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Notes on the Rediscovery and Taxonomic Status of *M. flaviflora N.W.Simmonds* and *M. thomsonii* (King ex Schumann) A.M.Cowan & Cowan (Musaceae) From India

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Abstract: The taxonomy of *Musa flaviflora* and *M. thomsonii* has been in a state of flux since their inception. Due to their close resemblance and lack of proper types and protologues they were treated as conspecific. Both species have been studied in detail based on live collection and protologues for their taxonomic status and circumscription. Here both the species are correctly identified and provided detailed description after the type collection. Photographs, distribution, types and ecological notes of both species are also provided.

Keywords: *Musa*, *M. flaviflora*, *M. thomsonii*, Musaceae, North-East India, rediscovery, taxonomic status.

Introduction

The genus *Musa* L. (Linnaeus, 1753) belongs to the family Musaceae with major centre of distribution in South and South-East Asian countries, Africa and Pacific Islands. The Family includes two other genera, *Ensete* Bruce *ex* Horaninow and *Musella* (Franchet) Wu and around 150 taxa in the world. In India about 20 taxa have been reported under two genera, *Ensete* and *Musa* (Karthikeyan *et al.,*1989, Uma *et al.,* 2005). India is well known for its vast genetic diversity of bananas comprising seeded wild species to seedless cultivars. This in support of the fact that the origin of *Musa* is South and South-East Asia including Indo-Myanmar region (Singh *et al.,* 2001). In India wild *Musa* species are largely distributed in North-Eastern States, Western Ghats, Eastern Ghats and Andaman and Nicobar Islands, because, these areas consists of tropical rain forests, wet evergreen forests, moist deciduous forest of low rainfall zones, which are favorable for its growth. Although India is considered as one of the centres of origin of family Musaceae, the taxonomy of many taxa is still in a state of flux. The endemism of many taxa in inaccessible forests, bulky nature of the pseudostem, etc. made the study difficult. No comprehensive work on Musaceae in India was made after Baker (1894) in Hooker's '*Flora of British India*'. Karthikeyan *et al.,* (1989) enumerated 21 species under two genera in '*Florae Indicae Enumeratio Monocotyledonae*'. Recently some new taxa were described from India viz. *M. velutina* subsp. *markkuana* M.Sabu *et al.,* (2013a), *M. velutina* var. *variegata* A.Joe *et al.,* (2013), *M. sabuana* Prasad *et al.,* (2013) etc. Besides these there are some new additions to the wild banana flora of India. Sabu *et al.,* (2013b) and Alfred *et al.,* (2013) recorded the occurrence of *M. chunii* Häkkinen and *M. laterita* Cheesman respectively from India.

During intensive explorations in North-East India, authors could collect curious specimens of wild banana species and found that taxonomy statuses of many species are still in confusion and several species need typification and clarification about its identity. This paper focuses mainly on the taxonomic history, correct identity and about the rediscovery of *M. flaviflora* N.W.Simmonds and *M. thomsonii* (King ex Schumann) A.M.Cowan & Cowan.

Baker (1893) mentioned four wild 'forms' in Sikkim under the heading *M. sapientum* subsp. 3. *M. seminifera* Lour, distinguished by Dr. King as *pruinosa, dubia, hookeri* and *thomsoni* and added "Dr. King thinks the two later forms as likely to be distinct specifically from *sapientum*. His *hookeri* is probably *M. sikkimensis* Kurz". He gave a small description to *thomsoni* and the diagnosis was as follows: "4. *thomsoni* (Kergel of Lepchas). Stem green, 12–15 ft.

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long, leaves glaucous only when young, conspicuously cuspidated at the apex, bracts ovate, outside with vertical streaks of yellow and purplish-brown, yellow inside; fruits 2/5 in. long, ¾ in. diam. faintly ribbed; seeds few, black soft, 1/5 in. diam. Surrounded by copious sweet pulp. Does not rise above 1500 feet". King collected the specimens from Sikkim known as 'Kergel', a vernacular name used by the tribe 'Lepchas' in Sikkim. The distinguishable characters from any other *Musa* are about the bract colouration and cuspidate nature of leaf apex. May be inspired from Baker's last sentence about the last two forms, Cowan and Cowan (1929) treated the first two forms as varieties of *M. sapientum* and the last two as two separate species viz. *M. thomsoni* and *M. hookeri* and the description of *M. thomsoni* as follows "In sheltered spots in the Lower Hill Forest "L.H.F." up to 1,500 ft. Stem 12–15 ft. high, 7–9 ins. in diameter at ground level. Stem green, except at the base, where it has brown spots. Seeds few, soft, black; pulp soft, sweet". But before Cowan and Cowan (1929), Schumann (1900) gave it to a varietal status under *M. sapientum* subsp. *seminifera*. After Cowan and Cowan this species was unknown to most botanists. Cheesman (1948b) came across King's four forms and about materials of those. He adds " There is materials of these forms in the Kew Herbarium, which may help to settle the nomenclature when the plants have been further studied on living specimens, but the first requirement is to determine by re-collection how many of the large-seeded species there are in Sikkim". During the Taxonomic revision of Musaceae in India, authors collected this species from Meghalaya, quite far from the type locality. After King, there has not been any collection of *M. thomsonii* and hence the present study forms the rediscovery of the taxon after lapse of more than a century.

Cheesman (1948a) described a plant flowered at Imperial College of tropical Agriculture, Trinidad and Tobago, which was introduced from Assam, by P.H. Carpenter Esq., of the Indian Tea Association at Tocklai Experimental Station. He called it as '*Mariani form*' of *M. acuminata*. The description was based on a specimen (I.R. 209) which was collected from Mariani Range of Assam, North-East India and the description was "Male bud in advanced blooming acute, the bracts convolute at the tip, the whole bud usually aborting before the fruits are mature and falling off; bracts rather bright red, moderately glaucous outside, yellow and shining within. Male flowers pale orange-yellow, the teeth of the compound tepal deep orange and about 5mm long….."

He also added " if this form has to be separated from *M. acuminata* it will probably prove conspecific with a plant from Tagwin, Myitkyina, Upper Burma (I.R. 183), which at present pending cytological studies. The Tagwin plant closely resembles the *Mariani form*…."

Subsequently, during the 'Banana Expedition trip' to India at 1954–55, Simmonds (1956) elevated 'the *Mariani form*' to species level by keeping Cheesman's I.R. 209 in Herb. Kew. as the type specimen. He also remarked that "This species resembles *M. acuminata* and on purely morphological grounds would be best treated as the northernmost subspecies of it". The recorded distribution in India include Assam, Manipur, Meghalaya and Nagaland. He gave several vernacular names for the species. After Simmonds the identity of this species is unclear to most botanists and they just enumerate the name in their works and some are mere compilation of Simmonds' work (Karthikeyan *et al.,* 1989, Hore *et al.,* 1992, Noltie 1994, Uma *et al.,* 2005, Ude *et al.,* 2002; Liu *et al.,* 2010; Singh 2010; Li *et al.,* 2010). Some workers even treated *M. flaviflora* as a synonym of *M. thomsonii*. This schism starts after Simmonds (1956).

Actual problem starts when Simmonds (1956) treated doubtfully *M. sapientum* subsp. *seminifera* form thomsonii *"thomsoni"* King Mss ex Baker and *M. thomsonii "thomsoni"* (King Mss ex Baker) Cowan and Cowan as synonyms, when he described *M. flaviflora*. He criticized the validity of *M. thomsonii*, which he thought it was inadequately described. Simmonds adds: "Baker states that the bracts have "vertical streaks of yellow and purplish brown" outside which does not agree with the bright red of *M. flaviflora*. His publication of the name, incidentally, by Arts, 42 and 43 of the code, is probably invalid". But Simmonds never include the notes regarding the inclusion of *M. thomsonii* as a synonym of his species, yet he was sure about the two taxa are different. And he conclude "*M. thomsoni* is so ill described and typified that it may well be rejected; if it can ever be certainly identified

then less confusion will result from the treatment adopted here than by taking up *thomsoni* for the Assam species if they are not in fact the same'.

After Simmonds many botanists used *M. thomsoni* as synonym of *M. flaviflora* (Simmonds 1960; Simmonds & Weatherup 1990; Shepherd 1999). But some thought about the rule of priority and without looking the difference in two species, treated *M. flaviflora* as the synonym of *M. thomsoni* (Häkkinen & Väre, 2008). Some treated both as different species (Karthikeyan *et al.,* 1989; Noltie 1994). This adds a great confusion among these two species.

As part of taxonomic revision of Musaceae in India, authors visited Mariani, Assam, the type location of the species (*M. acuminata* '*Mariani form*'). But the whole area is entirely changed. Now Mariani is a small town near Jorhat, and surrounding areas were acquired for tea plantations and couldn't collect the species from its type locality. But a plant collected from Zunheboto District, Nagaland, in non-flowering condition was grown in Calicut University Botanical Garden (CUBG) and flowered in CUBG and it was identified as *M. flaviflora*. Since Simmonds (1956), no live collection of this species has been made and hence the present collection forms the rediscovery of the taxon after a lapse of more than half a century. The authors also came across the two species and identified the two are different taxa and therefore here submit the two species as different.

The descriptions provided below from notes, live plants grown in CUBG as well as photos taken from living plants in the wild by completing the entire INIBAP *Musa* Descriptor List (IPGRI INIBAP/CIRAD 1996). The descriptive terminology here follows that used in the traditional banana taxonomic works by Simmonds (1962, 1966) and Argent (1976).

Musa flaviflora N.W.Simmonds, Kew Bull., 11(3): 471. 1956; In. Champion, Les bananiers et leur culture, 33. 1967; Karthikeyan *et al.*,, Flora Indica Enum. Monocot., 104. 1989; Hore *et al.*,, J. Econ. Tax. Bot., 16(2): 451. 1992; Noltie, Flora of Bhutan, 3(1): 182.1994; Häkkinen & Väre, Adansonia, 30(1): 77. 2008. **Fig. 1.**

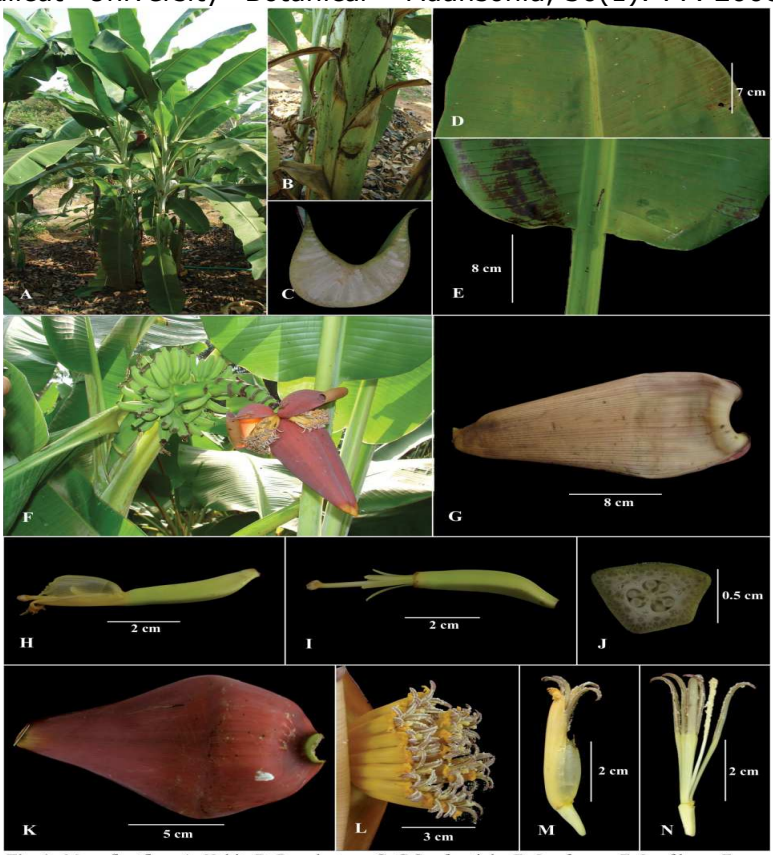

Fig. 1: *Musa flaviflora* A. Habit; B. Psuedostem; C. C.S. of petiole; D. Leaf apex; E. Leaf base; F. Inflorescence; G. Female bract-inner surface; H-J. Female flower parts; H. Entire flower; I. Flower without tepals; J. C. S. of ovary; K. Male bract; L. Male flowers; M. Male flower; N. Male flower without tepals. Photos by Alfred Joe.

Type: INDIA. Assam, Mariani hills, Cheesman E.E., I.C.T.A., I.R. 209 (spirit collection) K!), (Lectotype designated by Häkkinen & Väre, 2008)

Musa acuminata 'Mariani form' Cheesman, Kew Bulletin, 3(1): 28. 1948; Simmonds, Journ. Genetics, 51, 32-40. 1952.

Plants slender, suckers 3–4, close to the main shoot, 10–15 cm away, vertically arranged. Mature pseudostems 1.8–2.1 m high, 20–30 cm circumference at the base, green with some black blotches, covered with old brown leaf sheaths except apex region, apex waxy, sap watery. Leaf habit intermediate, laminae 150–155 × 36–51 cm, oblong-lanceolate, apex oblique, truncate, adaxially dark green with black blotches or dots, dull, abaxially medium green, appearance shiny, leaf bases symmetric, both rounded, midrib adaxially light green and abaxially yellow-green. Petioles 43–50 cm long, glaucous, petiole margins wide with erect, with blackish-brown scarious margin, and black-brown blotches at the base, petiole base winged and clasping the pseudostem. Inflorescences first erect at arising stage, then horizontal to sub-horizontal, peduncle 13–15 cm long, green, glabrous. Sterile bracts 1–2, deciduous, *c*. 30 × 10 cm, adaxially red and abaxially creamy pink, apex with leafy appendage. Female buds lanceolate, convolute, apex slightly imbricate. Female bracts 15–23.3 × 8–12.4 cm, moderately grooved, adaxially red with yellow tip, slightly glaucous, abaxially cream with pink tinge, shiny, apex acute, lifting one bract at a time, reflex and revolute before falling, cincinnus 12–20 flowers. Basal 5–8 hands female. Female flowers 12–20 per bract in a two rows, 6.5–8.5 cm long. Compound tepal 3.5–4 × 1.1–1.3 cm, yellow, ribbed at dorsal angles, lobes 5, 0.4–0.6 × 0.2–0.3 cm, dark yellow, outer two lobes with small horns. Free tepal 2.5–2.7 × 1.4–2 cm, boat-shaped, translucent cream tinged with yellow, apex corrugated, with a short acumen. Staminodes 5, 1.3–2.1 cm long, cream with brown apex. Ovary 3.8–4.1 cm long, straight, light green–yellow-green, with ovules in 2 rows per locule, style straight, exserted, 2.5–3.4 cm long, cream with some red dots towards the apex, surface with stiff hairs, stigma globose, creamy-grey, sticky. Male bud intermediate, apex imbricate, top-shaped and convolute at advanced blooming, rachis with a curve. Male bracts 10–17 × 7–10.5cm, moderately grooved, adaxially red with yellow tip, moderately glaucous, abaxially creamy pink, shiny, apex acute, lifting one bract at a time, reflex and revolute before falling, the whole bud degenerate before maturity of fruits. Male flowers on average 14–32 per bract in two rows, 5.8–6.2 cm long, falling with the bract, bract scars prominent. Compound tepal 3.3–4.5 × 1.2–1.6 cm, yellow, ribbed at dorsal angles, and with 5-toothed dark yellow lobes, 0.3–0.4 cm long. Free tepal 1.9–2.6 × 1–1.6 cm, translucent cream tinged with yellow, much darker at apex and base, boat-shaped, corrugated at apex, apex with small acumen. Stamens 5, 3.3–4.7 cm long, exserted, filament cream, 2–2.4 cm long, anther cream with pink tinge, 1.1–2.3 cm long. Ovary straight, rudiment, 0.9–1.5 cm long, creamy white, style slightly curved at base, inserted, 2.9–3.5 cm long, stigma globose, yellow. Fruit bunch lax, with 5–8 hands and 12–20 fruits per hand, in a two rows, fingers arranged perpendicular to the rachis, fruits glabrous, straight, slightly ridged, apex pointed, without any floral relicts, immature fruit peel color green, mature fruit peel color dull yellow with black blotches, pulp cream.

Habitat: Growing as under growth in wet evergreen forests.

Distribution: Assam, Nagaland, Manipur, Meghalaya.

Specimens examined: India, Nagaland: Zunheboto District, Nagutomi, 20 August 2011, N26^{0}08.093' E094^{0}30.299' 1297 m, *A. Joe & P.E. Sreejith 130726* (CALI!).

Conservation status: The species has been collected from only one locality of Nagaland at high altitudes and is very rare. Continued decline in area of occupancy and the threat to the population by forest fire may be a reason for the decline of population. Clearing of hills for Jhum cultivation and shifting cultivation can also cause damage to the existing population.

Phenology: In case of *Musa*, flowering season differ in different altitude and in separate climate conditions. But in our Garden it flowers throughout the year and produce fruits.

Etymology: The specific epithet was applied to the species due to its flowers suffused with yellow, in virtually complete methylation of the bract anthocyanins (Simmonds, 1956).

Notes: This species is different from other species in the Section in having comparatively small pseudostem, and orange-yellow flowers. But it shows more similarity to *M. acuminata* in its appearance of pseudostem, waxy nature towards the upper portion of pseudostem, male bud colour and shape.

M. thomsonii (King ex Schumann) A.M.Cowan & Cowan '*thomsoni*', Trees of North Bengal, 135. 1929. Karthikeyan *et al.*,, Flora Indica Enum. Monocot., 104. 1989; Noltie, Flora of Bhutan, 3(1): 181.1994. **Fig. 2.**

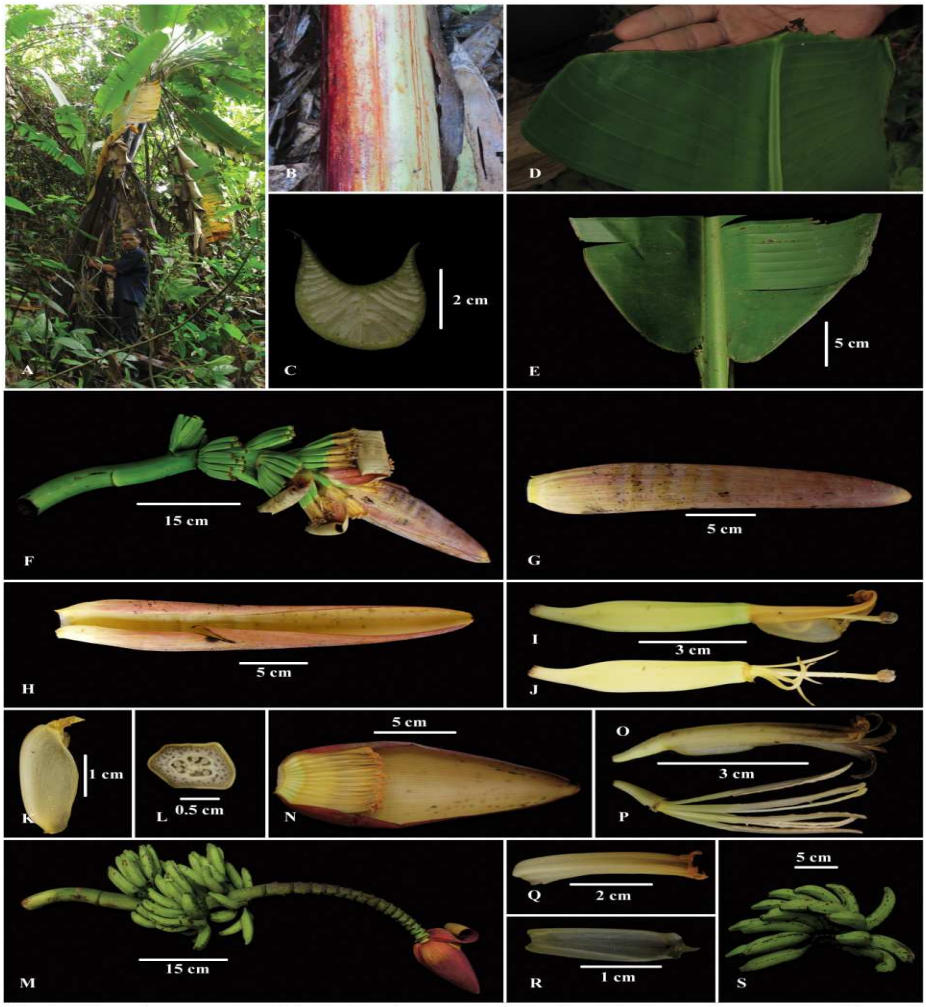

Fig. 2: *Musa thomsonii* A. Habit; B. Psuedostem; C. C.S. of petiole; D. Leaf apex; E. Leaf base; F. Inflorescence; G-H. Female bract; G. Adaxial surface; H. Abaxial surface; I-L. Female flower parts; I. Entire flower; J. Flower without tepals; K. Free tepal; L. C. S. of ovary; M. Inflorescence at advanced blooming; N. Male bract-inner surface with male flowers; O-R. Male flower parts; O. Entire flower; P. Flower without tepals; Q. Compound tepal; R. Free tepal; S. Fruit bunch. Photos by Alfred Joe.

Type: India, Sikkim, Ryang, 28 November 1877, 1500 ft, G. King [Acc. No. H.0014/91-53 (K!)], *G. King*, (Lectotype designated by Häkkinen & Väre, 2008).

Musa sapientum subsp. *seminifera* form *4. thomsoni* King ex Baker, Ann. Bot. 7: 214. 1893; Bull. Misc. Info., 1894(92): 256. 1894; Cheesman, Kew Bull. 327. 1948; Häkkinen & Väre, Adansonia, 30(1): 77. 2008; *Musa paradisiaca* subsp. *seminifera* (Lour.) Baker var. *thomsonii "thomsoni"* King. K. Schumann. In A. Engler (ed.), Pflanzenreich., IV, 45: 21. 1900.

Plants slender, suckers 2–3, close to the main shoot, 10–13 cm away, vertically arranged. Mature pseudostems 4–5 m high, 30–45 cm circumference at the base, light green with reddish-brown patches, covered with old leaf sheaths except apex region, apex glabrous, shiny, underlying color creamy green with red pigmentation, sap watery. Leaf habit intermediate, laminae 165–170 × 42–48 cm, oblong-lanceolate, apex oblique, truncate, cuspidate, adaxially dark green, dull, abaxially medium green, appearance

shiny, leaf bases symmetric, both rounded, midrib adaxially light green and abaxially yellow-green. Petioles 46–50 cm long, slightly waxy, petiole margins wide with erect, with blackish-brown scarious margin, and black-brown blotches at the base, petiole base winged and clasping the pseudostem. Inflorescences horizontal, peduncle 23–36 cm long, dark green, glabrous. Sterile bracts 1–2, deciduous, *c*. 62 × 16 cm, adaxially yellow-green, slightly glaucous, abaxially creamy, shiny, apex with leafy appendage. Female buds lanceolate, convolute. Female bracts 32–34.2 × 13.8–14.3 cm, moderately grooved, adaxially brown-purple with yellow streaks, slightly glaucous, apex acute, yellow, abaxially cream to creamy yellow, shiny, apex acute, lifting one bract at a time, persistent for two or three days, giving an appearance of lifting several bracts at a time, reflex and revolute before falling, cincinnus 16–18 flowers. Basal 8–12 hands female. Female flowers 16–18 per bract in a two rows, 9.8–10.3 cm long, yellow. Compound tepal 4.3–4.6 × 1.7–1.9 cm, orange-yellow, ribbed at dorsal angles, lobes 5, orange, outer two lobes with small horns. Free tepal 2.9–3 × 1.7–2 cm, boat-shaped, translucent cream tinged with yellow, apex corrugated at apex, with a short acumen, yellow. Staminodes 5, 2.2–2.5 cm long, cream with brown apex, irregularly arched. Ovary 6–6.5 cm long, straight, creamy green to light green or yellow green, with ovules in 2 rows per locule, style straight, exserted, 3.7–4 cm long, cream, stigma globose, creamy-grey, sticky. After female bunch there is a transitional bunch. Male bud lanceolate, intermediate to top shaped at advanced blooming, convolute, rachis falling with a curve. Male bracts 16–18 × 8–12 cm, moderately grooved, adaxially brown-purple with yellow striations, apex yellow, moderately glaucous, abaxially cream to creamy yellow, shiny, apex acute, lifting one bract at a time, reflex and revolute before falling. Male flowers on average 16–20 per bract in two rows, 5.2–8.3 cm long, falling with the bract, bract scars prominent. Compound tepal 4.6–6.3 × 1.1–1.5 cm, orange-yellow, ribbed at dorsal angles, and with 5-toothed orange lobes, 0.5–0.7 cm long. Free tepal 2.1–2.8 × 1.2–1.5 cm, translucent cream, boat-shaped, corrugated at apex, apex with small acumen, yellow. Stamens 5, 4.5–5 cm long, exserted, filament cream, 1.6–2.3 cm long, anther cream with pink tinge, 2.3–3.4 cm long. Ovary straight, rudiment, 1.2–2.1 cm long, creamy white, style straight, inserted, 4–5 cm long, stigma globose, creamy yellow. Fruit bunch lax, with 8–12 hands and 16–18 fruits per hand, in a two rows, fingers arranged perpendicular to the rachis, curved to one side, fruits glabrous, straight or curved, pronouncedly ridged, apex pointed, without any floral relicts, immature fruit peel color green.

Habitat: Growing as under growth in moist ravine black humous at evergreen forest and also near water streams.

Distribution: Sikkim and Meghalaya, North-East India.

Specimens examined: India. Sikkim: Ryang, 1875–76, 1500 ft, G. King, [Acc. No. H.0014/91-50 (K!)], 1875–76, 1500 ft, G. King, [Acc. No. H.0014/91-51 (K!)], 1875–76, 1500 ft, G. King, [Acc. No.H.0014/91-52 (K!)], Drawings (4 sheets), 1500 ft, G.King, 75/51 (CAL!), Meghalaya: Umkiang, Jaintia Hills, Jamsara, 02 May 2011, 154 m, *A. Joe & P.E. Sreejith 116177* (CALI!)

Notes: This species is different from other species in the Section in having bracts purple with yellow striations outside and cuspidate leaf apex.

Table.1: Major differences between *M. thomsonii* and *M. flaviflora*

Characters	*M. thomsonii*	*M. flaviflora*
Pseudostem height	4–5 m high	1.8–2.1 m high
Pseudostem color	Light green with reddish-brown patches	Green with small black blotches
Bract color	Adaxially brown-purple with yellow streaks and abaxially cream to creamy yellow	Adaxially red and abaxially cream with pink tinge
Female flower length	9.8–10.3 cm long	6.5–8.5 cm long
Compound tepal in female flowers	4.3–4.6 cm long, orange-yellow	3.5–4 cm long, yellow
Free tepal in female flowers	2.9–3 cm long	2.5–2.7 cm long
Staminodes	2.2–2.5 cm long	1.3–2.1 cm long
Ovary	6–6.5 cm long	3.8–4.1 cm long
Style surface	Smooth	Rough with stiff hairs
Male bud	Not degenerative after the maturity of fruits	Degenerating before maturity of fruits

Conclusion

"Musa taxonomy is still very obscure today just as it has been throughout its history despite attempts to clarify it" (Häkkinen 2008). Here authors concluded that both the species have their own identity and are distinct with the taxonomic confusion belonging to *M. flaviflora* and *M. thomsonii* is solved, but also suggest further studies of these two taxa, both by cytogenetically studies and molecular studies because of being relation with *M. acuminata*.

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