



## *Musa* × *formobisiana* (Musaceae), a new interspecific hybrid Banana

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**ABSTRACT:** Taiwan is near the northern limit of distribution of Musaceae. To understand the genetics and extent of genetic diversity in wild bananas in Taiwan, artificial hybrids between *Musa itinerans* var. *formosana* and *M. balbisiana* Colla, here named *Musa* × *formobisiana* H.-L. Chiu, C.-T. Shii & T.-Y.A. Yang *hybrid nov.*, were produced. Photos and a comparison of the characteristics of *Musa* × *formobisiana* with the parent species are provided. Voucher specimens are at the Herbarium, National Museum of Natural Science, Taiwan (TNM).

**KEY WORDS:** Musaceae, *Musa* × *formobisiana*, Hybrid banana, Taiwan.

### INTRODUCTION

*Musa* L. (1753) (Musaceae) is of enormous socio-economic importance. It has been estimated that *Musa* comprises roughly 60 to 70 species and over 1,000 cultivars (Häkkinen and Vare, 2008), all native to Southeast Asia, ranging from India and Thailand and south to New Guinea and Queensland, Australia (Gawel et al., 1992; Simmonds, 1962). Taiwan ranks as one of the most northern distribution areas for the genus (Chiu et al., 2011).

Edible bananas are derived from two wild species, *M. acuminata* Colla and *M. balbisiana* Colla (Cheesman, 1947; Heslop Harrison and Schwarzacher, 2007; Simmond and Shepherd, 1955). Edible banana cultivars are characterized by carpellate sterility in combination with parthenocarpy, and/or in combination with various levels of male sterility (De Langhe, 1987). Three groups of cultivars are recognized today. One group has characteristics of *M. acuminata*, another has characteristics of *M. balbisiana* and the third group has characteristics of both *M. acuminata* and *M. balbisiana* (Simmonds, 1962, 1966).

Cultivated bananas are threatened by several diseases and pests (Stover and Simmonds, 1987; Jones, 2000) and the impact of climate change (Calberto et al., 2015). The diseases and pests include fusarium wilt (*Fusarium oxysporum* f. sp. *cubense*, Foc), black leaf streak disease (BLS) (*Mycosphaerella fijiensis*), sigatoka disease (*M. musicola*), *Radopholus similis*, banana weevil (*Cosmopolites sordidus*), BBTV (banana bunchy top virus), and BSV (banana streak virus) (Bakry et al., 2009). Genetic improvement through hybridization using wild or improved diploid clones has thus focused on obtaining varieties resistant to the principal pests and diseases (Ortiz, 2013).

Four species plus four additional varieties of *Musa*

occur naturally in Taiwan. They are: *M. itinerans* var. *formosana* (Warb. ex Schum.) Häkkinen & C.-L. Yeh (Häkkinen et al., 2010; Chiu et al., 2011) [synonym: *M. formosana* (Warb. ex Schum.) Hayata (Hayata, 1917); *M. basjoo* Siebold & Zucc. ex Iinuma var. *formosana* (Warb. ex Schum.) S.S. Ying (Ying, 1985, 2000)], var. *kavananensis* H.-L. Chiu, C.-T. Shii & T.-Y.A. Yang, var. *chinensis* Häkkinen (Chiu et al., 2011), var. *chiumei* H.-L. Chiu, C.-T. Shii & T.-Y.A. Yang (Chiu et al., 2015), *M. insularimontana* Hayata (Hayata, 1913; Kao and Lai, 1978; Ying, 2000), and *M. yamiensis* C.-L. Yeh & J.-H. Chen (Yeh et al., 2008). *Musa balbisiana* Colla was reported as naturalized in Taiwan (Chiu et al., 2007).

Using natural variation or artificially created genetic diversity is a basic step in the genetic improvement of crop plants (Tenkouano et al., 2011). The diversity available in gene-banks can serve as source for banana and plantain crossbreeding (Ortiz and Swennen, 2014). To understand the genetics and extent of genetic diversity of wild bananas, *M. itinerans* var. *formosana* and *M. balbisiana* were crossed at the Taiwan Agricultural Research Institute (TARI) between 2005 and 2007. After a six-year period of field evaluation, we have identified a vigorous hybrid that we here name and describe as *Musa* × *formobisiana* H.-L. Chiu, C.-T. Shii & T.-Y.A. Yang *hybrid nov.* *Musa* × *formobisiana* provides useful information for banana breeding. Comparison of the characteristics of *Musa* × *formobisiana* with the parent species are provided as Table 1.

### MATERIAL AND METHODS

The maternal parent of *Musa* × *formobisiana* was *M. itinerans* var. *formosana*, a native and widely distributed banana in Taiwan. The paternal parent was

**Table 1.** The main diagnostic characters of *Musa × formobisiana*, *Musa itinerans* var. *formosana* and *Musa balbisiana*.

	<i>M. itinerans</i> var. <i>formosana</i> <sup>z</sup>	<i>Musa × formobisiana</i>	<i>M. balbisiana</i> <sup>y</sup>
Plant height	to 3 m <sup>z</sup>	to 2.5 m	to 5m
Rhizome length	0.3–1 m from parent plant	close to parent plant	close to parent plant
Number of suckers	to 5 (rhizomatous)	to 5	to 5
Underlying color of the pseudostem	light-green <sup>z</sup>	light-green	pale green
Pigmentation of underlying pseudostem	reddish brown to black blotch <sup>z</sup>	with large brownish black blotches	green
Sap color	watery	watery	watery
Petiole margins	erect	enclosed or inward	enclosed
Leaf size	130 × 30 cm	133 × 44 cm	127 × 33.5 cm
Upper surface of leaf	green	green	pale green
Peduncle color	pale green to rusty brown	pale green to rusty brown	pale green
Basal flowers	hermaphrodite, 8–12 in two rows	carpellatef, 12 in two rows on average	carpellate, 12–16 in two rows on average
Shape and size of male bud	ovoid lanceoloid 13 × 7 cm	broadly ovoid to ellipsoid, 14.8 × 10.2 cm	broadly ovoid to ellipsoid, 15.9 × 6.9 cm
External face color of bract	yellowish green with purple red streak towards to apex	red	deep pink-red, often greenish or yellow at extreme tip
Male bract lifting	lifting one bract at a time, revolute	lifting 2-3 bract at a time, revolute	several bracts lifted at the same time, no revolute
Flowers per bract	12–17 in two rows on average	12–14 in two rows on average	20 in two rows on average
Number of fruits	3–11 hands, 8–12 fruits per hand on average	4–6 hands, 6–8 fruits per hand on average	12–10 hands, 12–16 fruits per hand on average
Fruit size and shape	7 cm, straight, ridged	7.5–9.6 × 2.4–3.8 cm, crooked slightly ridged	8.5 × 10.8cm, straight, ridged
Pedicel	3 cm, pubescent	1.2 cm, pubescent	1.4 cm, pubescent
Color of immature fruit peel	pale green variably tinted purplish red <sup>z</sup>	pale green	pale green
Color of fruit peel at maturity	dull brownish yellow	dull yellow	pale yellow
Fruit at maturity	splitting length-wise occasionally <sup>z</sup>	not splitting	splitting length-wise occasionally

<sup>z</sup> Chiu *et al.* (2011); <sup>y</sup> Cheesman (1948) and Chiu *et al.* (2007)

*M. balbisiana*, a naturalized banana in Taiwan. Hybridization was conducted during 2005–2007. The progenies were segregated and did not easily set seeds under natural condition. Three years after crossing, several seeds were harvested. The harvested seeds were sown and the seedlings were planted at TARI. The plant described here was selected from among the progenies. The characteristics were recorded according to the Revised Banana Descriptors (IBPGR, 1984; IPGRI-INIBAP/CIRAD, 1996).

## TAXONOMIC TREATMENT

*Musa × formobisiana* H.-L. Chiu, C.-T. Shii & T.-Y.A. Yang., *hybrid nov.* **臺拔芭蕉 Fig. 1.**

TYPE: Taiwan, Taichung City, Wufeng District, H.-L. Chiu 19, 16 July 2014 (holotype, TNM S181216; isotypes, TNM S188067 & S188068; TAI)

Plant stooling freely, clumping close to parent plant; suckers normally 3–5, vertical. Mature pseudostems robust, more than 2.5 m long, 42–48 cm in diam. at base, green with varying brownish black pigmentation according to age, covered with varying amounts of dead brown leaf sheaths; leaf sheaths often with black markings, underlying color green with brownish black blotches, shiny; sap watery; leaf sheaths and petioles

devoid of wax.

Blade of 4th fully unfolded leaf from top of plant, ca. 133 × 44 cm, base obtusely rounded to oblique, entire, apex obtuse, lateral veins parallel, midrib usually prominent, often tearing between pinnate veins; both surfaces green, glabrous. Petiole 29 cm long, usually green, canal narrow, margin enclosed or incurved, basally not winged, clasping pseudostem. Spathe ligulate, ca. 37.5 × 25.8 cm wide at center, apex convolute; bracts pale red, spreading consecutively after flowering, scar prominent.

Inflorescence at first semi-erect to horizontal and then recurved; peduncle 55–80 cm long, robust, green, densely puberulent with short hairs, white or rusty brown; sterile bracts 2, bracts deciduous at opening of first carpellate flowers; basal flowers carpellate, upper flowers staminate.

Carpellate flowers 12 per bract, biseriata; compound tepals 3.3 cm long, with 2 prominent thickened keels, ribbed at dorsal angles, 5-lobed, yellow; free tepals translucent white, 2.4 cm long, oblong, acuminate, smooth; stamens 5, 5.2 cm long, filaments white, anthers pale yellow; pollen sterile; ovary inferior, pale green, glabrous, 5.2 cm long, markedly 5-angled, locules 3; style straight, 3.2 cm long, creamy white, stigma capitate, grayish black after pollination; ovules in 4 rows.



**Fig. 1.** *Musa × formobisiana* H.-L. Chiu, C.-T. Shii & T.-Y. A. Yang *hybrid nov.* **A.** Plant habit of *Musa × formobisiana*. **B.** Bract of male bud, dark red **C.** Suckers clump closely to parent plant. **D.** Seeds irregularly sub-globose, dark brown, warty. **E.** Base of mature pseudostems, green with varying brownish black pigmentation. **F.** Holotype of *Musa × formobisiana*. **G.** Isotype of *Musa × formobisiana*. **H.** Pericarp of fruits, whitish green.



Male buds before blooming broadly ovoid to ellipsoid, ca. 14.8 × 10.2 cm, pendulous; bracts slightly imbricate at blunt apex, dark red, broadly ovate, apex round; outer surface more or less glaucous, usually longitudinally ribbed, inner surface bright red, transversely corrugated between ribs; 2 or 3 bracts lifting at a time, revolute, then next 1 to 2 bracts lifting and revolute before the oldest bract shedding; scar of bracts prominent. Staminate flowers 12–14 per bract, in 2 rows, falling with bract, 4.5 cm long; compound tepals usually 5-lobed, 4.1 cm long, pale yellow, central lobe smaller than outer lobes; free tepals translucent white, 2.6 cm long, oblong acuminate, stamens 5, filaments white, style and anthers inserted; style straight, stigma cream, 3.7 cm long, ovary arching, pale green, glabrous, 1.4 cm long.

Fruit bunches pendent, lax, 4 to 6 hands per bunch; pedicels 1.1–1.4 cm long, pale green, minutely puberulent. Individual fruit usually negatively geotropic, 7.5–9.6 cm, 2.4–3.8 cm in diam., 6.4–7.2 g in weight, crooked slightly ridged and obscurely 5-angled at maturity, apex blunt and rather abruptly narrowed, with floral remnants; pericarp whitish green, minutely puberulent, dull yellow at full ripeness, not strongly aromatic, taste sweet and sour. Seeds dark brown, warty, 4.8–6 mm in diam., 3.5 mm long, irregularly subglobose; weight of 100 seeds = 5.70g.

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