THE WILD BANANAS OF PAPUA NEW GUINEA

G. C. G. ARGENT

ABSTRACT. The wild bananas of Papua New Guinea as represented by the genera *Ensete* and *Musa* are described and illustrated and their inter-relationships discussed. Keys are provided for the identification of all taxa and the distributions given of all species (including a considerable extension in the range of *M. lolodensis*, from Halmahera in the Moluccas). *Musa bukensis* Argent and *M. boman* Argent are described as new species and a new section *Ingentimusa* is established for *M. ingens*. The wild hybrids *M. banksii* x *M. schizocarpa* and *M. lolodensis* x *M. boman* are recorded for the first time and *M. angustigemma* is reduced to a subspecies of *M. peekelii*.

INTRODUCTION

Bananas are difficult to collect as adequate herbarium specimens, and representation in herbaria will probably remain poor; photographs and accurate field notes almost always convey more taxonomic information than dried herbarium material. Although pickled specimens are quite useful and ripe seed samples can be diagnostic, field observation is of paramount importance in the study of these plants.

The present paper is very largely based on field observations made whilst the author was working for the New Guinea Biological Foundation (NGBF) in what was then the Australian administered territory of Papua New Guinea. Observations on wild plants growing at the NGBF experimental banana garden just outside Lae, and at the Lae Botanical Garden, also contributed. Herbarium specimens are deposited in the Papua New Guinea national herbarium in Lae (LAE) with some duplicates distributed to Kew and elsewhere. Distributional data is wherever possible from personal observation of the author (obs.). Many other observations and herbarium records have been clearly listed by Simmonds (1956, 1960) and these references are cited where relevant to particular species without repeating the details of collections or localities. The maps summarise all reliable distributional data which is still very incomplete for most species; they were compiled from herbarium specimens, previously published records and my own observations.

The family Musaceae is treated here in the restricted sense of Hutchison (1934), Simmonds (1962, 1966) and others, in that the distichously bracteate *Heliconiae* are excluded. In Papua New Guinea only two genera, *Ensete* and *Musa*, occur. *Ensete* is represented by just one species, *E. glaucum*, while *Musa* is considered to be represented by nine species, in three of the five sections of the genus. Of the four sections used by Simmonds (1962, 1966), *Rhodochlamys* and *Callimusa* are absent but a new section *Ingentimusa* is created for *M. ingens*.

Chromosome counts quoted in this paper are based on work done at the Banana Research Board, Kingston, Jamaica and the Imperial College of Tropical Agriculture, Trinidad, and quoted in Simmonds (1962). Confirmatory counts were made in Lae for *M. maclayi* var. *maclayi*, *M. peekelii* subsp. *angustigemma* and *M. schizocarpa*.

Papua New Guinea is an important centre of wild banana distribution. The nine species of *Musa* recognised here represent almost a third of the known species in the genus and include five of the six species in sect. *Australimusa*. The latter species appear to be young and apparently still actively evolving, often with recognisable geographical variants, and little in the way of genetical isolating mechanisms (Simmonds 1962). Of the three species in sect. *Musa*, two are wide-ranging and the third an endemic. The remaining *M. ingens* is apparently an anomalous relic. The wild representatives of *Musa* are particularly interesting in illuminating origins and relationships in the main groups of cultivated bananas, although only brief reference will be made to this in the present paper; it is hoped to deal with these aspects in later papers.

Terminology

Most specialised terminology follows the able work of Simmonds (1966), but a few terms used in the present paper need explanation. Left- and right-handed leaves are the result of the habitual asymmetry of the lamina base in banana leaves. Left-handed leaves are those with the left-hand side of the lamina descending further down the petiole when the leaf is viewed from the adaxial side with the distal portion uppermost (fig. 1a). Right-handed leaves are those with the right-hand side of the lamina descending further when similarly viewed (fig. 1b–d). It is important not to use young sucker shoots and to assess several leaves, as occasional individual leaves can be misleading, but the character has been found to be very reliable in the wild bananas seen although cultivars do not show such regularity. The comparison of leaves of different species from a similar morphological position can be very informative, eliminating the great variability and often great dissimilarity of

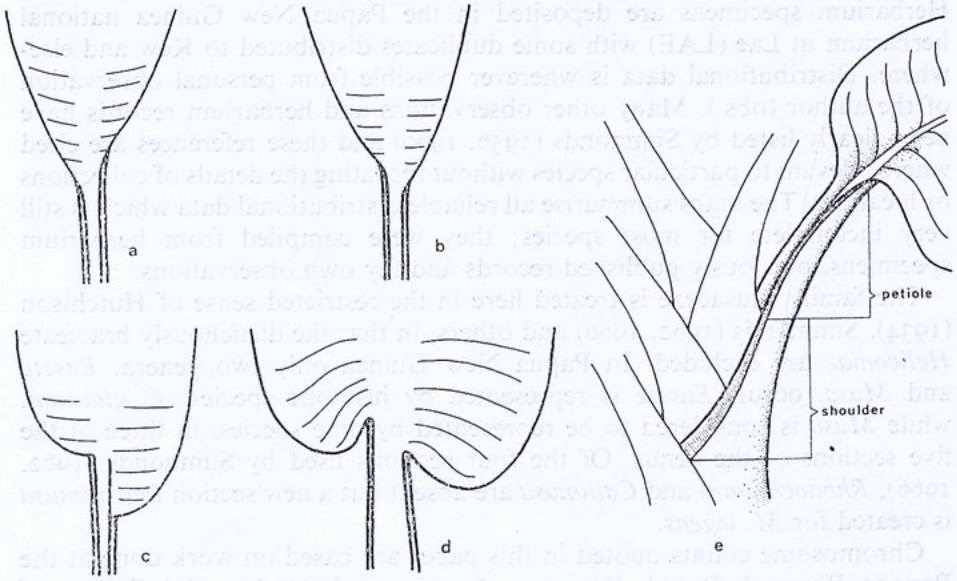

Fig. 1 a–d. Variation in the leaf bases of *Musa* species: a, left-handed cuneate—*M. schizocarpa*; b, right-handed cuneate—*M. maclayi*; c, right-handed rounded—*M. peekelii*; d, right-handed auriculate—*M. bukensis*; e, generalised drawing of a 4th-last leaf base to illustrate the terms petiole and shoulder.

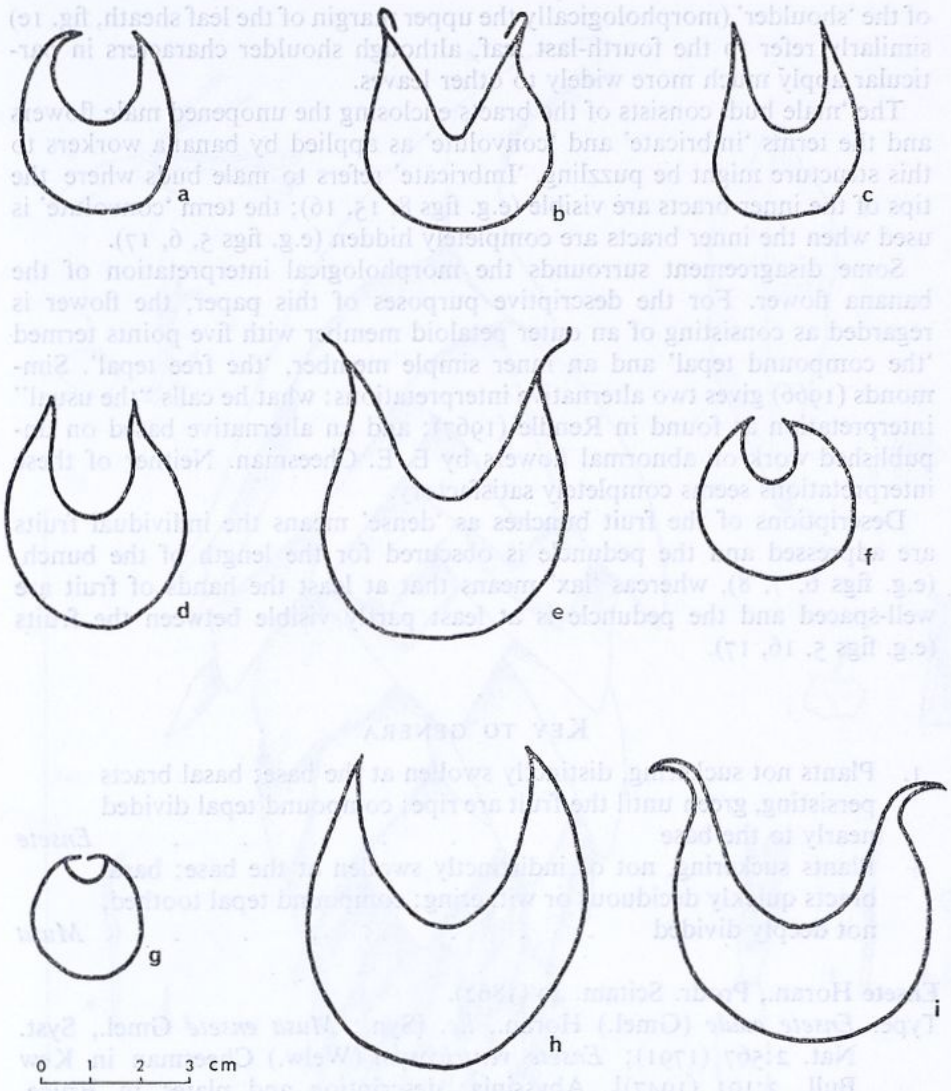

FIG. 2. Variation in transverse sections at the midpoint of the 4th-last petiole: a, *M. balbisiana*; b, *M. banksii*; c, *M. schizocarpa*; d, *M. maclayi*; e, *M. bukensis*; f, *M. peekelii*; g, *M. lolodensis*; h, *M. boman*; i, *M. ingens*.

juvenile leaves. Therefore, other leaf characters used apply strictly to the fourth-last, fully expanded, vegetative leaf below the inflorescence. It may be thought that vegetative characters requiring the presence of the inflorescence for their evaluation may be of little help, but in addition to the obvious cases where the inflorescence may be too young or too old to be useful, the vegetative characters can, with a little experience, be applied to completely vegetative plants. The petiole is described from the mid-point between sheath and blade. The 'TS' ratio is the vertical depth of the petiole canal divided by the vertical depth of petiole tissue beneath, as seen in transverse section at the mid-point of the petiole (variation illustrated in fig. 2). The ratio of petiole length to blade length (PB ratio) and the description

of the 'shoulder' (morphologically the upper margin of the leaf sheath, fig. 1e) similarly refer to the fourth-last leaf, although shoulder characters in particular apply much more widely to other leaves.

The 'male bud' consists of the bracts enclosing the unopened male flowers and the terms 'imbricate' and 'convolute' as applied by banana workers to this structure might be puzzling. 'Imbricate' refers to male buds where the tips of the inner bracts are visible (e.g. figs 8, 15, 16); the term 'convolute' is used when the inner bracts are completely hidden (e.g. figs 5, 6, 17).

Some disagreement surrounds the morphological interpretation of the banana flower. For the descriptive purposes of this paper, the flower is regarded as consisting of an outer petaloid member with five points termed 'the compound tepal' and an inner simple member, 'the free tepal'. Simmonds (1966) gives two alternative interpretations: what he calls "the usual" interpretation as found in Rendle (1967); and an alternative based on unpublished work on abnormal flowers by E. E. Cheesman. Neither of these interpretations seems completely satisfactory.

Descriptions of the fruit bunches as 'dense' means the individual fruits are adpressed and the peduncle is obscured for the length of the bunch, (e.g. figs 6, 7, 8), whereas 'lax' means that at least the hands of fruit are well-spaced and the peduncle is at least partly visible between the fruits (e.g. figs 5, 16, 17).

Key to genera

1. Plants not suckering, distinctly swollen at the base; basal bracts persisting, green until the fruit are ripe; compound tepal divided nearly to the base . . . . . *Ensete*

\+ Plants suckering, not or indistinctly swollen at the base; basal bracts quickly deciduous or withering; compound tepal toothed, not deeply divided . . . . . *Musa*

Ensete Horan., Prodr. Scitam. 40 (1862).

Type. *Ensete edule* (Gmel.) Horan., *l.c.* [Syn.: *Musa ensete* Gmel., Syst. Nat. 2:567 (1791); *Ensete ventricosum* (Welw.) Cheesman in Kew Bull. 2:101 (1947)]. Abyssinia: description and plates in Bruce, Travels in Arabia, Abyssinia and Nubia 5:36–46 (1970).

Monocarpic non-suckering herbs distinctly swollen at the base. All bracts persistent, the female bracts remaining green until the fruits are ripe. Flowers biseriately arranged, the flowers and bracts integral with each other and with the axis, abscission layers lacking. Compound tepal of the flower divided nearly to the base. Lamina of the free tepal about as long as broad, excluding the arista. Seeds more than 10 mm in diameter.

Represented in New Guinea by a single species.

E. glaucum (Roxb.) Cheesman in Kew Bull. 2:101 (1947). Fig. 3.

Syn.: *Musa glauca* Roxb. [Hort. Beng. 19 (1814)—nomen], Corom. Pl. 3: 96–98, tab. 300, (1819).

M. calosperma F. Muell. in Proc. Linn. Soc. N.S. Wales 10:355 (1885).

Ensete calospermum (F. Muell.) Cheesman in Kew Bull 2:102 (1947).

Lectotype (designated here). Tab. 300 in Roxb., Corom. Pl. 3 (1819).

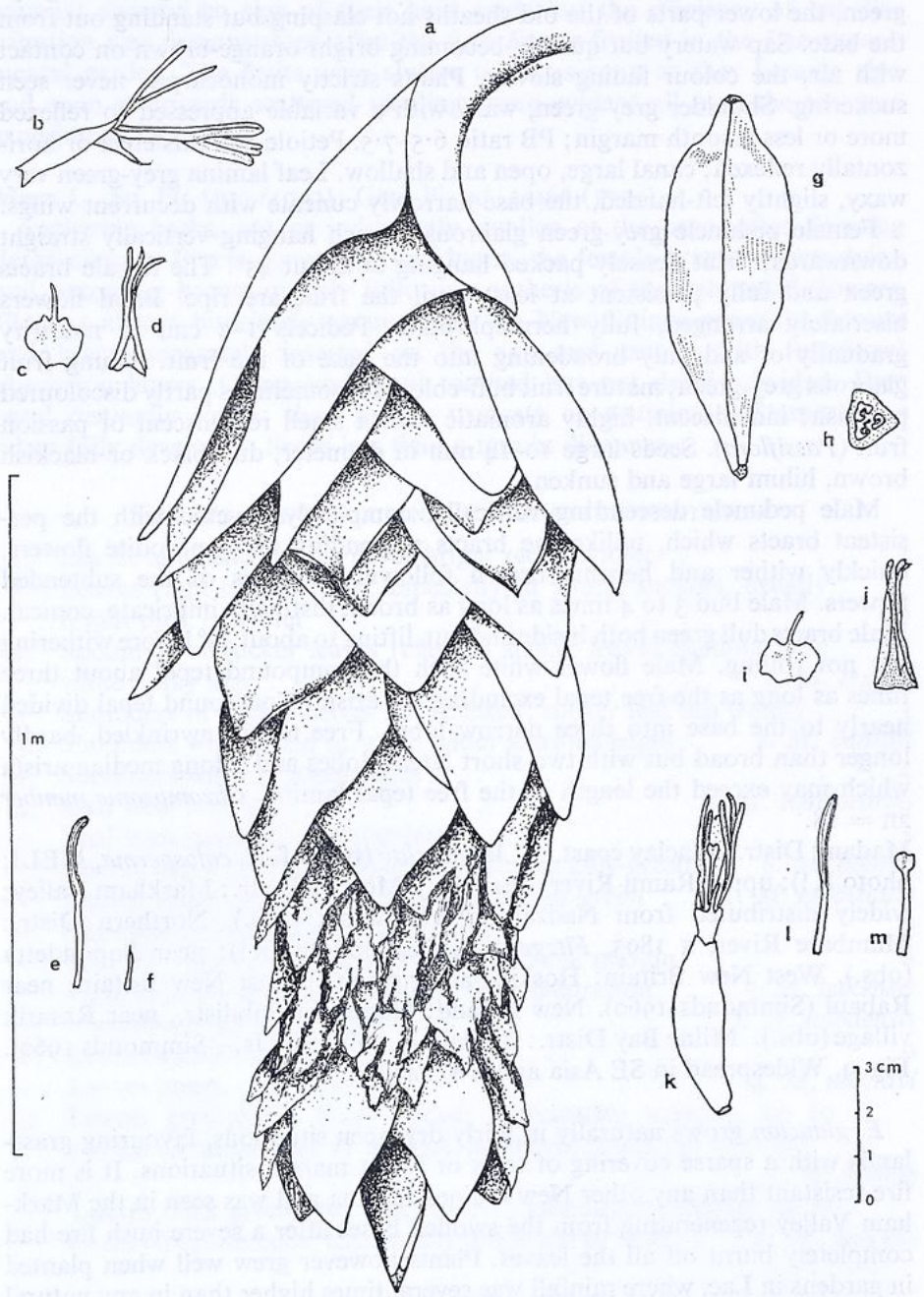

FIG. 3. *Ensete glaucum*: a, infructescence; b, male flower; c, free tepal of male flower; d, compound tepal of male flower; e, stamen; f, pistillode; g, mature fruit; h, T.S. of ovary; i, free tepal of female flower; j, compound tepal of female flower; k, female flower; l, stamen from female flower; m, style and stigma.
All drawn from specimens grown in Lae from Upper Markham Valley gatherings.

Pseudostem up to 5 m tall, the base more or less swollen, glaucous grey-green, the lower parts of the old sheaths not clasping but standing out from the base. Sap watery but quickly becoming bright orange-brown on contact with air, the colour fading slowly. Plants strictly monocarpic, never seen suckering. Shoulder grey-green, waxy with a variable appressed to reflexed more or less smooth margin; PB ratio 6·5–7·5. Petiole margins erect or horizontally reflexed; canal large, open and shallow. Leaf lamina grey-green very waxy, slightly left-handed, the base narrowly cuneate with decurrent wings.

Female peduncle grey-green glabrous. Bunch hanging vertically straight downwards; fruit densely packed hanging at about 45°. The female bracts green and fully persistent at least until the fruit are ripe. Basal flowers biseriately arranged, fully hermaphrodite. Pedicels 1–2 cm, at maturity gradually or suddenly broadening into the base of the fruit. Young fruit glabrous grey-green; mature fruit buff-coloured, sometimes partly discoloured purplish; indehiscent, highly aromatic with a smell reminiscent of passion fruit (*Passiflora*). Seeds large 10–14 mm in diameter, dull black or blackish brown, hilum large and sunken.

Male peduncle descending vertically, completely covered with the persistent bracts which, unlike the bracts subtending hermaphrodite flowers, quickly wither and become brown following anthesis of the subtended flowers. Male bud 3 to 4 times as long as broad, distinctly imbricate, conical. Male bracts dull green both inside and out, lifting to about 45° before withering but not rolling. Male flower white with the compound tepal about three times as long as the free tepal excluding the arista. Compound tepal divided nearly to the base into three narrow lobes. Free tepal unwrinkled, hardly longer than broad but with two short lateral lobes and a long median arista which may exceed the length of the free tepal lamina. *Chromosome number* $2n = 18$.

Madang Distr.: Maclay coast, *N. M. Maclay* (type of *M. calosperma*, MEL!; photo K!); upper Ramu River area (obs.). Morobe Distr.: Markham Valley; widely distributed from Nadzab to Marawassa (obs.). Northern Distr.: Mambare River, x 1895, *Fitzgerald* (MEL; photo. K!); near Popondetta (obs.). West New Britain: Hoskins airstrip (obs.). East New Britain: near Rabaul (Simmonds 1960). New Ireland: Namatani Subdistr., near Rasarik village (obs.). Milne Bay Distr.: Basilaki Is. (Moresby Is.—Simmonds 1960). Fig. 9. Widespread in SE Asia and SW Pacific.

E. glaucum grows naturally in fairly dry open situations, favouring grasslands with a sparse covering of trees or forest margin situations. It is more fire-resistant than any other New Guinea banana and was seen in the Markham Valley regenerating from the swollen bases after a severe bush fire had completely burnt off all the leaves. Plants however grew well when planted in gardens in Lae, where rainfall was several times higher than in any natural habitat, except on poorly drained soils where the roots rotted in wet weather. Although Simmonds (1960) gives the altitudinal range as from "sea level up to 1560 m", the present author never saw this species above c. 800 m.

The highly aromatic fruits are much sought after by fruit-bats which carry away the complete fruit as soon as it becomes ripe. Large seeds are rarely, if ever, swallowed by fruit-bats but are dropped while the fruit is eaten on some suitable perch; whole or partly eaten fruit may be dropped in

flight. Stomach contents of several bats examined after feeding amongst bananas showed no sign of their hard seeds but the efficiency of bat distribution was demonstrated after the first *Ensete* fruited in the Lae experimental garden. The fruits were always taken as soon as they became ripe and soon afterwards scattered seedlings were evident all over the ten acre experimental ground.

Musa L., Sp. Pl. 1043 (1753); Gen. Pl. ed. 2:466 (1754).

Suckering herbs, not or indistinctly swollen at the base, often forming dense clumps. Bracts commonly deciduous, the female bracts always dying and becoming brown quickly following anthesis of the subtended flowers. Flowers always biseriately arranged [in the New Guinea species]; flowers and bracts separately inserted on the axis and usually with functional abscission layers. Compound tepal toothed but not deeply divided. Free tepal distinctly longer than broad, truncate or acuminate. Stamens five when fully developed. Seeds less than 9 mm in diameter.

KEY TO SPECIES USING VEGETATIVE FEATURES

1. Leaves left-handed; sap never bright red or violet . . . 2
\+ Leaves right-handed; sap, especially in young suckers, usually bright pink or violet 6
2. Shoulders of sucker leaves reflexed; sucker leaves exuding pure white milky sap . . . . . 9. *M. ingens*
\+ Shoulders of sucker leaves not reflexed; sucker leaf sap watery . 3
3. Shoulders with broad (c. 1 cm wide) scarious edges 2. *M. banksii*
\+ Shoulders with ± green edges 4
4. Leaf base cuneate . . . . . 3. *M. schizocarpa*
\+ Leaf base rounded or auriculate 5
5. Leaves waxy above and beneath; petioles grey-green 8. *M. boman*
\+ Leaves waxy beneath only; petioles yellow-green . 1. *M. balbisiana*
6. Shoulders with broad scarious margin 7
\+ Shoulders with green or non-scarious black margin . . 8
7. Pseudostem with predominantly black coloration . 5. *M. bukensis*
\+ Pseudostem green or brown . . . . . 7. *M. lolodensis*
8. Leaves white-waxy beneath 9
\+ Leaves green, non-waxy . . . . . 4. *M. maclayi*
9. Leaves grey-green, waxy above; pseudostem massive, up to 130 cm circumference at the base; sap never bright red or violet . 8. *M. boman*
\+ Leaves dark green, not waxy above; pseudostem slender up to 60 cm circumference; sap usually bright red or violet . 6. *M. peekelii*

KEY TO SPECIES USING FRUIT AND MALE BUD CHARACTERS

1. Fruit dehiscent when ripe 2
\+ Fruit indehiscent 3
2. Fruit orange when ripe; bunch lax; male bud cream or flesh-pink . . . . . 7. *M. lolodensis*
\+ Fruit green when ripe; bunch dense; male bud dull green . 3. *M. schizocarpa*

3. Fruit not orange when ripe; bracts dull, never shiny outside . 4
+ Fruit orange when ripe; bracts dull or shiny 6
4. Fruit twice as long as wide; bracts with bright red undersides . 1. *M. balbisiana*
+ Fruit more than four times as long as wide; bracts variable in colour but never bright red underneath 5
5. Fruit with large seeds >6 mm diameter; male bud cream . 9. *M. ingens*
+ Fruit with small seeds <5 mm diameter; male bud green, yellow or purple . . . . . 2. *M. banksii*
6. Fruit including pedicel >14 mm long, flesh orange or cream; male bud predominantly cream with lifted bracts brownish . 7
+ Fruit including pedicel <12 mm long, flesh bright yellow; male bud variable but never as above 8
7. Fruit with cream flesh, slender, c. 3 cm broad, tapering gradually to the long >4 cm pedicel . . . . 9. *M. ingens*
+ Fruit with orange flesh at maturity, >4 cm broad, tapering abruptly to a short c. 2 cm pedicel . . . 8. *M. boman*
8. Bunch and male peduncle ± erect . . . 4. *M. maclayi*
+ Bunch variable, male axis descending ± vertically . . . 9
9. Bunch habit variable but never completely pendent; male bracts purple, hardly lifting away from the bud . . 5. *M. bukensis*
+ Bunch pendent; male bracts green or brown sometimes with purplish tips, lifting to a horizontal position well away from the bud . . . . . 6. *M. peekelii*

SECT. MUSA

Syn.: Subgenus *Eumusa* Baker in Ann. Bot. 7: 205 (1893).
Sect. *Eumusa* (Baker) Cheesman in Kew Bull. 2:109 (1947).

Type: *Musa paradisiaca* L., Sp. Pl. 1043 (1753).

Basic chromosome number 11. Sap always watery. Bracts dull and waxy at least outside. Fruit variable in colour but never orange-red.

1. M. balbisiana Colla in Memorie Reale Accad. Sci. Torino [Memoria sul Genere Musa e monografia del Medesimo] 25:384 (1820). Fig. 4.

Type. Not designated.

Pseudostems up to 6 m tall and 90 cms girth at the base, green to yellowish green, non-waxy, almost always forming dense clumps. Rhizomes short, the numerous suckers arising characteristically at a slight angle to the vertical. Shoulder yellowish-green with the edge non-scarious and appressed; PB ratio 3–4. Petiole margins incurved, green or becoming narrowly scarious; petiolar canal large; TS ratio 1·0. Lamina dark green above, greyish-green very waxy below. Midrib and petiole a characteristic yellow-green colour; lamina base markedly auriculate, left-handed.

Peduncle glabrous, pale green, smooth. Bunch hanging almost horizontally to diagonally downwards, never particularly dense and sometimes very lax; often irregular due to failure of pollination and subsequent fruit development, quite commonly in the wild failing to set any fruit. Hands attempt a vertical stance but many are unable to assume this orientation owing to the limited curvature possible in the short fruits. Basal flowers

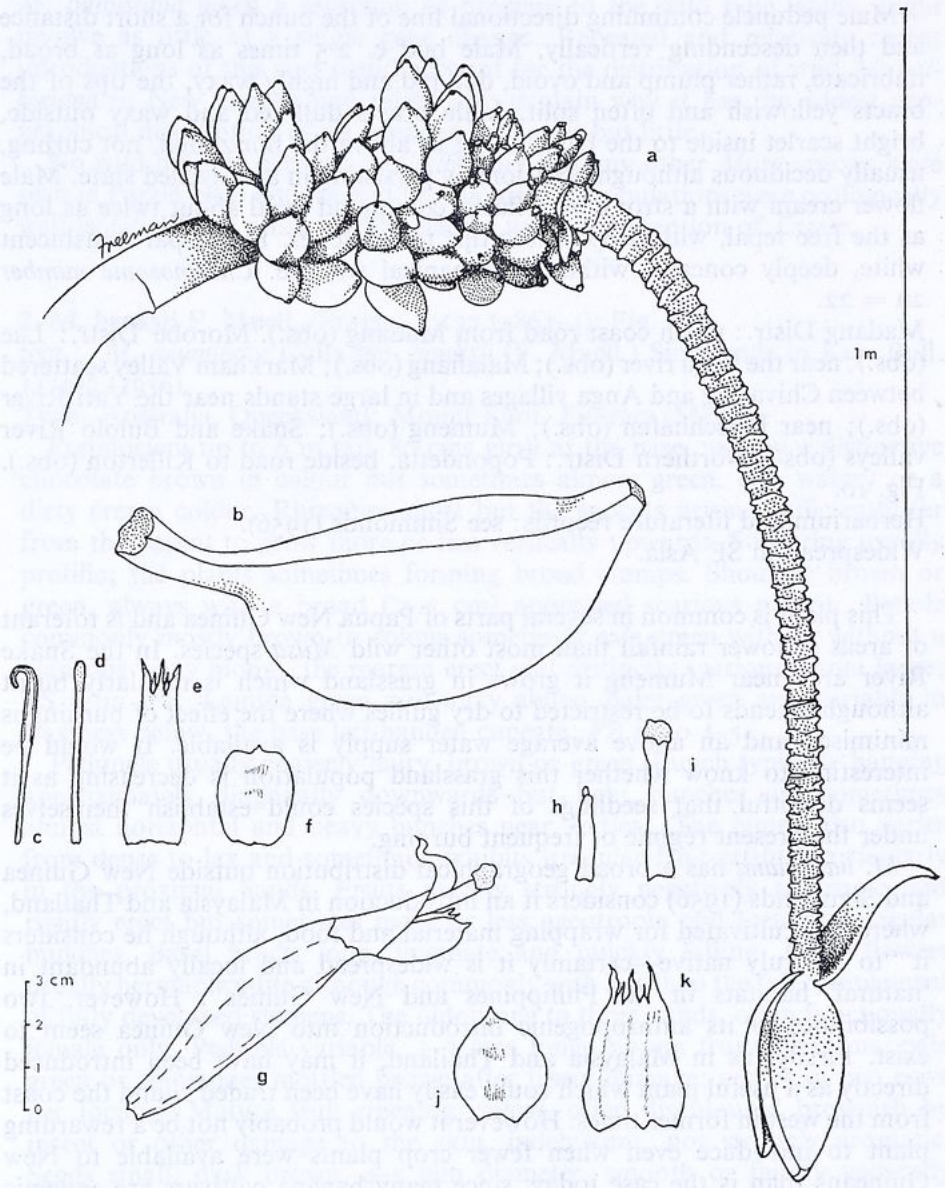

FIG. 4. *Musa balbisiana*: a, infructescence; b, mature fruit; c, stamen of male flower; d, pistillode; e, compound tepal of male flower; f, free tepal of male flower; g, female flower; h, staminode from female flower; i, style and stigma; j, free tepal from female flower; k, compound tepal from female flower.
All drawn from specimens grown in Lae originating from Snake River near Mumeng.

functionally female with variable development of staminodes which were never observed to have good pollen. Pedicels long, 2·5–3·5 cm. Young fruits with pale green, glabrous, somewhat waxy skins. Ovules in four rows per loculus. Mature fruit pale buff-yellow in colour, indehiscent, not highly aromatic, short and squat, 8–11 × 4–5 cms. Seeds 4–6 mm diameter rounded, plump, brown and mamillose; hilum small slightly sunken to slightly raised.

Male peduncle continuing directional line of the bunch for a short distance and then descending vertically. Male bud c. 2·5 times as long as broad, imbricate, rather plump and ovoid, dull red and highly waxy, the tips of the bracts yellowish and often split. Male bracts dull red and waxy outside, bright scarlet inside to the base, lifting to above the horizontal, not curling, usually deciduous although occasionally persisting in a shrivelled state. Male flower cream with a strong pink flush; compound tepal about twice as long as the free tepal, with deep yellow tips to the lobes. Free tepal translucent white, deeply concave, without a subapical wrinkle. *Chromosome number* $2n = 22$.

Madang Distr.: north coast road from Madang (obs.). Morobe Distr.: Lae (obs.); near the Busu river (obs.); Malahang (obs.); Markham Valley scattered between Chivasing and Anga villages and in large stands near the Yati River (obs.); near Finschhafen (obs.); Mumeng (obs.); Snake and Bulolo River valleys (obs.). Northern Distr.: Popondetta, beside road to Killerton (obs.). Fig. 10.

Herbarium and literature records: see Simmonds (1956).

Widespread in SE Asia.

This plant is common in several parts of Papua New Guinea and is tolerant of areas of lower rainfall than most other wild *Musa* species. In the Snake River area near Mumeng it grows in grassland which is regularly burnt although it tends to be restricted to dry gullies where the effect of burning is minimised and an above average water supply is available. It would be interesting to know whether this grassland population is decreasing as it seems doubtful that seedlings of this species could establish themselves under the present régime of frequent burning.

M. balbisiana has a broad geographical distribution outside New Guinea and Simmonds (1956) considers it an introduction in Malaysia and Thailand, where it is cultivated for wrapping material and food, although he considers it "to be truly native—certainly it is widespread and locally abundant in 'natural' habitats in the Philippines and New Guinea". However, two possibilities of its anthropogenic introduction into New Guinea seem to exist. Firstly, as in Malaysia and Thailand, it may have been introduced directly as a useful plant which could easily have been traded round the coast from the west in former times. However it would probably not be a rewarding plant to introduce even when fewer crop plants were available to New Guineans than is the case today, since many banana cultivars are endemic to New Guinea and it seems likely that parthenocarpic forms would already be available. Moreover, the indigenous *Heliconia* seems to provide superior wrapping material for most culinary purposes. A second possibility which might, however, have more merit is that primitive diploid parthenocarpic cultivars were introduced which were entirely derived from *M. balbisiana*, i.e. would be of genotype BB in Simmonds, cultivar classification (1966). These would produce viable seeds in the event of pollination and could easily revert to the wild non-parthenocarpic plant which would establish in old garden sites. Cultivars in the Markham Valley might well be of this type although their chromosome numbers have yet to be determined. Some cultivars set substantial numbers of seed when pollinated and such plants could well prove to be the "Trojan horse" for the introduction of wild

M. balbisiana given a reversion of progeny to the wild type which might involve as little as a single gene change. Repeated and relatively recent introductions of this sort could account for the distribution of wild *M. balbisiana* in New Guinea and might also explain why it has the widest geographical distribution of all bananas yet varies but little.

No wild hybrids between *M. balbisiana* and any other *Musa* species were seen in Papua New Guinea and the majority of populations were ecologically well isolated from other wild Musaceae with the exception of *Ensete*.

2. M. banksii F. Muell., Fragm. 4:132 (1863–4). Fig. 5.
Syn.: *M. acuminata* Colla ssp. *banksii* (F. Muell.) Simmonds in Kew Bull. 11:463 (1956).
Type. Australia, Queensland: Mount Eliot, *Fitzalan* (MEL).

Pseudostem up to 6 m tall, 80 cms girth at the base, usually a distinctive chocolate brown in colour but sometimes almost green. Sap watery or a dirty cream colour. Rhizomes short but the suckers arising sufficiently far from the parent to grow more or less vertically upwards. Suckering usually prolific; the plants sometimes forming broad clumps. Shoulder brown or green, always with a broad (> 1 cm) appressed scarious margin. Petiole commonly mostly brown in colour sometimes pale green with or without a glaucous waxy bloom, the margin erect and distinctly scarious, canal large; TS ratio 1·2. Lamina green non-waxy above, paler green and variable in waxiness below, the base left-handed cuneate; PB ratio 4–5.

Peduncle usually coarsely hairy, brown or green. Bunch typically hanging approximately diagonally downwards but light bunches are sometimes almost horizontal and heavy bunches near vertical. The bunch also varies from dense to lax and sometimes exhibits irregular fruit-setting particularly in the proximal hands. Fruits usually strongly negatively geotropic and rigidly erect but sometimes more or less ageotropic and forming irregular bunches. Basal bracts long, lingulate and quickly falling. Basal flowers usually hermaphrodite although commonly with less than the full complement of fully developed stamens. The oldest one to three hands, often functionally female only. Pedicels variable, 1–3 cms long. Young fruits glabrous, pale green or sometimes mottled brown after insect damage; ovules in two rows per loculus. Mature fruit ripening yellow, often discoloured brownish by insect or other damage to the skin, indehiscent, not strongly aromatic. Seeds small, dark brown, 4–5 mm diameter, smooth or faintly vertically striolate, hilum small, hardly sunken but with a slightly raised collar, the umbo hardly raised.

Male peduncle very characteristically at first growing almost horizontally although becoming diagonal under the increasing weight of the developing fruit, later becoming positively geotropic and descending vertically. Male bud convolute, slender and pointed, 2–2·5 times as long as broad, variable in colour from pale green or yellow to deep dull red or purple often somewhat waxy. Male bract dull outside, coloured as the bud, shiny inside and pale green to pink or red, the colour always fading towards the bract insertion. Bracts lifting to a low angle and then rolling backwards and quickly falling. Male flower cream, the compound tepal c. twice as long as the free tepal. Compound tepal with bright sulphur yellow tips. Free tepal translucent

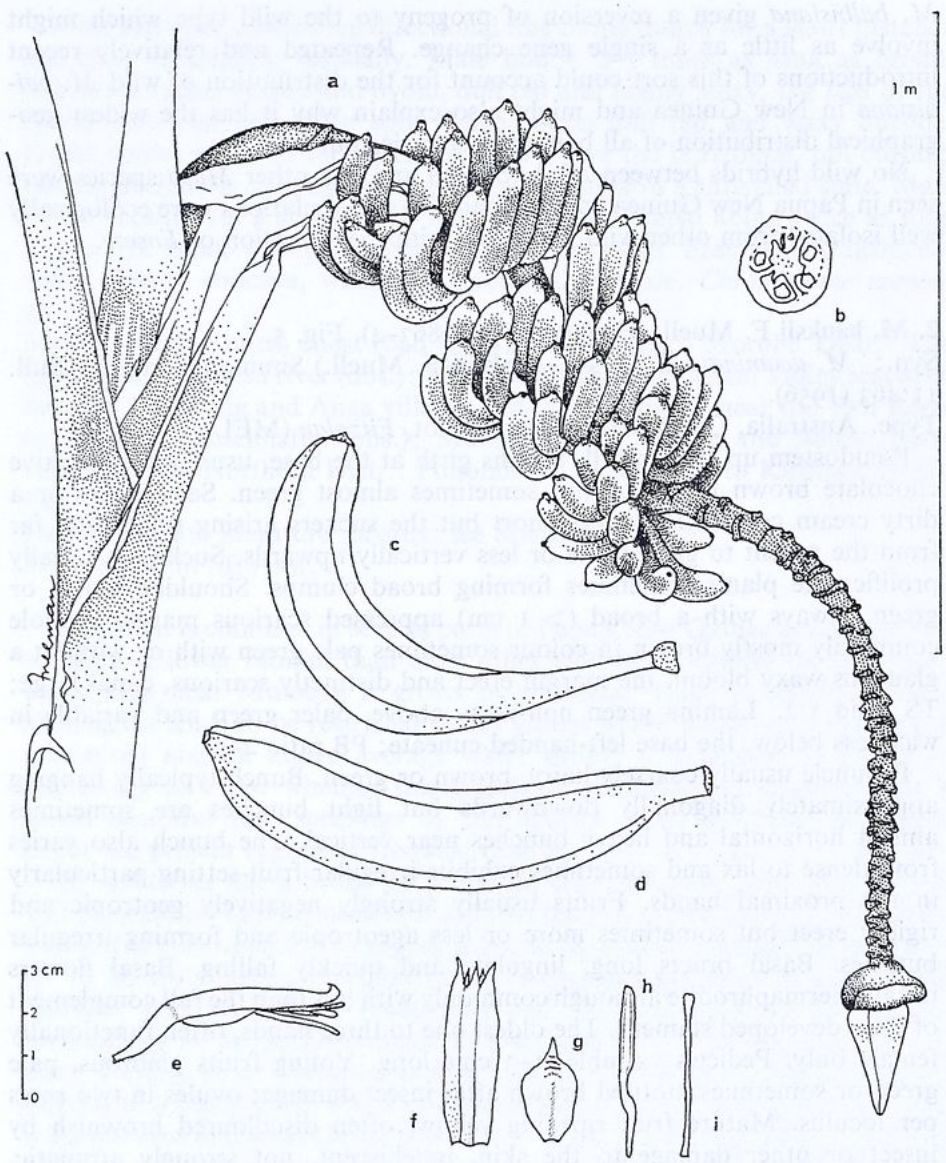

FIG. 5. *Musa banksii*: a, infructescence; b, T.S. of fruit; c, mature fruit (Sepik); d, mature fruit (Lae); e, male flower; f, compound tepal of male flower; g, free tepal of male flower; h, stamen of male flower; i, style and stigma of male flower.
All except 'c' drawn from material grown and originating near Lae; 'c' drawn from specimen collected near Aitape, West Sepik District.

white, ovate-acuminate with a distinctly wrinkled area at the base of the acumen. *Chromosome number* 2n = 22.
West Sepik Distr.: near Vanimo (obs.); Pagei (obs.); Imonda (obs.); Kilifas (obs.); Amanab (obs.); Lumi (obs.); Aitape, NGBF 1119 (LAE). East Sepik Distr.: Maprik (obs.); Yangoru (obs.); Wewak (obs.). Western Highlands Distr.: Baiyer River (obs.). Tabibuga (obs.) Madang Distr.: Bundi (obs.); Bogia (obs.); Madang, north coast roadside (obs.); Gogol River (obs.); Kar Kar

Island (obs.). Eastern Highlands Distr.: Kassam Pass (obs.). Manus Distr.: near Perikawa (obs.); Sabon village near Lorengau (obs.). Morobe Distr.: Umboi Island (obs.); Lae, NGBF 1129, 1130, 1131 (LAE); Markham Valley, common in forested situations (obs.); Gabensis to Zenag (obs.); Mongi River (obs.); Bulolo (obs.); Finschhafen (obs.). Central Distr.: Kerema (obs.); Musgrave River (obs.). Northern Distr.: Popondetta to Kokoda (obs.). Herbarium and literature records: see Simmonds (1956). Fig. 11.

M. banksii is the most widespread *Musa* in New Guinea and its range extends into Queensland, Samoa and possibly the Philippines. It is common throughout most of its range and although variable in such obvious characters as bract colour, these variations do not correlate well with geographical patterns of distribution. An exception noted in the Sepik Districts was a distinctive form which had a glabrous peduncle and long pedicellate tapering fruit. Simmonds (1956) has suggested the possibility of introgression by a form of *M. acuminata* from West Irian and this remains an interesting theory. Another minor variant was noted on Manus Island where the vegetative parts were flushed pink in a manner not seen on the mainland, but unfortunately no mature specimens were observed and material from the site did not develop in time for observation of the fruit and flower structure.

I have not followed Simmonds (1956) in reducing *M. banksii* to a subspecies of *M. acuminata*. There is still very little knowledge of *Musa* from West Irian or the islands to the west of New Guinea and it is premature to assume a cline linking *M. banksii* with Malayan forms of *M. acuminata*. Artificial pollination experiments under garden conditions are not a substitute for field observations on the breeding behaviour of populations; certainly *M. acuminata* ssp. *malaccensis* growing in the Lae Botanic Gardens, although established for many years and growing in close proximity to *M. banksii*, showed no evidence of producing any hybrids.

M. banksii was common as a roadside plant in various lowland secondary situations. It was never seen in large pure stands although the seedlings were sometimes dominant over substantial patches of disturbed ground. This species seemed to have a great burden of pests and diseases, and casual observations indicated that the clumps do not maintain themselves for such long periods as some other *Musa* species.

Hybrids between *M. banksii* and *M. schizocarpa* are described under the latter, but gene exchange with some diploid banana cultivars cannot be ruled out and might explain some of the variability of bract colour and other characters.

3. M. schizocarpa Simmonds in Kew Bull. 11:474 (1956). Fig. 6.
Type. Papua New Guinea, Sepik Distr.: near Dagua, 7 xii 1954 *Simmonds* B.E. 13 (K).

Pseudostem up to 10 m tall, 100 cm in girth at the base, dark blackish brown in the lower part gradually becoming bright non-waxy or paler waxy green above which may be irregularly blotched dark brown; sap watery. Rhizomes short, suckers emerging close to the parent stem but growing away vertically. Clumps mostly rather small. Shoulder green usually without wax but sometimes with copious wax in var. B. Shoulder margin non-scarious

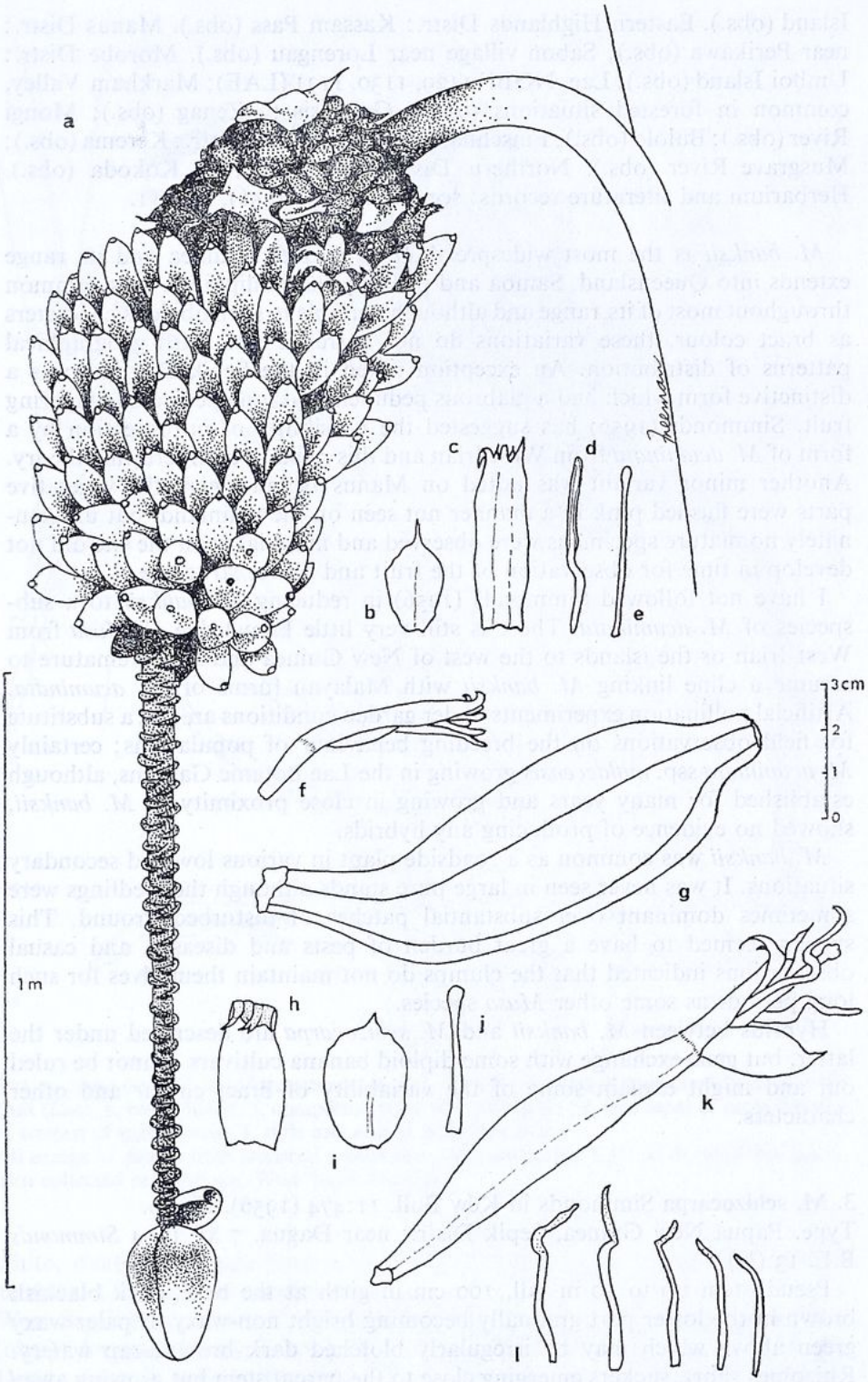

FIG. 6. *Musa schizocarpa*: a, infructescence; b, free tepal; c, compound tepal; d, stamen; e, style and stigma; f, male flower; g, mature fruit before splitting; h, compound tepal of hermaphrodite flower; i, free tepal of hermaphrodite flower; j, style and stigma from hermaphrodite flower; k, hermaphrodite flower; l, stamens from hermaphrodite flower.
All drawn from specimens grown and originating near Lae.

green sometimes with a black edge and often with a few large irregular wrinkles. Petiole pale green, non-waxy except in var. B, margins erect and green, canal deep and open, TS ratio 1·0. Leaf lamina non-waxy deep green above paler green and often waxy below; left-handed with cuneate base (fig. 1a); PB ratio 6·5–7·5.

Peduncle green, glabrous. Bunch very dense, sometimes curved in the upper part but the lower part and usually the whole bunch hanging vertically downwards. Fruits occasionally curved upwards but usually spreading outwards through compression. Basal bracts long and lingulate, rapidly rolling back and quickly falling. Basal flowers hermaphrodite, biseriately arranged. Pedicels 2–3 cm long. Young fruit glabrous, distinctive dark green with purplish flush; ovules in two rows per loculus. The mature fruit short and broad, often strongly angular, bottle-nosed, dark green and schizocarpic with the skin peeling back in a rather irregular fashion to expose the gleaming white flesh. Seeds 6–7 mm in diameter, dark brown or blackish, hilum small, level or slightly sunken but with a raised collar, umbo small, not raised often almost obsolete.

Male peduncle descending vertically down from the bunch. Male bud dull green, convolute, with a distinctly rounded distal end. Male bracts dull green outside quickly going grey or brownish after lifting, the inside green. These bracts rapidly curl backwards on lifting and were always observed to be fully deciduous. Male flower creamy-white the compound tepal almost twice as long as the free tepal and with pale yellow tips to the lobes. Free tepal translucent white, ovate-acuminate with a more or less wrinkled area at the base of the acumen.

Two variants of this species can be recognised and informally designated as follows: var. A, plant large, rarely fruiting when less than 7 m tall, without obvious wax, male bracts curling from the distal end only; var. B, plant small, often fruiting when only 2–3 m high, the leaf sheaths and shoulders distinctly waxy, male bracts curling from both distal and proximal ends.

West Sepik Distr.: near Vanimo (obs.); Imonda (obs.); Kilifas (obs.); Pagei (obs.); Amanab (obs.); Lumi (obs.). East Sepik Distr.: Apangai Village (obs.); Maprik (obs.); Yangoru (obs.); Wewak (obs.). Western Highlands Distr.: Baiyer River (obs.); Tsau River (obs.). Madang Distr.: Bundi (obs.); along north coast road from Madang (obs.); Gogol River (obs.); Koropa Village near Dumpu (obs.). Eastern Highlands Distr.: Kassam pass (obs.). Morobe Distr.: near Kaiapit (obs.); Leron River bridge (obs.); widespread and often abundant in the lower Markham Valley (obs.); Oompsis to Zenag pass (obs.); Bulolo (obs.); Wau, NGBF 1133 (LAE); Lae (common), NGBF 1132 (LAE); Buso River (obs.); Mongi River (obs.); Finschhafen (obs.). Central Distr.: Aieme (Musgrave) River (obs.). Milne Bay Distr.: near Gurney (obs.). Herbarium and literature records: see Simmonds (1956). Fig. 12.

M. schizocarpa is widely distributed on the New Guinea mainland and the two variants recognised above seem to have more or less distinct geographical distributions, var. A being widely distributed along the north-east coastal area whilst var. B was found in a small inland area close to the border with

West Irian. It is interesting that Simmonds at first (1956) noted two forms then later decided that the differences were due to habitat and state of maturity. Plants from the West Sepik District were, however, distinct in the characters Simmonds mentions, particularly in the paler green fruits, smaller stature and much waxier appearance when grown alongside local plants in Lae. Although the paler fruit colour appears to be a rather trivial genetic difference (mixed populations were noted at Amanab), the smaller stature is distinctive. *M. schizocarpa* at Amanab often fruited at only 2 m high and cultivated specimens from this region behaved similarly in Lae alongside local plants of several times the stature. The curious difference in bract rolling was observed from only a limited number of plants and the status of these forms must remain tentative pending further investigations in the Sepik Districts and in the eastern region of West Irian. It seems that either a cline occurs from east to west and that further collections from intermediate localities might make this clear or that, as in *M. banksii*, another species or subspecies occurs in West Irian and a zone of introgression occurs which includes the West Sepik District and some of the Papuan plateau. *M. schizocarpa* commonly occurs as occasional clumps in disturbed areas with a suitably high rainfall but can sometimes form almost pure stands. The two largest stands seen (north of Lae and near Finschhafen) were in both cases on thin soil overlying limestone. This species often grows with *M. maclayi* in the Lae area and vegetative specimens can be difficult to identify. If *M. maclayi* has purple juice there can be no confusion although leaf base characters and general stature can also be used to separate them, *M. schizocarpa* being left-handed with a broader pseudostem than the more slender *M. maclayi* with its right-handed leaves. *M. schizocarpa* is easily separable from *M. banksii*, and hybrids with that species, by the absence of any scarious margin on the shoulders. The fruit is quite distinct from that of any other known banana.

M. banksii × M. schizocarpa

Pseudostem up to 8 m tall and 90 cms in girth at the base. Rhizomes short but the plants sometimes forming quite large clumps. Shoulders green with brown blotches and a narrow, c. 5 mm wide, appressed scarious margin. Leaf lamina green, non-waxy above, pale green hardly waxy below, the base cuneate and left-handed.

Peduncle green glabrous in all specimens seen. Bunches lax, almost invariably with poor fruit development, the fruit weakly negatively geotropic. Young fruit dark green. Mature fruit ripening yellowish-green often with many dark almost black blotches or the whole bunch blackish. Fruit usually indehiscent but occasional fruits may partially and irregularly split near the apex. Seeds intermediate in size between those of the parent species, 5–6 mm in diameter when fully developed, but often with a high proportion of undeveloped ovules and always with less seed per fruit than either of the parents.

Male peduncle with the habit of *M. banksii*, but the male bud intermediate between the two parents being more slender than in *M. schizocarpa* although blunter at the tip than *M. banksii*. It typically has the dull green colour of *M. schizocarpa* although sometimes purple bracts occur. Male flowers well-developed and pollen apparently good.

West Sepik Distr.: coast road near Vanimo (obs.). East Sepik Distr.: near Wewak on road to Dagua (obs.). Madang Distr.: north coast road from Madang (obs.). Morobe Distr.: Lae, Markham Road, NGBF 1134 (LAE); Gabensis (obs.).

In almost all characters, these plants are intermediate between *M. banksii* and *M. schizocarpa* yet they form a distinct taxonomic entity and were not observed to intergrade with either parent. The bottle-necked fruit shape in some forms of *M. banksii* may suggest a limited introgression of *M. schizocarpa* genes but never to the extent of causing difficulty with determination.

The occurrence of this hitherto unrecorded natural hybrid is not really surprising considering that the parents commonly grow together and have the same chromosome number. Although both parents must normally be self-pollinating, *M. banksii* at least commonly fails to develop functional stamens in some hands of the bunch and occasionally in all hands so that the female parent is more likely to be this species. Mr K. Shepherd (pers. comm.) has diagnosed *M. schizocarpa* parentage in the cultivar 'Galan' from New Britain and New Ireland, and personal observations suggest that this species may have contributed a substantial number of clones by hybridisation. The spontaneous occurrence of wild hybrids may well be the source of these clones although it must be pointed out that hybridisation could also occur between *M. schizocarpa* and diploid '*acuminata*' type (AA) cultivars.

Several collections of this hybrid were planted in the NGBF collection in Lae and grown to maturity. It appears to be quite common and was found in most places where the two parents grew together.

SECT. AUSTRALIMUSA Cheesman in Kew Bull. 2:110 (1947).
Type. *M. textilis* Née in Anal. Cienc. Nat. 4:123 (1801).

Basic chromosome number 10. Sap very commonly bright red or violet occasionally watery. Male bud usually with shiny bracts. Fruit [in all New Guinea species] ripening bright red-orange.

4. M. maclayi F. Muell. ex Miklouho-Maclay in Proc. Linn. Soc. New South Wales 10:348 (1885).
Type. Papua New Guinea. Morobe: Maclay coast, *N. de Miklouho-Maclay*, sketches and letter addressed to von Mueller (MEL).

Pseudostem up to 10 m tall and 100 cms in girth, predominantly brown below becoming bright non-waxy green above with a variable amount of brown streaking and mottling. Sap variable from watery cream to pink or bright purple. Rhizomes short, suckers arising more or less vertically from the ground and plants forming dense clumps with many pseudostems. Shoulder green non-waxy, edge appressed or reflexed often undulate, commonly blackish but always non-scarious. Petiole pale green non-waxy, margins erect or reflexed more or less green; TS ratio 1·0. Leaf lamina bright green non-waxy above paler but also without wax below. Leaf base right-handed and cuneate (fig. 1b) to rounded (or weakly auriculate in var. *erecta*); PB ratio 7–10.

Peduncle glabrous green. Bunch held stiffly erect, variable from very dense to moderately lax. Hands of fruit weakly ascending or more usually spreading by compression. Female bracts long, glossy green outside, cream inside, usually quickly deciduous but persistent in subsp. *ailuluai*. Basal

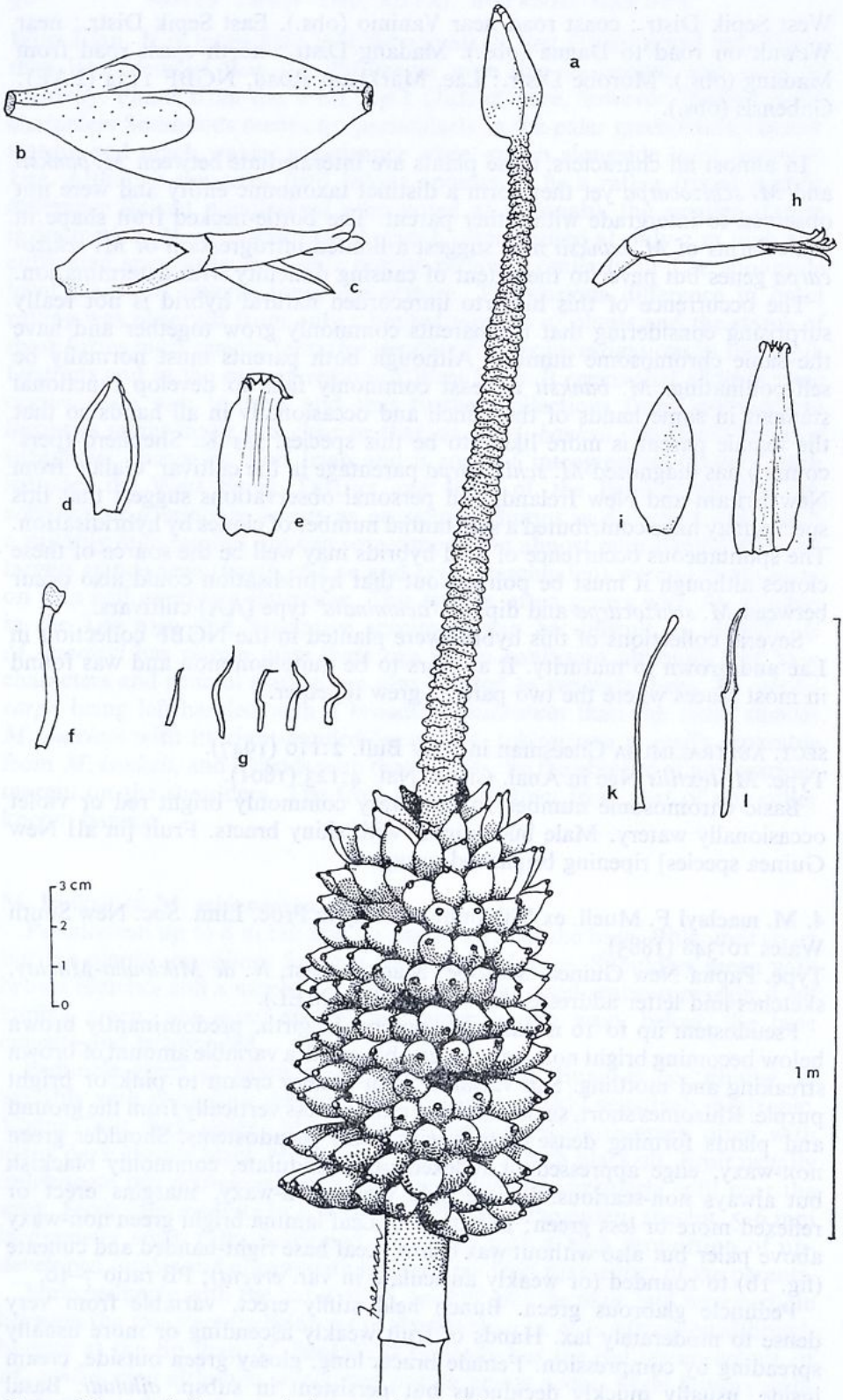

FIG. 7. *Musa maclayi* ssp. *maclayi* var. *maclayi*: a, infructescence; b, mature fruit; c, female flower; d, free tepal of female flower; e, compound tepal of female flower; f, style and stigma of female flower; g, staminodes of female flower; h, male flower; i, free tepal of male flower; j, compound tepal of male flower; k, style and stigma of male flower; l, stamen of male flower.

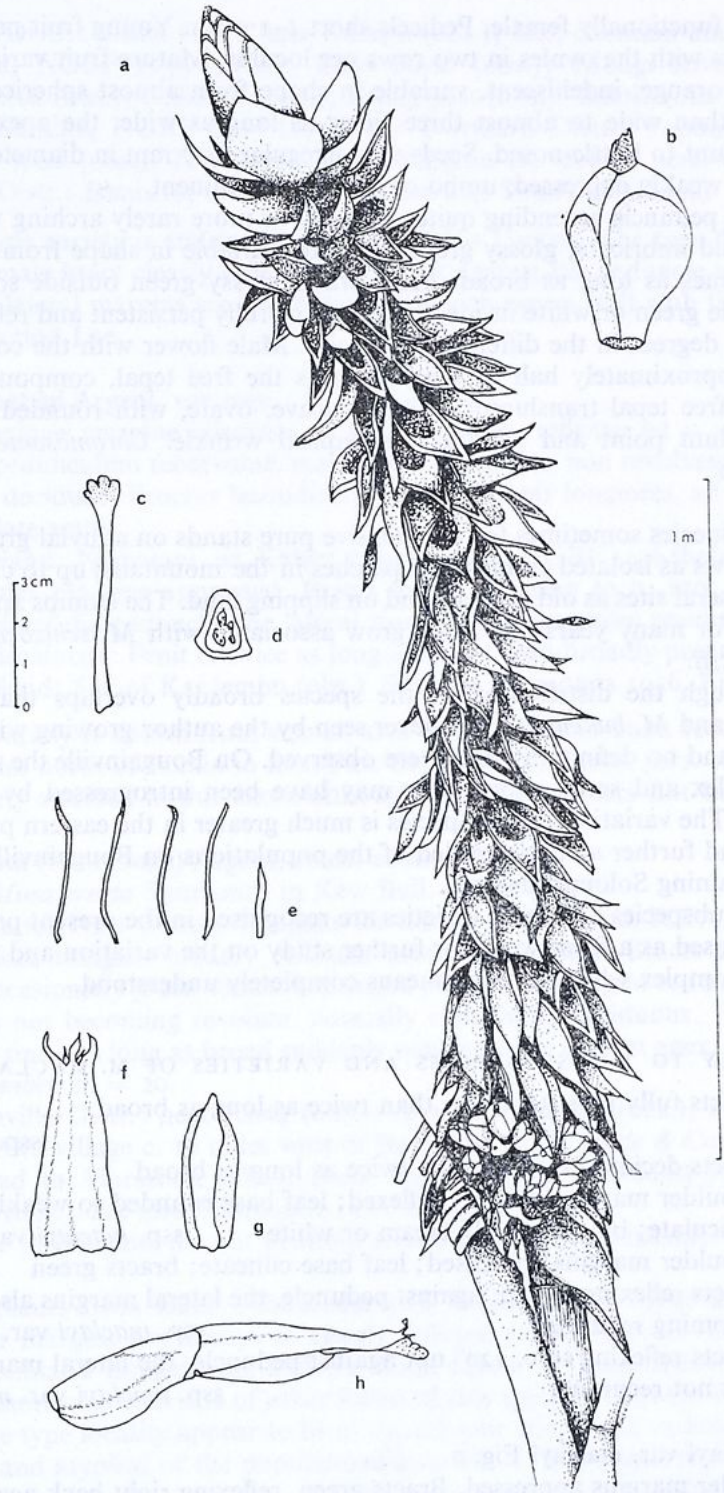

FIG. 8. *Musa maclayi* ssp. *ailuluai*: a, infructescence; b, mature fruit; c, style and stigma of female flower; d, T.S. of ovary; e, staminodes; f, compound tepal; g, free tepal; h, female flower.
Drawn from type clone grown in Lae originating from Fergusson Island, at Ailuluai.

flowers functionally female. Pedicels short 1–1·5 cm. Young fruit pale green, glabrous with the ovules in two rows per loculus. Mature fruit variable pale to rich orange, indehiscent, variable in shape from almost spherical hardly longer than wide to almost three times as long as wide, the apex varying from blunt to bottle-nosed. Seeds very irregular, 6–7 mm in diameter, hilum usually weakly depressed, umbo obsolete to prominent.

Male peduncle ascending quite vertically or more rarely arching with age. Male bud imbricate, glossy green or white, variable in shape from twice to three times as long as broad. Male bracts glossy green outside sometimes very pale green or white inside, deciduous or fully persistent and reflexing in varying degrees in the different subspecies. Male flower with the compound tepal approximately half as long again as the free tepal, compound tepal cream, free tepal translucent white, concave, ovate, with rounded apex or short blunt point and without a subapical wrinkle. *Chromosome number* 2n = 20.

This species sometimes forms extensive pure stands on alluvial gravels but also grows as isolated clumps and patches in the mountains up to c. 1000 m in such seral sites as old gardens and on slipping land. The clumps apparently persist for many years and often grow associated with *M. schizocarpa* and *M. banksii*.

Although the distribution of the species broadly overlaps that of *M. peekelii* and *M. bukensis* it was never seen by the author growing with either species and no definite hybrids were observed. On Bougainville the situation is complex and some populations may have been introgressed by another species. The variation of this species is much greater in the eastern part of its range and further study is needed of the populations on Bougainville and in the remaining Solomon Islands.

Two subspecies and three varieties are recognised in the present paper and may be used as a framework for further study on the variation and affinities of this complex which is by no means completely understood.

Key to the subspecies and varieties of M. maclayi

1. Bracts fully persistent, less than twice as long as broad . . ssp. *ailuluai*
+ Bracts deciduous, more than twice as long as broad . . 2
2. Shoulder margins broadly reflexed; leaf base rounded to weakly auriculate; bracts usually cream or white ssp. *maclayi* var. *erecta*
+ Shoulder margins appressed; leaf base cuneate; bracts green . 3
3. Bracts reflexing to 180° against peduncle, the lateral margins also becoming recurved . . . . ssp. *maclayi* var. *maclayi*
+ Bracts reflexing to c. 120° not against peduncle, the lateral margins not recurving . . . . ssp. *maclayi* var. *namatani*

ssp. **maclayi** var. **maclayi** Fig. 7.

Shoulder margins appressed. Bracts green, reflexing right back against the peduncle and with the lateral edges also becoming strongly revolute, completely deciduous. Fruit two to three times as long as broad, blunt or bottle-necked.

Morobe Distr.: Bintia Creek near Kaiapit (obs.); Lae, common and locally abundant, NGBF 1135 (LAE); Buso River (obs.); Mongi River (obs.) Finschhafen (obs.); Gabensis (obs.); Zenag pass (obs.); Bulolo (obs.); Buso; (obs.); Garaina, NGBF 6965 (LAE, K). Northern Distr.: Popondetta to Kokoda road (obs.); NW slope Mt Lamington (R. Johns, pers. comm.). Central Distr.: Isuarava, *Carr* 15590 (K). See also Simmonds (1956). Fig. 13.

The type variety is endemic to mainland New Guinea. The type drawings show a male bract clearly reflexed right back against the peduncle and look as if the lateral margins are also turned in, which agrees well with the populations round Lae.

var. **namatani** Argent, **var. nov.**

Os vaginae margine adpresso. Bracteae virides, reflexae ad c. 120° sed non ad pedunculum recurvatae, marginibus lateralibus non revolvescentibus, omnino deciduae. Fructus latitudine plus minusve bis longiores, ad basin et apicem late acuti.

New Ireland: Namatani, nr. Kalam village, *Argent* NGBF 1136 (holo. LAE).

Shoulder margins appressed. Bracts green, reflexing to c. 120° but not back against the peduncle, the lateral margins not becoming revolute, completely deciduous. Fruit c. twice as long as broad with broadly pointed ends. New Ireland: SW of Kantembu (obs.). See also Simmonds 1956. Fig. 13.

This variety is known from a small area in New Ireland but a record from c. 20 miles north of Pomio in East New Britain (M. Bourke, pers. comm.) is tentatively ascribed to this taxon although the specimen has not been seen.

var. **erecta** (Simmonds) Argent, **comb. et stat. nov.**

Syn.: *Musa erecta* Simmonds in Kew Bull. 8: 571 (1953).

Type. Papua New Guinea. Bougainville Distr.: Buka Island, ICTA 200 (K).

Shoulder margins broadly reflexed, green and rugose. Bracts cream or white occasionally green sometimes tinged purple, reflexing to c. 100°, lateral margins not becoming revolute, normally completely deciduous. Fruit two to three times as long as broad suddenly contracted in a blunt apex. *Chromosome number* 2n = 20.

Bougainville Distr.: near Kieta (obs.); Aropa plantation (obs.); near Buin (obs.); Aku village c. 10 miles west of Buin Station, *Schodde & Craven* 4022 (K); road to Maratona (obs.); Buka Island (obs.); east coast road near Sohano (obs.). See also Simmonds 1956. Fig. 13.

Endemic to Bougainville but possibly also in the Solomon Islands.

The plants from Buka Island, the type locality, have loose and wavy shoulder margins not always so clearly reflexed as in plants of this variety from mainland Bougainville and the bract colour is often yellowish-green and so more characteristic of other forms of this species. Thus the specimens from the type locality appear to be at the extreme end of the variation of the variety and atypical of the populations as a whole. Simmonds (1953) in the type description reported that the bracts were variably persistent but the author never saw more than occasional persistent withered bracts which had a very different appearance from the fully persistent stubby bracts of *M. maclayi* ssp. *ailuluai*.

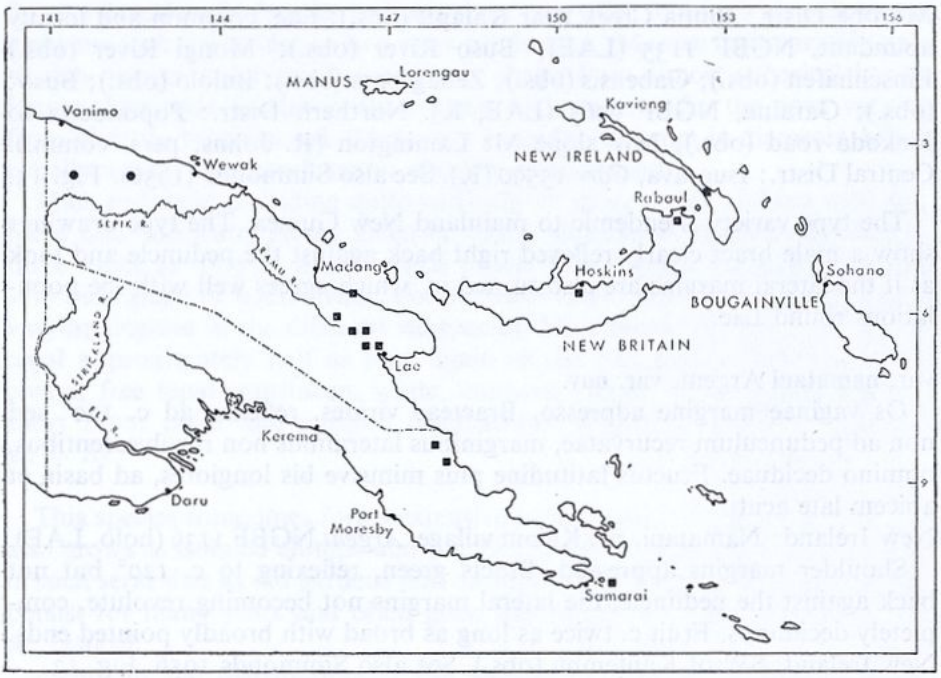

FIG. 9. Distribution of: ● *M. lolodensis*; ■ *E. glaucum.*

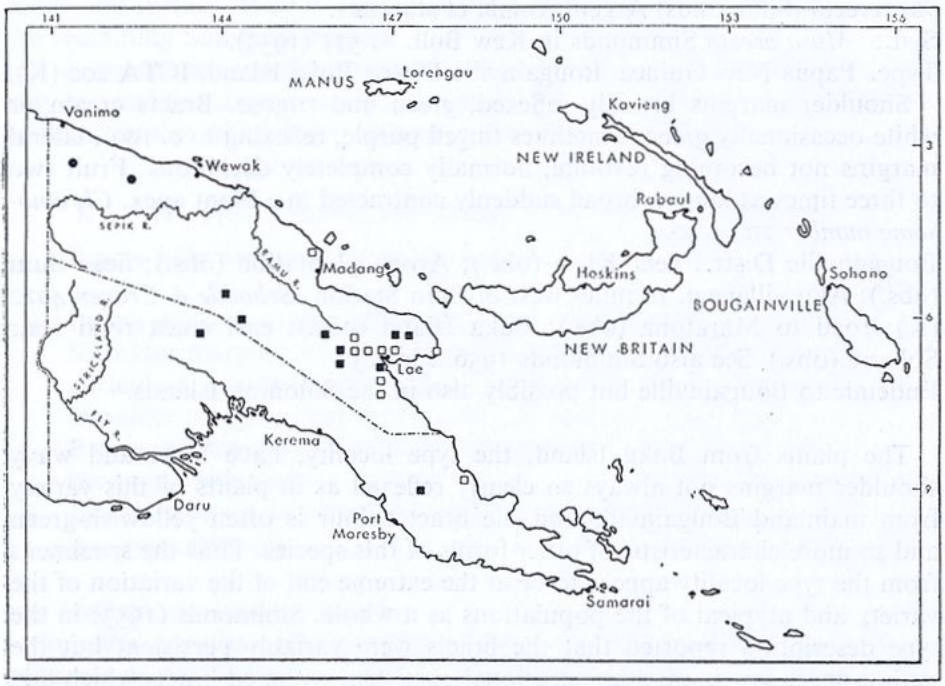

FIG. 10. Distribution of: ● *M. boman* (total range); ■ *M. ingens* (total range); □ *M. balbisiana.*

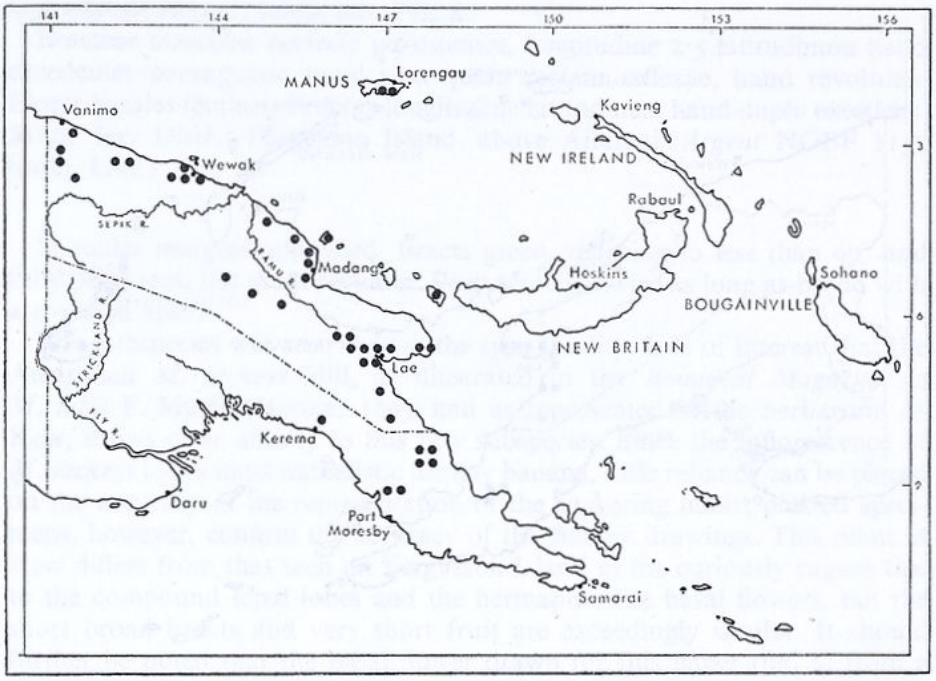

FIG. 11. Distribution of: ● *M. banksii*

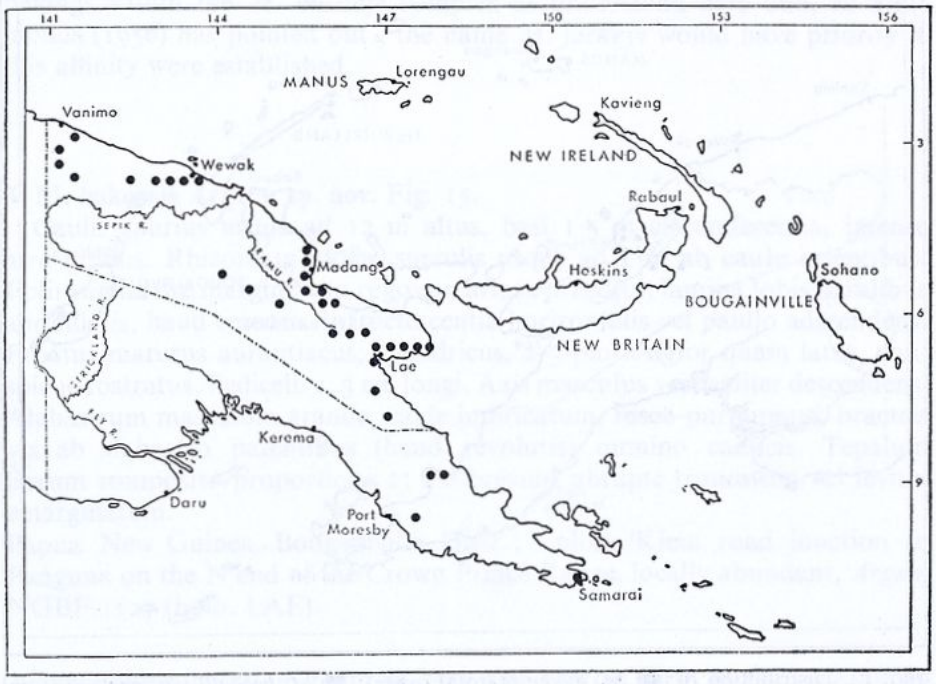

FIG. 12. Distribution of: ● *M. schizocarpa* (total range).

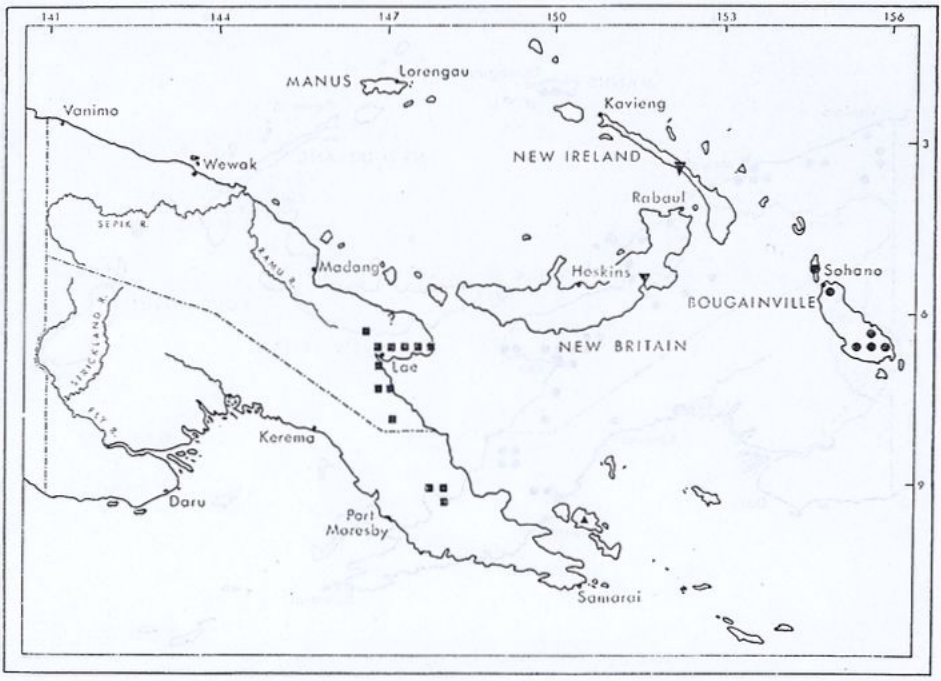

FIG. 13. Distribution of: *M. maclayi*: ● ssp. *maclayi* var. *erecta*; ■ ssp. *maclayi* var. *maclayi* (total range); ▼ ssp. *maclayi* var. *namatani* (total range); ▲ ssp. *ailuluai* (total range).

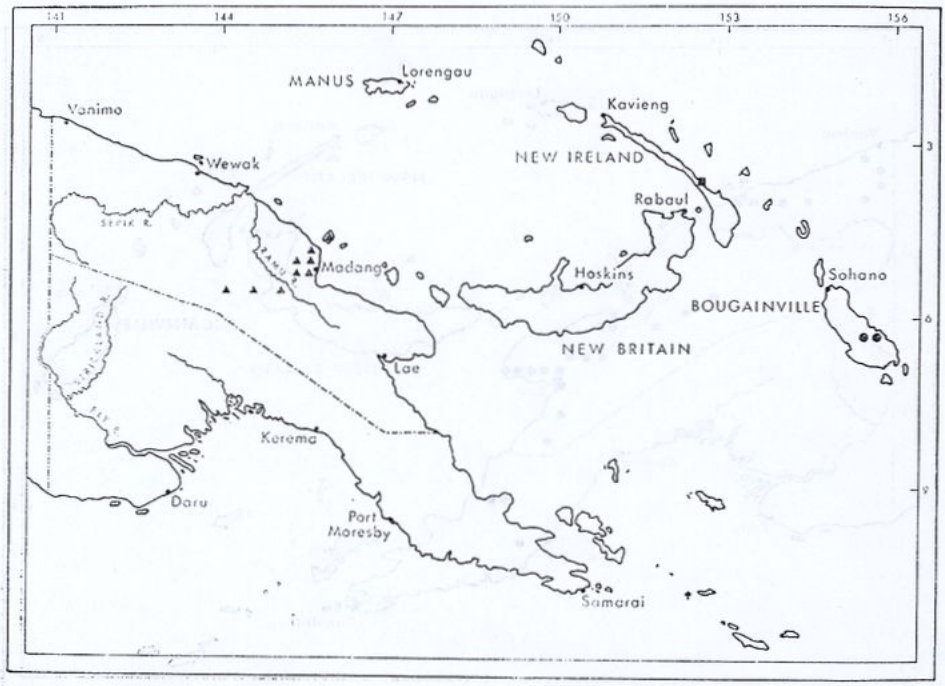

FIG. 14. Distribution of: ● *M. bukensis* (total range); ■ *M. peekelii* ssp. *peekelii* (total range); ▲ *M. peekelii* ssp. *angustigemma* (total range).

ssp. **ailuluai** Argent, **subsp. nov.** Fig. 8.

Bracteae masculae perfecte persistentes, longitudine 2·5 latitudinum haud excedentes perangulam haud plus quam rectam reflexae, haud revolutae. Flores basales feminei. Fructus longitudine latitudinem haud duplo excedens. Milne Bay Distr.: Fergusson Island, above Ailuluai, *Argent* NGBF 1137 (holo. LAE). Fig. 13.

Shoulder margins appressed. Bracts green, reflexing to less than 90° and fully persistent, not at all revolute. Fruit scarcely twice as long as broad with a rounded apex.

This subspecies was seen only in the type locality. It is of interest that the Australian *M. jackeyi* Hill, as illustrated in the *Botanical Magazine* as *M. hillii* F. Muell. (Hooker 1895) and as represented in the herbarium at Kew, shows close affinity to this new subspecies. Since the inflorescence of *M. jackeyi* looks most unrealistic for any banana, little reliance can be placed on the accuracy of the representation of the suckering habit; pickled specimens, however, confirm the accuracy of the smaller drawings. This plant at Kew differs from that seen on Fergusson Island in the curiously rugose tips to the compound tepal lobes and the hermaphrodite basal flowers, but the short broad bracts and very short fruit are exceedingly similar. It should further be noted that the basal flower drawn for this paper (fig. 8) from a Fergusson Island plant grown in Lae exhibited very highly developed staminodes and it is quite possible that subsequent inflorescences on better grown plants might well have produced hermaphrodite basal flowers as observed in *M. jackeyi*. It is unfortunate that *M. jackeyi* seems not to have been seen in Queensland for many years and is possibly extinct. It is most likely that it belongs within the *M. maclayi* complex as understood here and, as Simmonds (1956) has pointed out , the name *M. jackeyi* would have priority if this affinity were established.

5. M. bukensis Argent, **sp. nov.** Fig. 15.

Caulis spurius usque ad 12 m altus, basi 1·5 m circumferentia, intense atro-nitidus. Rhizomata longa, surculis usque ad 1 m ab caule orientibus. Folii vagina ore margine lata rugosa scariosa praedita; lamina lobis basalibus auriculatis, haud ceracea. Infructescentia horizontalis vel paullo adscendens. Fructus maturus aurantiacus, cylindricus, 2–3-plo longior quam latus, conspicue rostratus. Pedicelli c. 3 cm longi. Axis masculus verticaliter descendens. Alabastrum masculum grande, valde imbricatum, fusco-purpureum, bracteis vix ab alabastro patentibus (haud revolutis) omnino caducis. Tepalum librum composito proportione 1: 2·8 brevius, abrupte truncatum vel leviter emarginatum.

Papua New Guinea. Bougainville Distr.: Loloho/Kieta road junction to Panguna on the N end of the Crown Prince Range, locally abundant, *Argent* NGBF 1127 (holo. LAE).

Pseudostem large, up to 12 m high and 150 cm girth at the base, of an intense glossy black colour throughout, or sometimes with a little green or

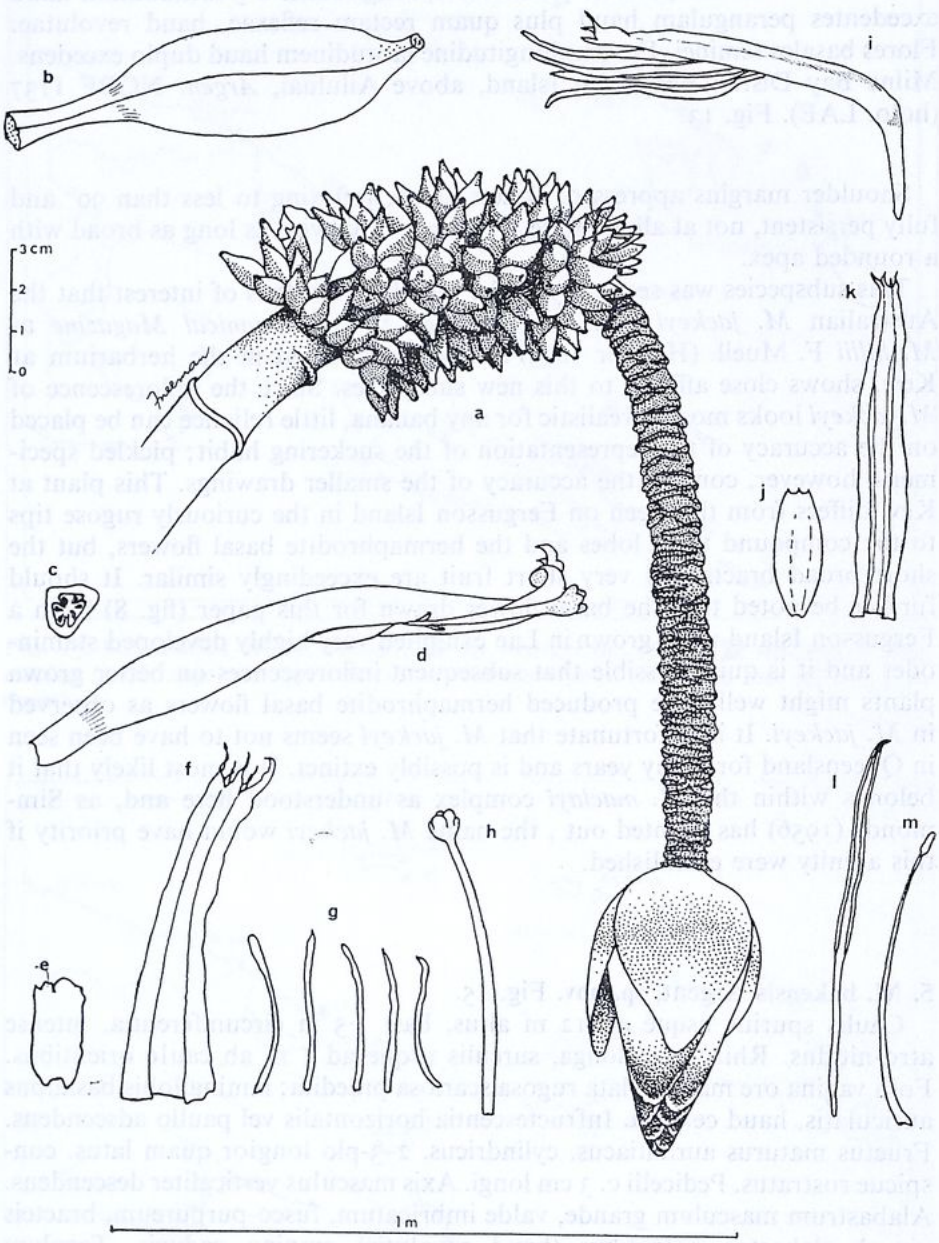

FIG. 15. *Musa bukensis*: a, infructescence; b, mature fruit; c, T.S. of ovary; d, female flower; e, free tepal of female flower; f, compound tepal of female flower; g, staminodes of female flower; h, style and stigma of female flower; i, male flower; j, free tepal of male flower; k, compound tepal of male flower; l, stamen of male flower; m, pistillode of male flower.

All drawn from the type clone grown in Lae from material collected on Crown Prince Range, Bougainville.

brown in the upper part. Sap yellowish, white or pale to deep purple. Rhizomes long, the young suckers emerging up to 1 m from the parent stem. Shoulder dark brown or brownish green with a very broad (c. 2 cm wide) appressed but rugose, scarious margin. Petiole with irregular dark brown patches below and narrow horizontally reflexed wings which are scarious in the lower part but green above; TS ratio 1·0. Leaf lamina green, without wax, strongly right-handed with auriculate basal lobes (fig. 1d); PB ratio 6–8.

Peduncle stout, glabrous, green or brown. Bunch habit variable, horizontal or slightly ascending, often curved, moderately dense. Fruit apparently ageotropic standing out round the stem with little tendency to curve. Basal bracts long, purplish, quickly deciduous. Basal flowers functionally female. Pedicels long, up to 3 cms. Young fruit green, glabrous with the ovules in two rows per loculus. Mature fruits rich coppery orange in colour, cylindrical, between 2–3 times as long as broad and with a long slender beak at the apex. Seeds black, 4–6 mm in diameter, angular, vertically striolate, with a slightly depressed hilum and distinctly raised umbo.

Male peduncle descending more or less vertically. Male bud large, almost conical, broadest about one quarter of the distance from the base, just over twice as long as broad, strongly imbricate for about one third of its length, dark purple with some cream at the base. Male bracts barely lifting away from the bud, not curling back, dark shining purplish red outside, cream inside except at the purplish tips. The male bracts are often removed by fruit bats but otherwise two or three bracts hang limply round the bud; the bracts are eventually fully deciduous leaving the axis bare. Male flower with the compound tepal nearly three times as long as the free tepal. Compound tepal white with pale yellow tips to the lobes which are very deeply divided for sect. *Australimusa*. Free tepal more or less ovate in outline, but abruptly truncated distally or slightly emarginate, with a very short central apiculus.

Bougainville Distr.: Loloho/Kieta road junction to Panguna, *Argent* NGBF 1128 (LAE). Fig. 14.

This species is common along the Loloho to Panguna road often growing in large stands along the roadside or on old disused garden sites. It ascends to at least 1000 m on the hills around Panguna but shows little sign of flowering at this altitude.

The above description was compiled from material collected near Lonzero Village on the Loloho to Panguna road and plants from this area subsequently grown on the N.G.B.F. experimental ground in Lae. The plants are very distinct from *M. maclayi*, its closest relative, but there is some evidence of introgression between the two species as, for example, in the black pseudostem pigmentation and a tendency for the male bud to be inclined in some populations of *M. maclayi*. A great deal more field-work needs to be done on Bougainville to establish the distribution of this species and to investigate what happens to populations at any points of contact between *M. bukensis* and *M. maclayi*. There is a link between *M. bukensis* and *M. peekelii* from New Ireland in the purplish coloration of the bracts and the fruit shape; surface corrugations are also similar in the two species. *M. peekelii*, however, always has a fully descending fruit bunch, non-scarious petiole margins and rounded, not auriculate, leaf bases.

6. M. peekelii Lauterbach in Bot. Jahrb. 50:306, fig. 1 (1913). Fig. 16. Type. New Ireland Distr. [Neu Meckleburg]: Lahur bei Namatani, auf roten Lehm, 9 iii 1910, *Peekel* 390 (WRSL).

Pseudostems up to 10 m tall and 80 cm in girth, predominantly of a rich brown colour in the lower part, brown or non-waxy green above. Sap variable, usually bright violet or purple but occasionally pale pink or cream. Rhizomes short; suckers arising more or less vertically from the ground and plants often forming dense clumps with many pseudostems. Shoulder non-waxy, green, commonly with a narrow appressed non-scarious black margin. Petiole pale yellowish-green, not or slightly waxy in the upper part, margins usually turned inwards over the canal; TS ratio 0·6. Leaf lamina bright green non-waxy above paler and very waxy below. Leaf base right-handed and rounded (fig. 1c); PB ratio 3–4·5.

Peduncle glabrous green, the bunch hanging vertically downwards moderately to extremely lax. Hands of fruit more or less ageotropic standing out or hanging at an angle. Basal bracts long, lingulate, brown or green, shiny, deciduous or often at least partly persistent. Basal flowers functionally female but often with staminodes. Pedicels short c. 1 cm long. Young fruit pale green, glabrous, with the ovules in two rows per loculus. Mature fruit rich orange in colour, indehiscent, cylindrical, about three times as long as broad, blunt or bottle-nosed. Seeds very irregular, 6–7 mm in diameter, characteristically broader than deep, hilum depressed, umbo obsolete to prominent.

Male peduncle descending vertically downwards, often becoming very long (3 m). Male bud imbricate, slender, from 3–4 times as long as broad. Occurring in the two colour forms: shiny brown or shiny green; and, in New Ireland, with purple streaks and tips to the bracts. Male bracts shiny, coloured similarly to the male bud but paler on the adaxial surface, lifting to approximately a horizontal position to display the flowers and varying from tardily but completely deciduous to completely persistent. Male flower with the compound tepal nearly half as long again as the free tepal. Compound tepal cream sometimes with yellow tips to the lobes; free tepal translucent white, concave, ovate with a short broad acumen and no subapical wrinkle. *Chromosome number* 2n = 20.

M. angustigemma cannot be maintained as an independent species on the basis of the characters given to separate it from *M. peekelii* (Simmonds 1962). The fruits of *M. peekelii* are not dehiscent and no difference in bract persistence of the two populations was discovered; both vary from fully deciduous to fully persistent. It is proposed here to maintain *M. angustigemma* as a subspecies of *M. peekelii*. The geographical distribution of these subspecies is distinct and they may be separated morphologically as follows:

1. Ripe fruit with surface fissuring; male bud with prominent purple tips to the bracts . . . . . ssp. *peekelii*

\+ Ripe fruit smooth; male bud not purple at the tips of the bracts . ssp. *angustigemma*

ssp. **peekelii.** Fig. 16b.

This subspecies has a characteristic superficial fissuring of the ripe fruit which is also typically suddenly contracted to a bottle-nose at the distal

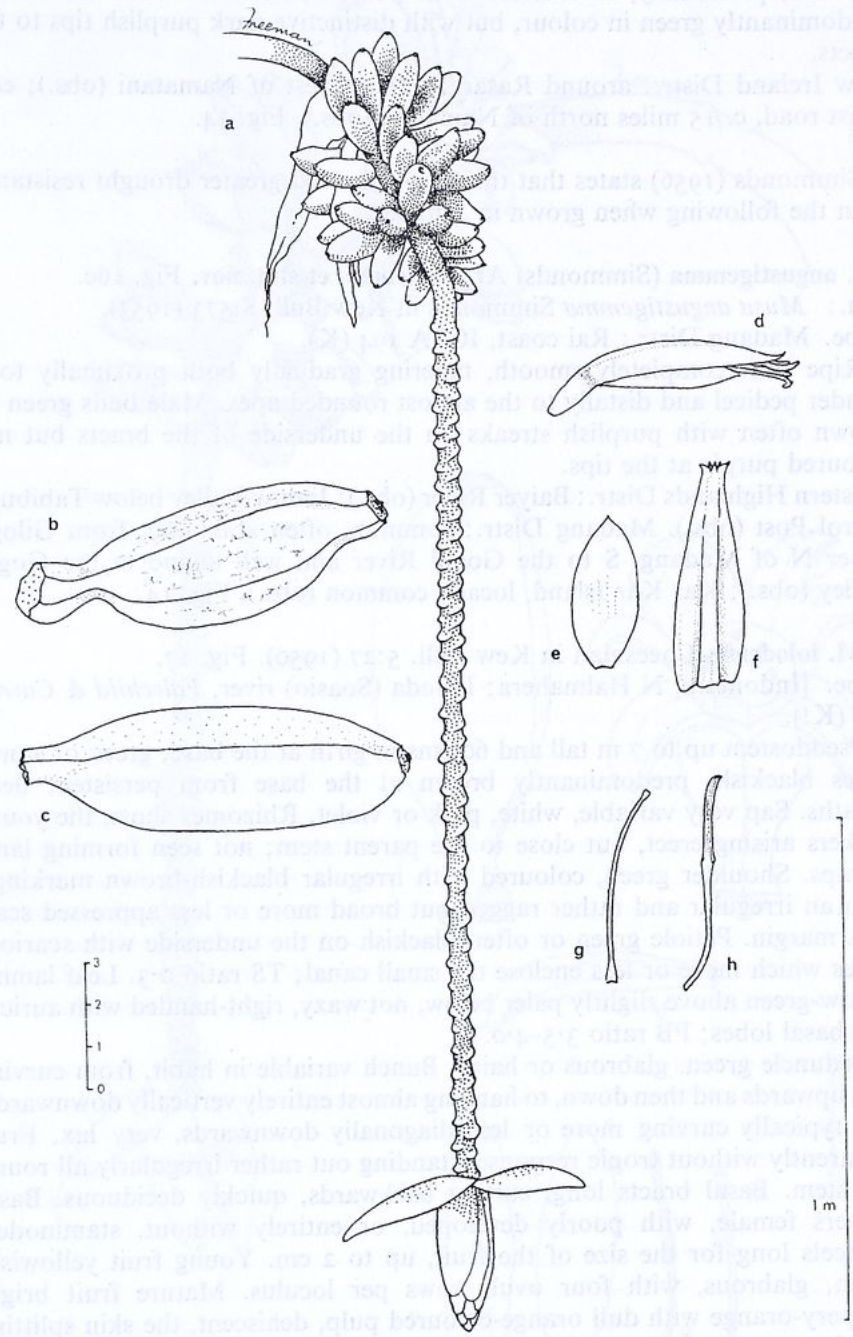

FIG. 16. *Musa peekelii*: a, infructescence; b, mature fruit (ssp. *peekelii*); c, mature fruit (ssp. *angustigemma*); d, male flower; e, free tepal of male flower; f, compound tepal of male flower; g, pistillode of male flower; h, stamen from male flower.
All except 'b' drawn from living material collected near Madang; 'b' drawn from a specimen collected near Namatani.

end and, proximally, to a short stout pedicel. The male buds are always predominantly green in colour, but with distinctive dark purplish tips to the bracts.

New Ireland Distr.: around Rasarik village west of Namatani (obs.); east coast road, c. 15 miles north of Namatani (obs.). Fig. 14.

Simmonds (1956) states that this taxon showed greater drought resistance than the following when grown in Jamaica.

ssp. **angustigemma** (Simmonds) Argent, **comb. et stat. nov.** Fig. 16c.

Syn.: *Musa angustigemma* Simmonds in Kew Bull. 8:573 (1953).

Type. Madang Distr.: Rai coast, ICTA 194 (K).

Ripe fruit completely smooth, tapering gradually both proximally to a slender pedicel and distally to the almost rounded apex. Male buds green or brown often with purplish streaks on the underside of the bracts but not coloured purple at the tips.

Western Highlands Distr.: Baiyer River (obs.); Jimmy Valley below Tabibuga Patrol Post (obs.). Madang Distr.: common, often abundant, from Gilogil River N of Madang, S to the Gogol River and well inland in the Gogol Valley (obs.); Kar Kar Island, locally common (obs.). Fig. 14.

7. **M. lolodensis** Cheesman in Kew Bull. 5:27 (1950). Fig. 17.

Type. [Indonesia] N Halmahera; Loloda (Soasio) river, *Fairchild & Curran* 388 (K!).

Pseudostem up to 7 m tall and 60 cms in girth at the base; green or sometimes blackish, predominantly brown at the base from persistent dead sheaths. Sap very variable, white, pink or violet. Rhizomes short, the young suckers arising erect, but close to the parent stem; not seen forming large clumps. Shoulder green, coloured with irregular blackish-brown markings, with an irregular and rather ragged but broad more or less appressed scarious margin. Petiole green or often blackish on the underside with scarious edges which more or less enclose the small canal; TS ratio 0·3. Leaf lamina yellow-green above slightly paler below, not waxy, right-handed with auriculate basal lobes; PB ratio 3·5–4·0.

Peduncle green, glabrous or hairy. Bunch variable in habit, from curving first upwards and then down, to hanging almost entirely vertically downwards, but typically curving more or less diagonally downwards, very lax. Fruit apparently without tropic response, standing out rather irregularly all round the stem. Basal bracts long, curling backwards, quickly deciduous. Basal flowers female, with poorly developed, or entirely without, staminodes. Pedicels long for the size of the fruit, up to 2 cm. Young fruit yellowish-green, glabrous, with four ovule rows per loculus. Mature fruit bright coppery-orange with dull orange-coloured pulp, dehiscent, the skin splitting into irregular segments and curling backwards, not highly aromatic, more or less ovoid about twice as long as wide. Seeds c. 6 mm in diameter, irregularly and sharply angled but with a very smooth surface; hilum more or less flush with the testa surface, without a raised collar; umbo small, slightly elevated or obsolete.

Male peduncle descending vertically. Male bud convolute or slightly imbricate, rather less than twice as long as broad, deep or pale pink to

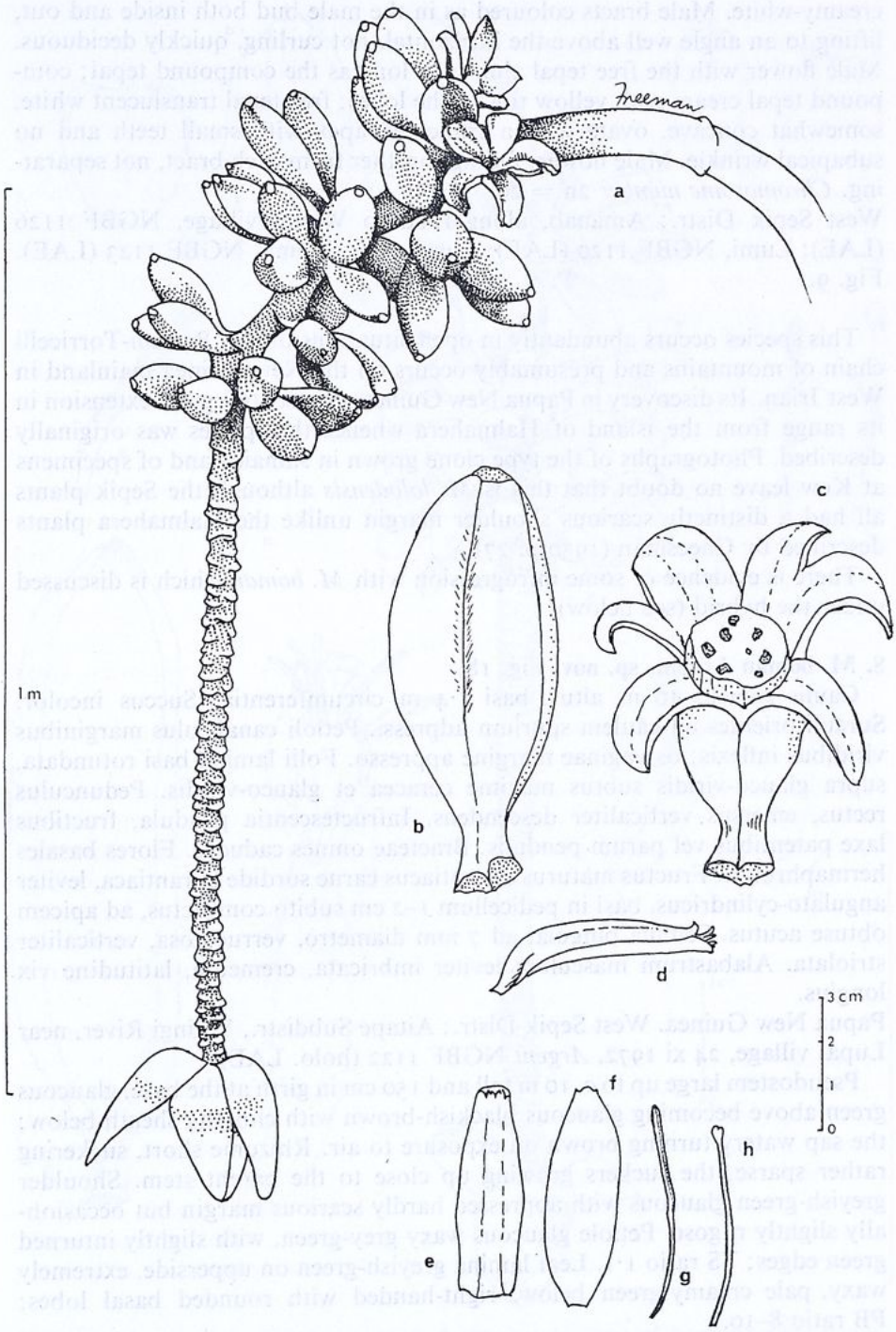

FIG. 17. *Musa lolodensis*: a, infructescence; b, mature fruit before splitting; c, mature fruit after splitting; d, male flower; e, compound tepal of male flower; f, free tepal of male flower; g, stamen of male flower; h, pistillode of male flower.
All drawn from material grown in Lae from material collected near Amanab, West Sepik District.

creamy-white. Male bracts coloured as in the male bud both inside and out, lifting to an angle well above the horizontal, not curling, quickly deciduous. Male flower with the free tepal almost as long as the compound tepal; compound tepal cream with yellow tips to the lobes; free tepal translucent white, somewhat concave, ovate with a truncated apex with small teeth and no subapical wrinkle. Male flowers falling together from each bract, not separating. *Chromosome number* 2n = 20.
West Sepik Distr.: Amanab, along road to Wamu village, NGBF 1126 (LAE); Lumi, NGBF 1120 (LAE); Lumi, near Fatima, NGBF 1123 (LAE). Fig. 9.

This species occurs abundantly in open situations on the Bewani-Torricelli chain of mountains and presumably occurs on the New Guinea mainland in West Irian. Its discovery in Papua New Guinea represents a great extension in its range from the island of Halmahera whence the species was originally described. Photographs of the type clone grown in Jamaica and of specimens at Kew leave no doubt that this is *M. lolodensis* although the Sepik plants all had a distinctly scarious shoulder margin unlike the Halmahera plants described by Cheesman (1950 p. 27).

There is evidence of some introgression with *M. boman* which is discussed under the hybrid (see below).

8. **M. boman** Argent, **sp. nov.** Fig. 18.

Caulis spurius 10 m altus, basi 1·4 m circumferentia. Succus incolor. Surculi orientes ad caulem spurium adpressi. Petioli canaliculus marginibus viridibus inflexis; os vaginae margine appresso. Folii lamina basi rotundata, supra glauco-viridis subtus maxime ceracea et glauco-viridis. Pedunculus rectus, emersus verticaliter descendens. Infructescentia pendula, fructibus laxe patentibus vel parum pendulis. Bracteae omnes caducae. Flores basales hermaphroditi. Fructus maturus aurantiacus carne sordide aurantiaca, leviter angulato-cylindricus, basi in pedicellum 1–2 cm subito contractus, ad apicem obtuse acutus. Semina pinguia, ad 7 mm diametro, verruculosa, verticaliter striolata. Alabastrum masculum leviter imbricata, cremeum, latitudine vix longius.
Papua New Guinea. West Sepik Distr.: Aitape Subdistr., Yalingi River, near Lupai village, 24 xi 1972, *Argent* NGBF 1122 (holo. LAE).

Pseudostem large up to c. 10 m tall and 150 cm in girth at the base, glaucous green above becoming glaucous blackish-brown with clinging sheath below; the sap watery turning brown on exposure to air. Rhizome short, suckering rather sparse, the suckers growing up close to the parent stem. Shoulder greyish-green glaucous with appressed hardly scarious margin but occasionally slightly rugose. Petiole glaucous waxy grey-green, with slightly inturned green edges; TS ratio 1·1. Leaf lamina greyish-green on upperside, extremely waxy, pale creamy-green below, right-handed with rounded basal lobes; PB ratio 8–10.

Peduncle whitish, waxy and glabrous. Bunch emerging almost horizontally but becoming vertically pendent by maturity, fruits apparently without tropic response, spreading irregularly or semi-pendent. Basal bracts pale cream, lingulate, reflexing and curling, quickly deciduous. Basal flowers fully hermaphrodite with well developed stamens. Pedicels 1·5–2·5 cm long.

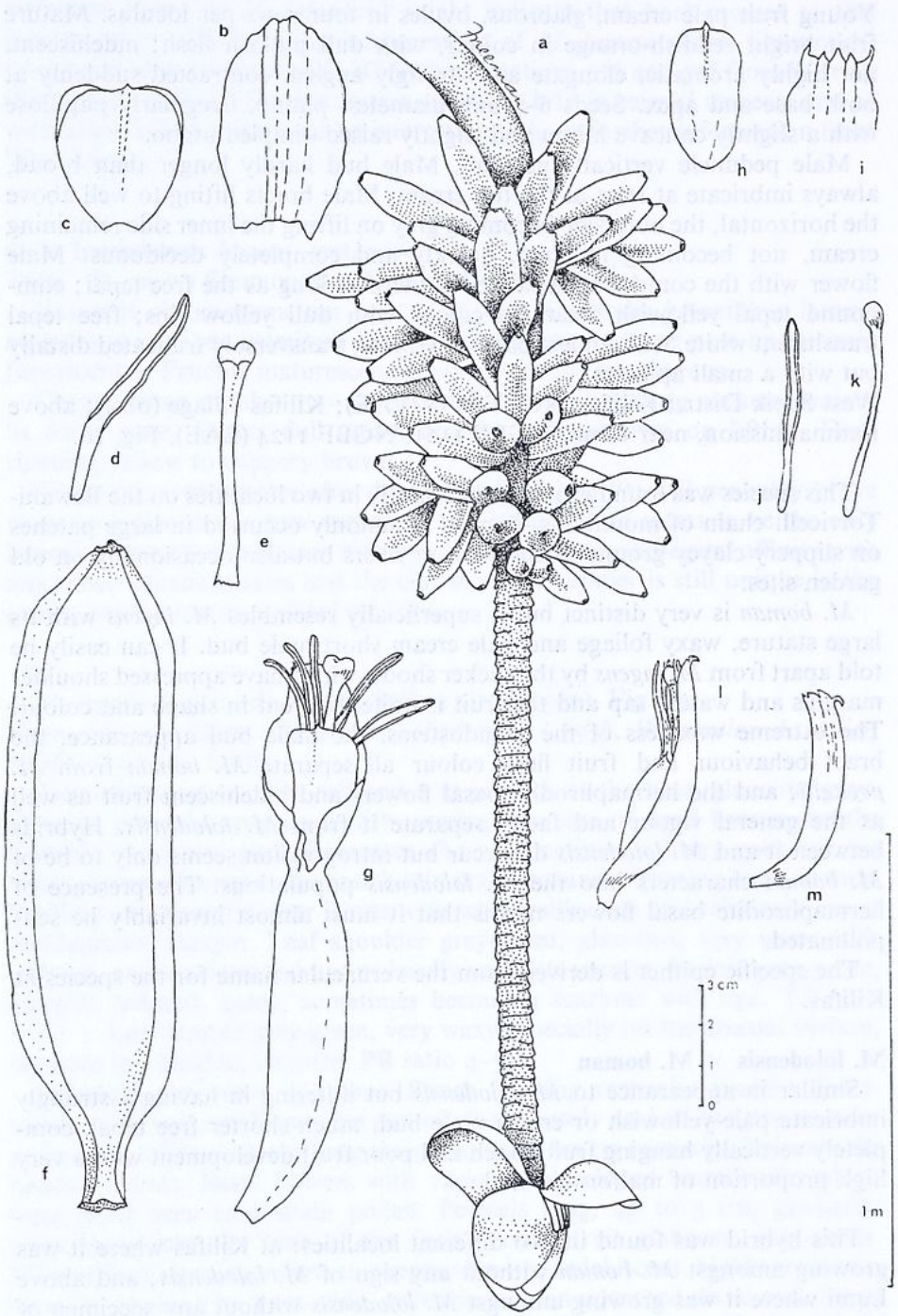

FIG. 18. *Musa boman*: a, infructescence; b, compound tepal of hermaphrodite flower; c, free tepal of hermaphrodite flower; d, stamen of hermaphrodite flower; e, style and stigma of hermaphrodite flower; f, mature fruit; g, hermaphrodite flower; h, free tepal of male flower; i, tips of compound tepal of male flower; j, stamen of male flower; k, style and stigma of male flower; l, male flower; m, smaller male flower.
All drawn from living material of type, Yalingi River near Lupai, West Sepik District.

Young fruit pale cream, glabrous, ovules in four rows per loculus. Mature fruit bright reddish-orange in colour, with dull pinkish flesh; indehiscent, not highly aromatic, elongate and strongly angled, contracted suddenly at both base and apex. Seeds 6–7 mm diameter, plump, irregularly papillose with a slightly concave hilum and slightly raised dimpled umbo.

Male peduncle vertically pendent. Male bud hardly longer than broad, always imbricate at least at the tip, cream. Male bracts lifting to well above the horizontal, the outerside becoming grey on lifting the inner side remaining cream, not becoming revolute, quickly and completely deciduous. Male flower with the compound tepal about twice as long as the free tepal; compound tepal yellowish cream in colour with dull yellow tips; free tepal translucent white, without a subapical wrinkle, transversely truncated distally but with a small apiculus.

West Sepik Distr.: Kilifas, NGBF 1138 (LAE); Kilifas village (obs.); above Fatima mission, near Lumi, NGBF 1121, NGBF 1124 (LAE). Fig. 10.

This species was found growing abundantly in two localities on the Bewani-Torricelli chain of mountains. It most commonly occurred in large patches on slippery clayey ground at the sides of rivers but also occasionally on old garden sites.

M. boman is very distinct but it superficially resembles *M. ingens* with its large stature, waxy foliage and pale cream short male bud. It can easily be told apart from *M. ingens* by the sucker shoots which have appressed shoulder margins and watery sap and the fruit is quite different in shape and colour. The extreme waxiness of the pseudostems, the male bud appearance, the bract behaviour and fruit flesh colour all separate *M. boman* from *M. peekelii*; and the hermaphrodite basal flowers and indehiscent fruit as well as the general vigour and facies separate it from *M. lolodensis*. Hybrids between it and *M. lolodensis* do occur but introgression seems only to be of *M. boman* characters into the *M. lolodensis* populations. The presence of hermaphrodite basal flowers means that it must almost invariably be self-pollinated.

The specific epithet is derived from the vernacular name for the species at Kilifas.

M. lolodensis × M. boman

Similar in appearance to *M. lolodensis* but differing in having a strongly imbricate pale-yellowish or cream male bud, much shorter free tepal, completely vertically hanging fruit bunch and poor fruit development with a very high proportion of malformed seed.

This hybrid was found in two different localities: at Kilifas where it was growing amongst *M. boman* without any sign of *M. lolodensis*; and above Lumi where it was growing amongst *M. lolodensis* without any specimen of *M. boman* seen in the vicinity. Both sites however were within a few miles of known specimens of the other parent and it is quite possible more extensive searching would have revealed even closer specimens. The Kilifas hybrid was grown in the Botanic Gardens in Lae where it flowered when less than 2 m high, considerably smaller than the plant in its native habitat. Although both hybrid plants recorded had nearly sterile fruit, the cream-bracted, slightly

imbricate forms of *M. lolodensis* might indicate that back-crosses to this species occur with resulting introgression of *M. boman* genes. Simmonds' "probable new *Australimusa*" ICTA introductions 526 and 528 from W Irian (Simmonds 1960) fit the description of this hybrid in several respects and as with other bananas it would be interesting to have further information from West Irian.

SECT. **Ingentimusa** Argent, **sect. nov.**
Type. *M. ingens* Simmonds in Kew Bull. 14:198 (1960).

Numerus chromosomatum n = 7. Succus in surculis juvenilibus lacteus aquosus in partibus veteribus. Bracteae impolitae eburneae post apertionem fumascentes. Fructus maturescens ochraceus usque porphyreus.

Chromosome number n = 7. Sap white-milky in young suckers, watery in older parts. Bracts dull cream becoming grey-brown on lifting. Fruit ripening yellow to coppery brown.

Simmonds (1960) notes after describing *M. ingens* "It will probably prove to be best placed in a new section of the genus". This seems to be the only logical course of action since it shows no obvious morphological affinity with any other banana species and the chromosome number is still unique in the genus, confirming its isolated position.

9. **M. ingens** Simmonds in Kew Bull. 14:198 (1960). Fig. 19.
Type. Morobe Distr.: Skindewai, 1620 m, 6 i 1956, *Womersley & Miller*, NGFD 8368 (K, LAE).

Pseudostem up to 15 m tall and 2 m in girth at the base, glaucous grey-green in general appearance with varying amounts of dead brown sheaths covering the lower part. Rhizomes short; sometimes solitary pseudostems with sparse suckering at the base but in many instances forming large clumps. Seedling and young sucker leaves with white milky sap and relatively broad cartilaginous margin. Leaf shoulder grey-green, glaucous, very waxy with reflexed, non-scarious and not or hardly undulate margin. Petiole grey-green, margins reflexed, green, sometimes becoming scarious with age; TS ratio 1·0–1·1. Leaf lamina grey-green, very waxy especially on the abaxial surface, the base left-handed, cuneate; PB ratio 4–5.

Peduncle grey-green, glabrous. Bunch hanging vertically straight downwards, or in very small bunches curved; fruit densely packed hanging at more or less 45°, often with the long shrivelled basal bracts persisting between the hands of fruit. Basal flowers with variously developed staminodes which were never seen to contain pollen. Pedicels long, up to 5 cm, gradually broadening into the base of the fruit. Young fruit glabrous, grey-green. Mature fruit ripening yellow to coppery-brown, indehiscent, highly aromatic, up to 18 cm long by 3 cm wide, cylindric with an upturned distal end. Seeds 8–9 mm diameter, irregular and strongly angled but smooth or faintly striolate, hilum slightly concave, umbo faint or obsolete.

Male peduncle descending vertically, vigorous, up to 2 m long and often persisting after the fruits have ripened. Male bud convolute or slightly imbricate, quite variable in shape from almost spherical with blunt rounded apex to obovoid with a broad point; colour dull pale cream with grey flushes.

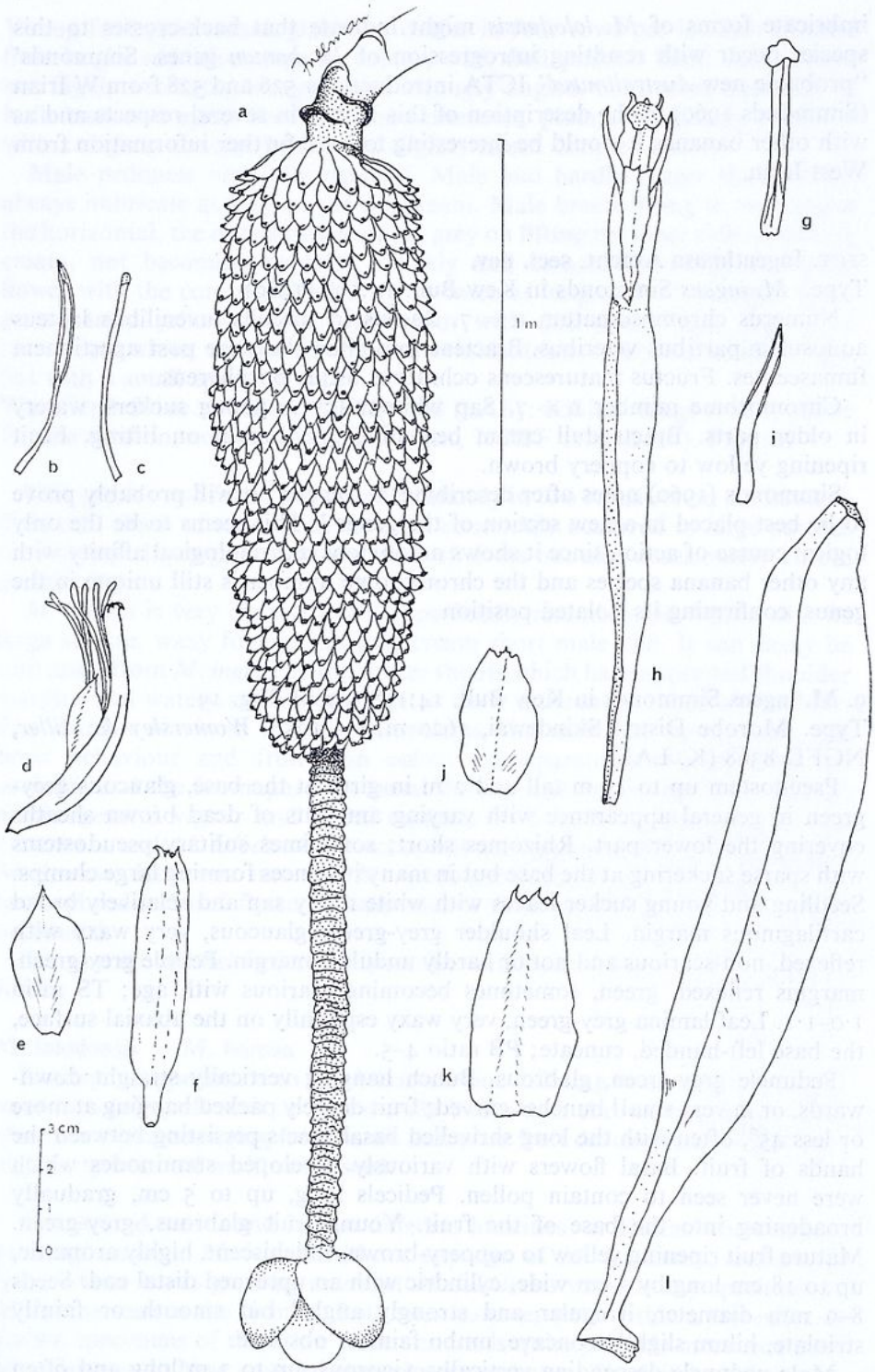

FIG. 19. *Musa ingens*: a, infructescence; b, stamen from male flower; c, pistillode; d, male flower; e, free tepal of male flower; f, compound tepal of male flower; g, style and stigma of hermaphrodite flower; h, hermaphrodite basal flower; i, stamen of basal flower; j, free tepal of basal flower; k, compound tepal of basal flower; l, mature fruit.
All drawn from living material collected on the Kassam Pass.

Male bracts dull, becoming grey-brown on lifting, thick and leathery in texture often with hooded tips, only slowly deciduous so that often three or four lifted unshrivelled bracts are present around the male bud. Sometimes shrivelled male bracts are irregularly persistent. Male flower with the compound tepal almost twice as long as the free tepal; compound tepal cream with pale yellow tips to the lobes; free tepal translucent white, ovate-acuminate. *Chromosome number* 2n = 14.
Western Highlands Distr.: Kubor range, Kamang, Minj valley, *Vink* 16444 (K); above Tsau River north of Banz (obs.). Madang Distr.: Bundi Kara near Bundi Patrol Post (obs.). Eastern Highlands Distr.: Kassam Pass (obs.); eastern slopes of Mt Piora (obs.). Morobe Distr.: eastern slopes of Mt Shungol (obs.); Sarawaket Mountains near Kasonombe (obs.); above Mindik (obs.). Northern Distr.: north-east slopes of Mt Victoria above Kokoda (obs.). See also Simmonds (1960). Fig. 10.

This species is common in several parts of the highlands and undoubtedly will be found in many more localities. Variation in male bud shape may have a geographical basis but too little information is at present available. The altitudinal range of the species is from 1000–2100 m although fruiting specimens appear to be restricted to the lower 600 m of the altitudinal range. The seed germinated at sea level in Lae but did not establish; suckers brought down to the lowlands became progressively more emaciated and died unless placed in air conditioning at least during the night. The species thus seems intolerant of continuous high temperatures.

Acknowledgments

This work was done during the 3 year tenure of a Research Fellowship of the New Guinea Biological Foundation who generously provided financial support and were always helpful and encouraging. The field collections could never have been made without the friendly co-operation, help and advice so freely given by the local people in all the regions visited.

The University of Technology in Lae provided land for the cultivation of the living collections and the Department of Forests provided herbarium facilities and most helpful advice. Mr R. Freeman and Mrs R. Purves ably executed the drawings, and Gillian Meadows the maps, for which I am very grateful. Mr B. L. Burtt rendered the diagnoses into Latin and gave most generous advice.

I wish particularly to thank Professor L. Pryor for his interest and encouragement at every stage of this research and Mr K. Shepherd for his valuable critical comment.

References

Cheesman, E. E. (1950). Classification of the bananas III: Critical notes on species. *Kew Bull.* 5:27–28.

Hooker, J. D. (1895). Musa hillii. *Bot. Mag.* 121: tab. 7401.

Hutchinson, J. (1934). *The families of flowering plants II: The monocotyledons.* Macmillan & Co. London 1–243.

RENDLE, A. B. (1967). *The classification of flowering plants*, I. Ed. 2. Cambridge University Press.

SIMMONDS, N. W. (1953). Classification of the bananas III: Critical notes on species. *Kew Bull.* 8:571–572.

——(1956). Botanical results of the banana collecting expedition 1954–55 *Kew Bull.* 11:463–489.

——(1960). Notes on banana taxonomy. *Kew Bull.* 14:198–212.

——(1962). *The evolution of the bananas*. Longmans, London.

——(1966). *Bananas*. 2nd ed. Longmans, London.