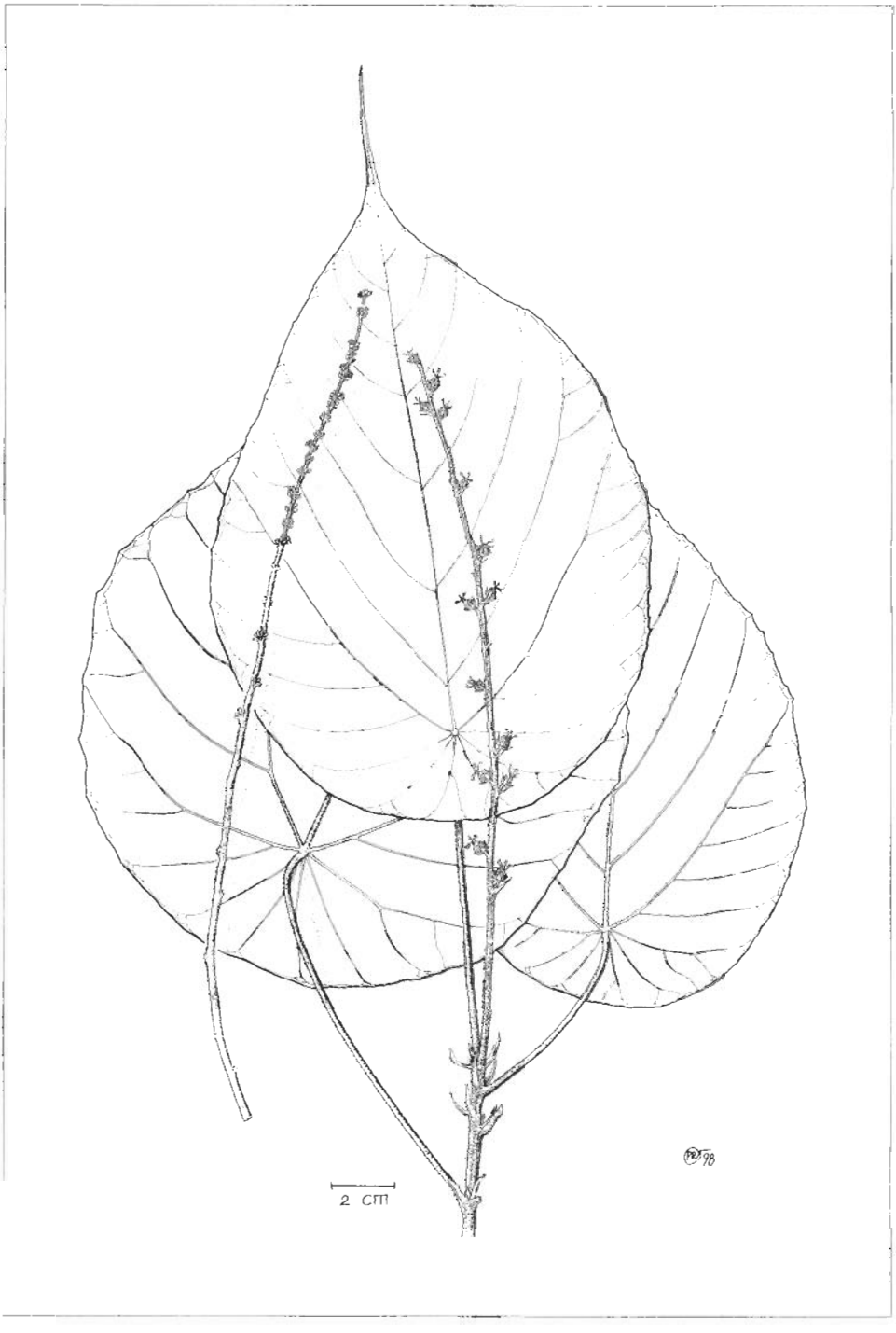

Figure 30. *Mallotus lackeyi* Elmer. Habitus of pistillate plant and detail of staminate inflorescence.

Figure 31. *Mallotus leucodermis* Hook.f. Habitus of pistillate plant and detail of staminate inflorescence.

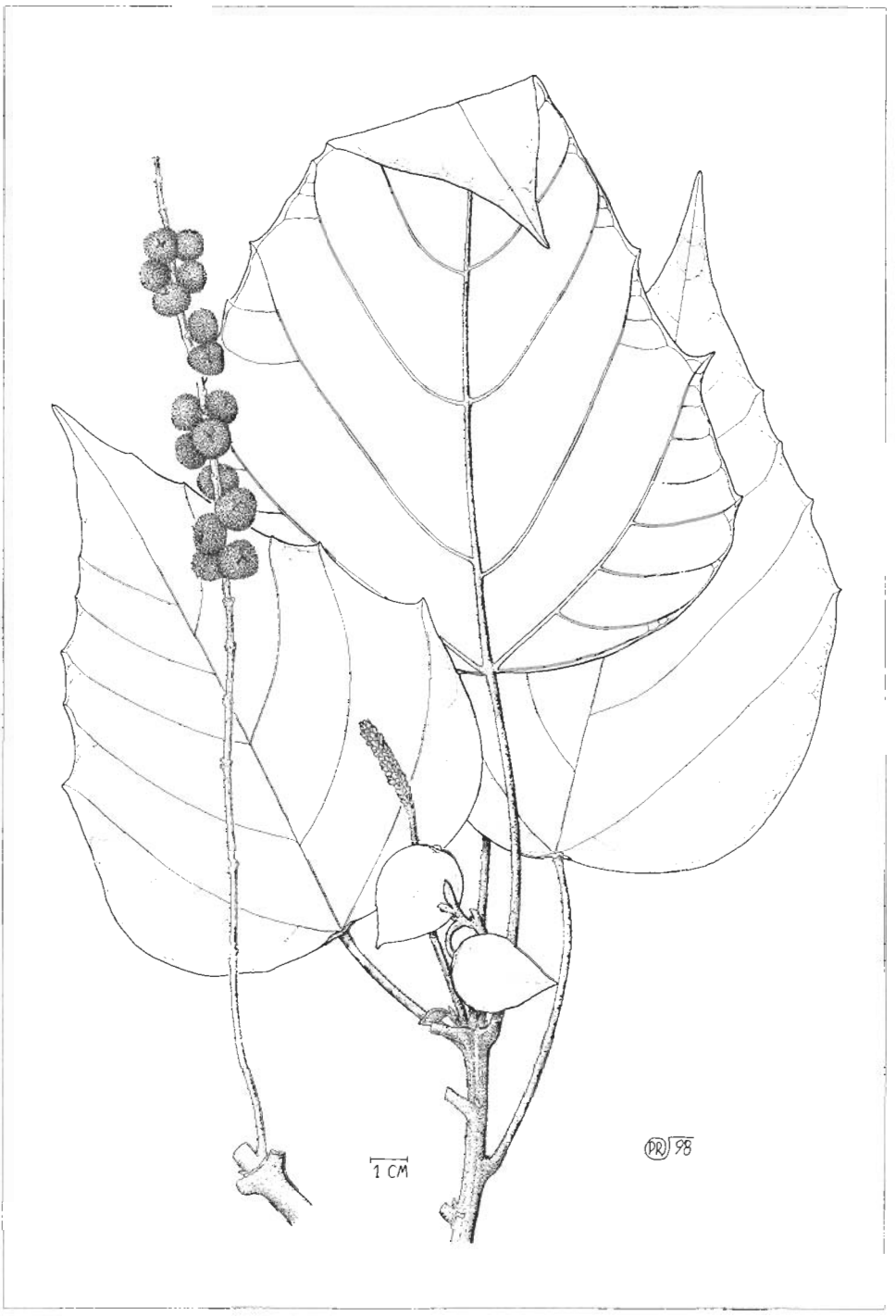

Figure 32. *Mallotus macrostachyus* (Miq.) Müll.Arg. Habitus of young staminate plant and detail of pistillate inflorescence.

Figure 33. *Mallotus miquelianus* (Scheff.) Boerl. Habitus of pistillate plant and detail of staminate inflorescence.

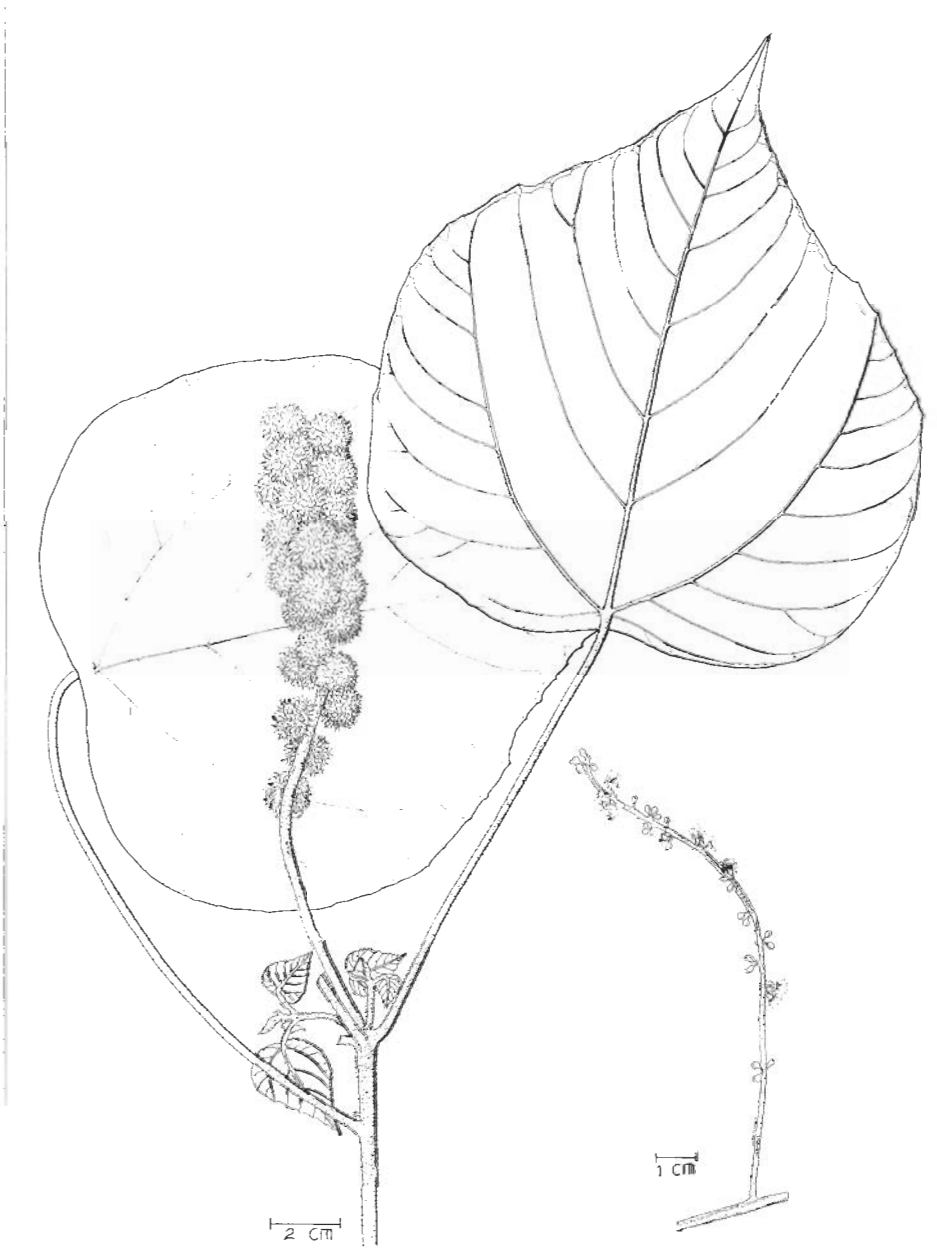

Figure 34. *Mallotus mollissimus* (Geisel.) Airy Shaw. Habitus of pistillate plant and detail of a part of the staminate inflorescence.

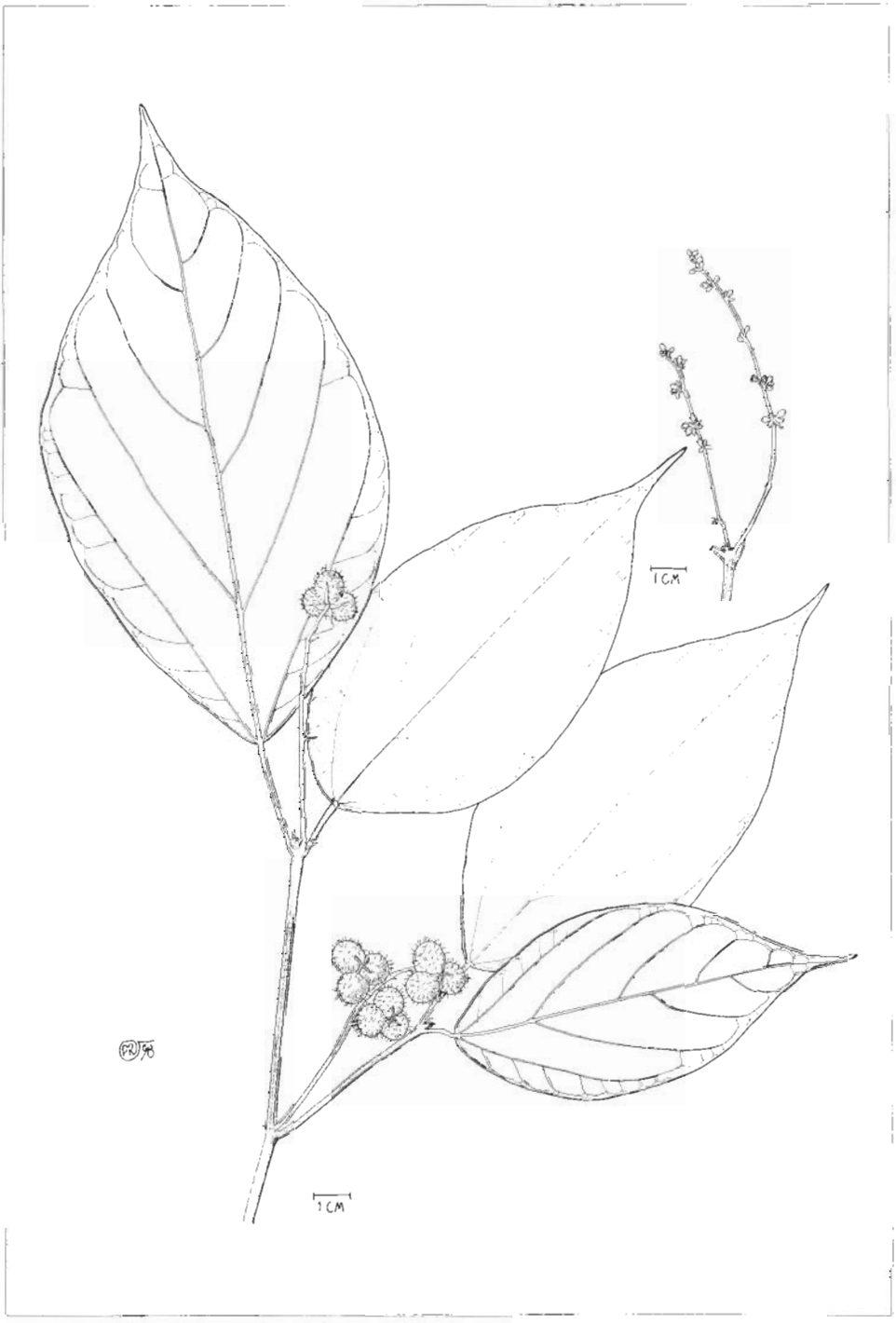

Figure 35. *Mallotus moritzianus* Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

Figure 36. *Mallotus muticus* (Müll.Arg.) Airy Shaw. Habitus and detail of pistillate inflorescence.

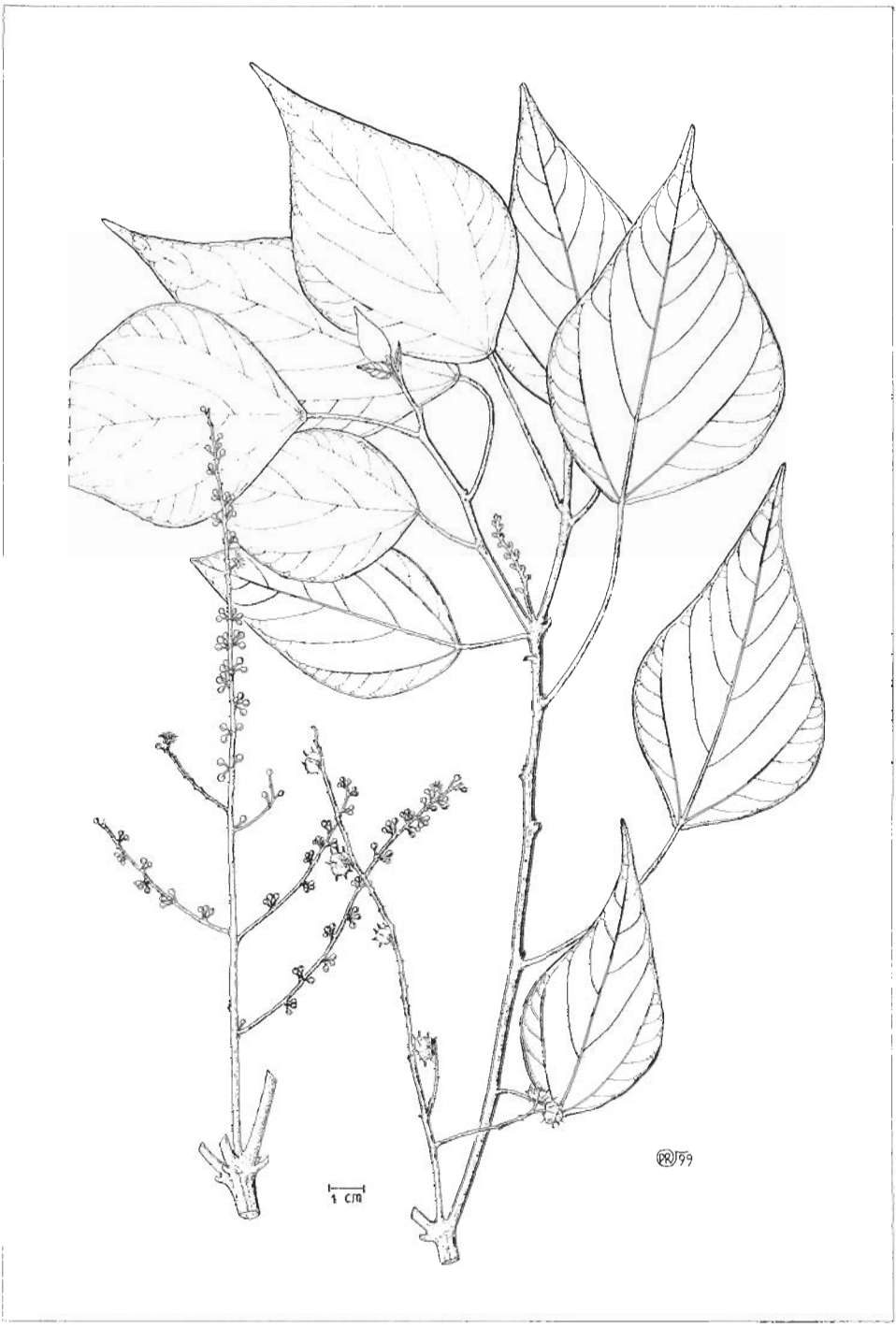

Figure 37. *Mallotus paniculatus* (Lam.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

Figure 38. *Mallotus peltatus* (Geisel.) Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

Figure 39. *Mallotus penangensis* Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

Figure 40. *Mallotus penangensis* Müll.Arg. Habitus of pistillate plant and detail of staminate inflorescence.

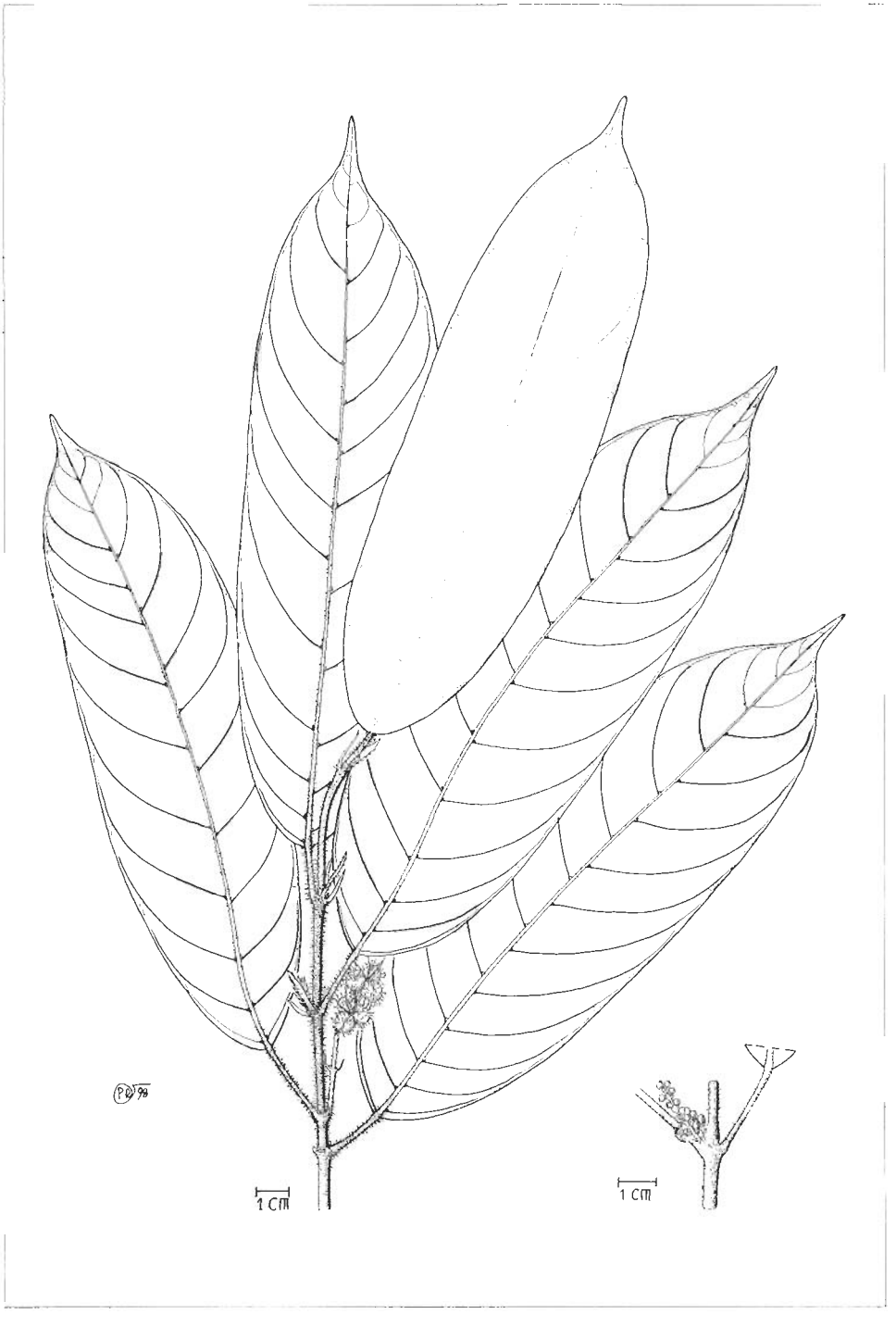

Figure 41. *Mallotus stipularis* Airy Shaw. Habitus of pistillate plant and detail of staminate inflorescence.

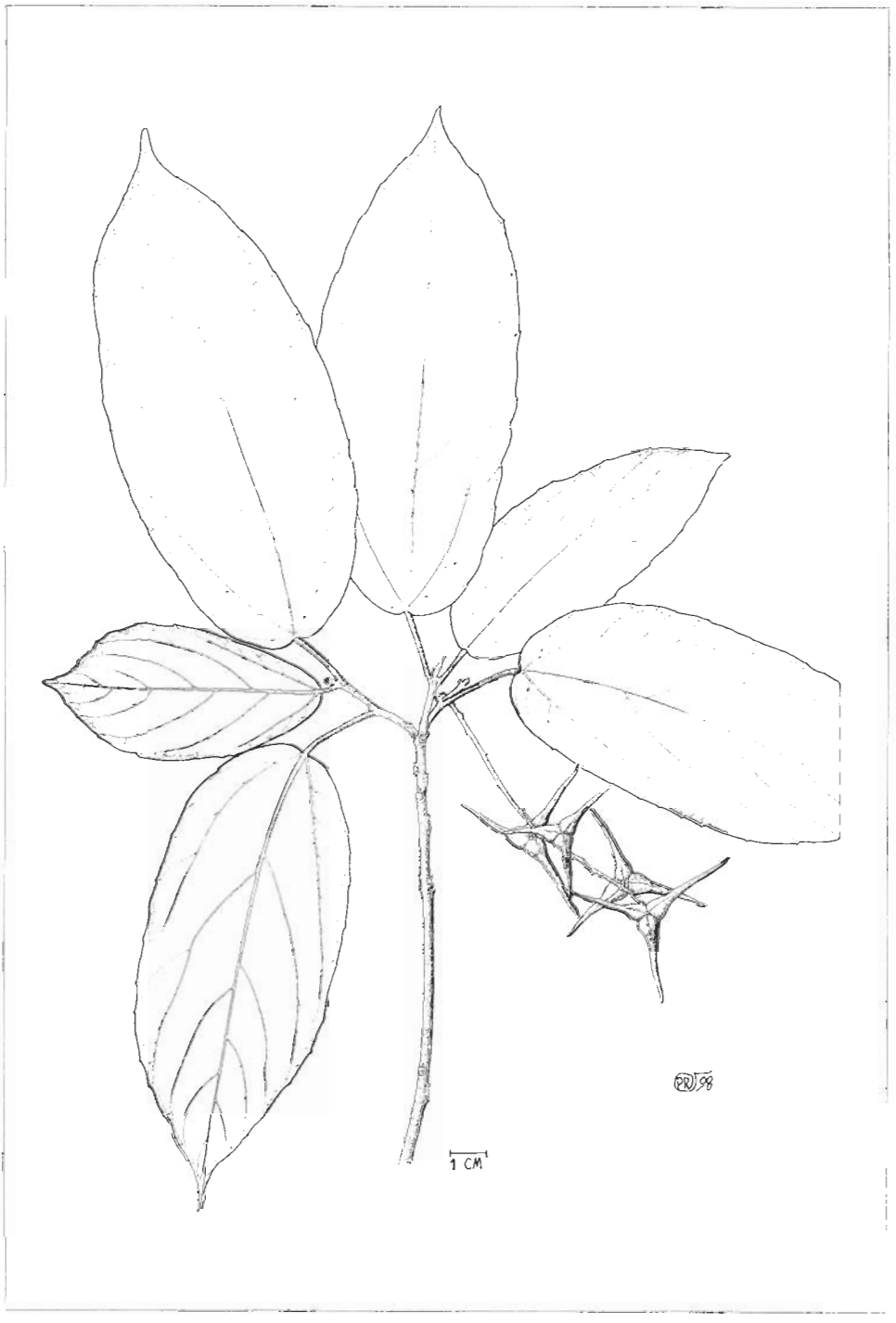

Figure 42. *Mallotus sumatranus* (Miq.) Airy Shaw. Habitus of pistillate plant.

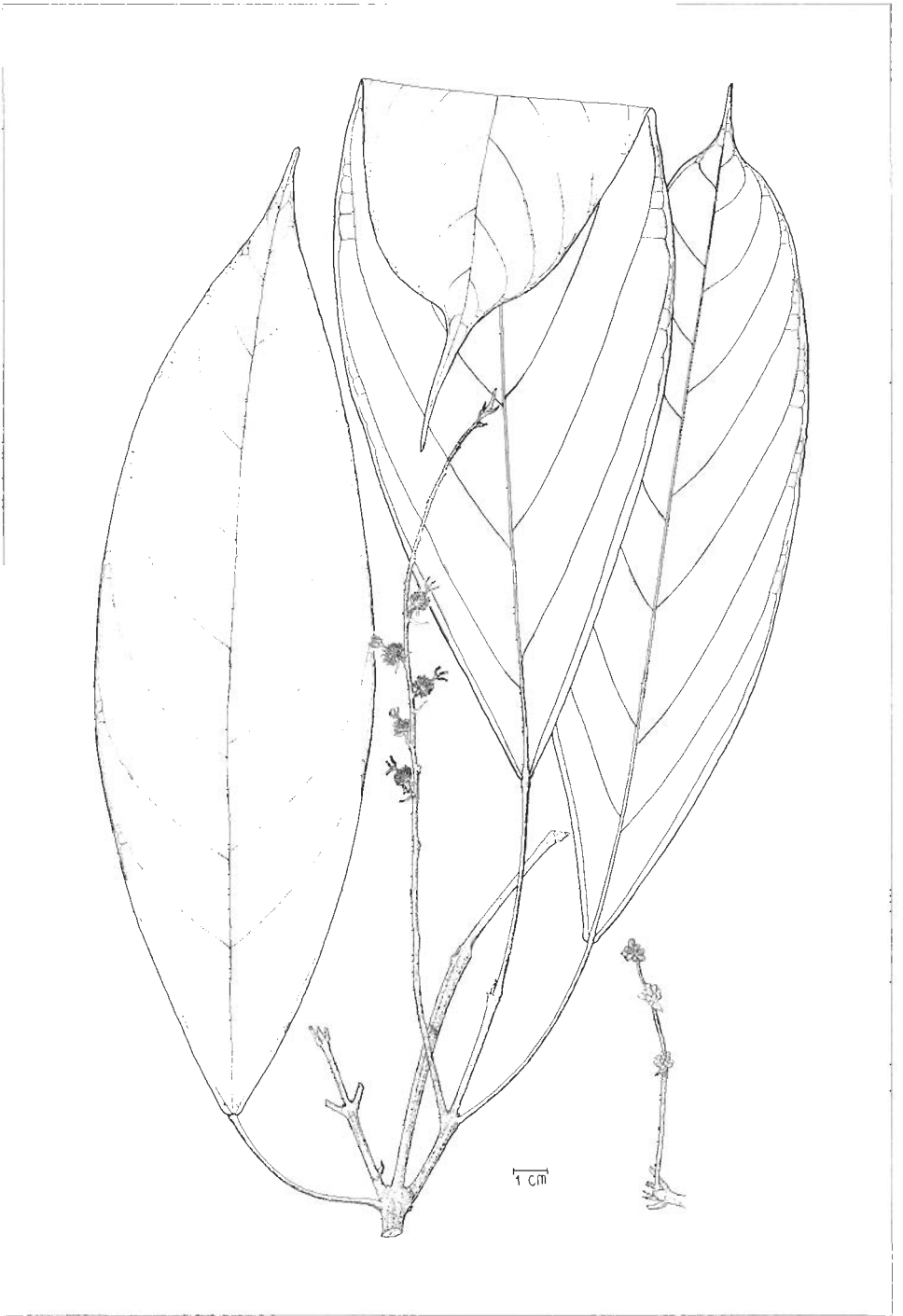

Figure 43. *Mallotus wrayi* King ex Hook.f. Habitus of pistillate plant and detail of staminate inflorescence.

Acknowledgements

The identification and nomenclature problems we faced while working on *Macaranga* could not have been solved without the invaluable help of T.C. Whitmore and S.J. Davies. We are very grateful for their help. We would also like to thank Birgitte Fiala and Jan Frits Veldkamp for their comments on earlier versions of this manuscript. This study is supported by a grant of the Netherlands Foundation for the Advancement of Tropical Research (WOTRO), within the Priority Programme 'Biodiversity of Disturbed Ecosystems'.

References

Airy Shaw, H.K., 1975. The Euphorbiaceae of Borneo. *Kew Bulletin Additional Series* **4**: 160—174.

Argent, G., A. Saridan, E.J.F. Campbell, P. Wilkie, G. Fairwater, J.T. Hadiah, D.J. Middleton, C. Pendry, M. Pinard, M. Warwick and K.S. Yulita, 1998. *Manual of the Larger and More Important Nondipterocarp Trees of Central Kalimantan Indonesia.* Volume **1**. Forest Research Institute Samarinda, Samarinda, Indonesia.

Bodegom, S., P.B. Pelser and P.J.A. Keßler, 1999. *Seedlings of Secondary Forest Tree Species of East Kalimantan, Indonesia.* Tropenbos Kalimantan Series **1**, MOFEC-Tropenbos Kalimantan Project, Samboja, Indonesia.

Keßler P.J.A. and K. Sidiyasa, 1994. *Trees of the Balikpapan-Samarinda Area, East Kalimantan, Indonesia.* Tropenbos Series **7**. The Tropenbos Foundation, Wageningen.

Keßler P.J.A., K. Sidiyasa, Ambriansyah and Arifin Zainal, 1995. *Checklist of Secondary Forest Trees in East and South Kalimantan, Indonesia.* Tropenbos Documents **8**. The Tropenbos Foundation, Wageningen.

Pax, F. and K. Hoffmann, 1914. Euphorbiaceae - Acalypheae - Mercurialinae. In: A. Engler (ed.): *Das Pflanzenreich* **IV. 147. vii**, Wilhelm Engelmann, Leipzig and Berlin: 145—208; 298—395.

Sidiyasa K., Arbainsyah and P.J.A. Keßler, 1999. *List of Collections Stored at the Wanariset Herbarium East Kalimantan - Indonesia.* The International MOFEC-Tropenbos Kalimantan Project Samboja, Indonesia.

Whitmore, T.C., 1975. *Macaranga*. In: Airy Shaw, H.K. (ed.) The

Euphorbiaceae of Borneo. *Kew Bulletin. Additional Series* **4**: 140—159

Index of Exsiccatae

Afandi Ma'roef AM 216: **36** — Ambri *et al.* AA 24: **34**; 48: **16**; 84: 16; 400: **38**; 446: **45**; 477: **26**; 1187: **40**; 1190: **40**; 1200: **27**; 1474: **38**; 1592: **26**; 1606: **40**; 1616: **25**; 1619: **25**; 1628: **37**; 1720: **35**; 1742: **42** — Ambri *et al.* W 2: **42**; 10: **10**; 24: **2**; 57: **17**; 72: **5**; 78: **35**; 83: **42**; 99: **42**; 138: **40**; 266: **13**; 298: **25**; 333: **42**; 335: **42**; 636: **13**; 767: **27**; 1001: **10**; 1009: **14**; 1010: **21**; 1024: **7** — Ambriansyah AA 663: **36**; 689: **5**; 716: **3**; 774: **46**; 1025: **5**; 1155: **25**; 1494: **14**; 2064: **7**; 2152: **34** — Ambriansyah *et al.* AA 186: **26**; 187: **2**; 207: **33**; 242: **41**; 288: **20**; 675: **33**; 991: **41**; 1159: **40**; 1676: **13**; 1678: **33**; 1696: **40** — Ambriansyah *et al.* Berau 589A: **29**; 598: **31**; 602: **44**; 805: **33**; 883: **38** — Ambriansyah *et al.* W 943: **14**; 950: **2**; 971: **25**; 980: **14**; 984: **5** — Arbainsyah AA 1849: **40**; 1869: **27**; 1928: **27**; 1934: **40** — Arbainsyah *et al.* AA 2033; 2045: **25** — Arifin AA 627: **7** — Arifin *et al.* AA 1643: **26**; 1645: **20**; 1653: **38**; 1708: **37**; 1753: **35**; 1787: **41**; 1804: **26** — Arifin Berau 557: **3**; 559: **44** — Arifin *et al.* Berau 556: **3**; 561: **44**; 563: **29**; 725: **34**; 999: **31**.

Balgooy 5718: **26**; 5902 A: **7**; 6076: **7**; 6124: **7** — Balgooy *et al.* 5882: **25**; 5883: **19**; 5884: **14**; 5902: **35**; 5912: **10**; 5916: **14**; 5920 A: **20**; 5948 B: **20**; 5965: **42** — bb 2126: **37**; 11895: **34**; 12129: **42**; 16188: **5**; 16901: **5**; 25145: **10**; 34248: **5**.

Endert 1498: **45**; 1534: **26**; 1606: **40**; 1845: **10**; 1866: **36**; 1989: **45**; 2089: **38**; 2196: **30**; 2200: **27**; 2434: **10**; 3028: **41**; 3089: **13**; 3266: **15**; 3488: **33**; 3735: **46**; 4021: **41**; 4032: **27**; 4081: **13**; 4087: **41**; 4671: **13**; 4694: **33**; 4772: **41**; 4811: **26**; 4812: **26**; 4831: **29**; 4919: **31**; 4959: **19**; 4982: **5**; 5096: **38**; 5098: **38**; 5114: **36**; 5153: **33**; 5158: **20**; 5167: **38**; 5173: **46**; 5185: **36**; 5267: **8**.

Forman 445: **46**; 456: **46**; 460: **26**.

Geesink 8904: **25**; 8927: **12**; 8956: **6**; 9044: **7**; 9299: **13**; 9315: **8** — Goverse *et al.* Berau 429: **40**; 430: **40**; 461: **3**; 473: **31**.

Hamdi AA 2113: **19**; 2119: **40**.

Iwatsuki *et al.* B 7216: **14**; 7301: **36**; 7302: **36**.

Kato *et al.* B 4772: **46**; 4781: **41**; 5363: **41**; 5524: **32**; 6122: **17**; 6531: **41**; 10212: **46**; 10214: **10**; 11254: **7**; 11441: **46**; 11760: **28**; 11827: **8**; 11888: **38** — Kartawinata 1317: **26**; 1475A: **6** — Kessler PK 611: **13**; 619: **13** — Kessler *et al.* Berau 28: **25**; 31: **25**; 36: **11**; 38: **11**; 52: **14**; 56: **1**; 61: **19**; 81: **40**; 101: **42**; 117: **27**; 120: **37**; 150: **42**; 157: **1**; 158: **14**; 164: **29**; 174: **29**; 272: **14**; 277: **20**; 293: **19**; 194: **29**; 200: **31**; 201: **31**; 255: **38**; 270: **40**; 296: **19**; 323: **3**; 357: **1**; 358: **27**; 370: **25**; 376: **5**; 379: **18**; 604: **42**; 615: **29**; 616: **18**; 618: **31**; 701: **38**; 740: **17**; 856: **46** — Kessler *et al.* PK 745: **25**; 786: **25**; 787: **25**; 789: **37**; 794: **37**; 796: **37**; 825: **40**; 843: **19**; 863: **26**; 875: **40**; 899: **20**; 900: **10**; 910: **27**; 953: **27**; 973: **27**; 977: **20**; 989: **20**; 1002: **20**; 1054: **40**; 1077: **25**; 1089: **40**; 1100: **33**; 1102: **37**; 1114: **25**; 1130: **25**; 1131: **26**; 1159: **25**; 1164: **40**; 1203: **37**; 1231: **26**; 1244: **40**; 1291: **25**; 1292: **25**; 1298: **35**; 1302: **37**; 1303: **37**; 1320: **25**; 1328: **10**; 1329: **1**; 1333: **1**; 1350: **37**; 1351: **37**; 1388: **26**; 1405: **38**; 1435: **40**; 1446: **20**; 1960: **38**; 1968: **36**; 1972: **19**; 1988: **19**; 1989: **37**; 2031: **27**; 2038: **6**; 2071: **40**; 2076: **40**; 2119: **26**; 2210: **22**; 2281: **36**; 2285: **25**; 2347: **20**; 2356: **40**; 2383: **40** — Kostermans 217: **36**; 4062: **17**; 4121: **17**; 4160: **17**; 4321: **13**; 4344: **18**; 4940: **42**; 5011: **19**; 5344: **36**; 5512: **42**; 5616: **5**; 5686: **34**; 5950: **42**; 6011: **36**; 6023: **19**; 6026: **6**; 6229: **42**; 6356: **42**; 6428: **17**; 6433: **4**; 6685: **31**; 6693: **42**; 7019: **31**; 7563: **42**; 7625: **42**; 8632: **42**; 9134: **42**; 9239: **9**; 9320: **29**; 9637: **36**; 10026: **26**; 10065: **17**; 10155: **42**; 10156: **18**; 10178B: **42**; 10179: **42**; 10229: **42**; 10531: **27**; 10696: **36**; 12644: **38**; 12691: **2**; 13113: **23**; 13148: **24**; 13156: **27**; 13762: **28**; 13985: **38**; 14053: **42**; 21010: **38**; 21017: **41**; 21077: **46**; 21092: **46**; 21132: **38**; 21137: **41**; 21262: **40**; 21264: **33**; 21345: **28**; 21417: **19**; 21443: **38**; 21541: **5**; 21548: **38**; 21571: **36**; 21591: **33**; 21595: **32**; 21596: **36**; 21643: **7**; 21716: **38** — Kramadibrata 137: **35**; 248: **19**.

Leeuwenberg *et al.* 13107: **40** — Leighton 72: **17**; 73: **42**; 92: **46**; 218: **26**; 264: **27**; 373: **26**; 382: **40**; 394: **14**; 430: **36**; 512: **34**; 570: **10**; 762: **33**; 885: **25**; 912: **2**; 1025: **17**; 1026: **42**; 1084: **20**; 1091: **42**.

Marsemi 14: **26** — McDonald *et al.* 3456: **46** — Meijer 1915: **26**; 2091: **36**; 2452: **38** — Mogea 2668: **27** — Murata *et al.* B 455: **26**; 479: **26**; 572: **35**; 797: **14**; 941: **46**; 1123: **27**; 1277: **27**; 3028: **35**.

Nedi 733: **36**.

Paymans 20: **14**.

Rahayu 140: **20** — Ramlanto 16: **40**; 28: **17**.

Sauveur 3: **42**; 25: **17**; 26: **17**; 57: **14**; 100: **42**; 132: **42** — Sidiyasa S 298: **40**; 436: **36**; 438: **33**; 440: **28**; 476: **17**; 502: **27**; 525: **28**; 531: **27**; 632: **5**; 639: **40**; 670: **20**; 754: **18**; 756: **18**; 762: **17**; 790: **21**; 805: **13**; 823: **5**; 1140: **41**; 1141: **41**; 1157: **33**; 1157 A: **46**; 1171: **33**; 1172: **36**; 1181 A: **17**; 1213: **38**; 1214: **35**; 1246: **42**; 1248: **17**; 1282: **35** — Sidiyasa *et al.* S 557: **42**; 829: **2** — Slik Berau 578: **26**; 579: **26**; 580: **26**; 581: **31**; 582: **19**; 584: **46** — Slik W 1043: **2**; 1044: **17**; 1045: **7**; 1046: **2**; 1047: **26**; 1048: **17**; 1049: **2**; 1050: **19**; 1051: **21**; 1052: **13**; 1053: **25**; 1054: **40**; 1055: **40**; 1056: **5**; 1057: **20**; 1058: **35** — Slik *et al.* FS 7: **33**; 12: **28**; 13: **46**; 14: **36**; 15: **36**; 17: **33**; 18: **41**; 21: **27** — Slooten 2137: **36** — Soetisna 16: **40** — Soewanda 35396: **42**.

TFB 1243: **40**; 1254: **27**.

Ueda *et al.* B 11586: **13**.

Valkenburg JVV 1208: **35**; 1261: **13** — Valkenburg *et al.* JVV 1065: **27**.

Wiriadinata 289: **36**; 324: **42**; 612: **46**; 653: **10**; 694: **27**; 715: **46**; 811: **46**; 816: **32**; 1146: **25**; 1182: **20** — Wiriadinata *et al.* 63: **19**; 1073: **10**.