A New Variety of *Musa itinerans* (Musaceae) in Taiwan

*Hui-Lung Chiu*
Division of Plant Germplasm, Taiwan Agricultural Research Institute, Taichung City 413, Taiwan.
chl@tari.gov.tw

*Chou-Tou Shii*
Department of Horticulture, National Taiwan University, Taipei City 106, Taiwan.
shiict@ntu.edu.tw

*T. Y. Aleck Yang*
Department of Botany, National Museum of Natural Science, Taichung City 400, Taiwan;
Department of Life Science, National Chung Hsing University, Taichung City 402, Taiwan.
Author for correspondence: aleck@nmns.edu.tw
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**ABSTRACT.** *Musa itinerans* Cheesman var. *formosana* (Warb.) Häkkinen & C. L. Yeh is one of the three wild bananas in Taiwan and represents the taxon previously recognized as *M. formosana* (Warb. ex Schum.) Hayata [= *M. basjoo* Siebold & Zucc. ex Inumia var. *formosana* (Warb. ex Schum.) S. S. Ying]. The gross morphology of *M. itinerans* var. *formosana* is stable. Some populations without variegation on the pericarps and the bracts of male buds were mainly found in a restricted area of northeast Taiwan. The morphological characteristics of the nonvariegated populations are otherwise similar to those of *M. itinerans* var. *formosana*. Their principal distinction is based on the absence of the purplish red streaking on both the pericarps and the male, fertile bracts. This character of nonvariegation is stable across the taxon's habitat and as cultivated through a 9-year period of observation. From molecular evidence, the DNA sequence for the ITS region of ribosomal DNA (rDNA) is highly similar in both populations. The nonvariegated population is herein segregated as the new variety, *M. itinerans* var. *kavalanensis* H. L. Chiu, C. T. Shii & T. Y. A. Yang. Photos for the three varietal taxa, *M. itinerans* var. *chinensis*, variety *formosana*, and variety *kavalanensis*, and a key to Taiwanese wild bananas are also provided.

**Key words:** ICUN Red List, *Musa*, Musaceae, native banana, Taiwan.

The Musaceae are distributed throughout tropical Asia, the Pacific Islands, Africa, and Australia. As currently circumscribed, the family includes three genera, *Musa* L., *Ensete* Horan., and *Musella* (Franch.) C. Y. Wu (Cheesman, 1947; Li, 1978). The largest and most economically important genus in this family is *Musa*, which contains roughly 60 to 70 species (Häkkinen & Väre, 2008), all native to Southeast Asia, ranging from India, Thailand, China, Taiwan, and south to New Guinea and Queensland in Australia. *Musa acuminata* Colla and its hybrids with *M. balbisiana* Colla account for edible bananas and plantains grown worldwide (Simmonds, 1962; Gawel et al., 1992).

Three native *Musa* species in Taiwan have been recognized in the literature, including *M. itinerans* Cheesman var. *formosana* (Hayata) Häkkinen & C. L. Yeh (also known as *M. ×paradisiaca* var. *formosana* Warb. ex Schum., *M. formosana* (Warb. ex Schum.) Hayata, or *M. basjoo* Siebold & Zucc. ex Inumia var. *formosana* (Warb. ex Schum.) S. S. Ying), *M. insularimontana* Hayata, and *M. yamiensis* C. L. Yeh & J. H. Chen, respectively. The first taxon, *M. itinerans* var. *formosana*, has been studied by several taxonomists, e.g., Kao and Lai (1978), Ying (1985), Liaw (1992), Ying (2000), Chiu et al. (2004, 2007, 2010), Chiu (2005), Häkkinen and Väre (2008), and Häkkinen et al. (2010). This taxon was published in 1900 by Schuman, and in 1917 Hayata later transferred it from a variety to a distinct species, i.e., *M. formosana*; however, this rank was also accepted by Kao and Lai (1978), Ying (1985), Liaw (1992), Ying (2000), Chiu et al. (2004, 2007, 2010), Chiu (2005), Häkkinen and Väre (2008), and Häkkinen et al. (2010). This taxon was published in 1900 by Schuman, and in 1917 Hayata later transferred it from a variety to a distinct species, i.e., *M. formosana*; however, this rank was also accepted by Kao and Lai (1978), Wu and Kress (2000), Yang et al. (2001), Chiu et al. (2004, 2007, 2010), and Chiu (2005). Furthermore, Ying transferred this Taiwanese native species as a variety of a different species, i.e., *M. basjoo* var. *formosana* in 1985.

*Musa basjoo* has been commonly referred to as the Japanese fiber banana and is native to the Ryukyu Islands (Baker, 1891; Cheesman, 1948; Wu & Kress, 2000; Turner et al., 2002). In fact, *M. basjoo* is also native to China and grows very commonly in the southern and southwestern parts of the country.

Musa itinerans var. formosana can be easily distinguished from M. basjoo by its bract imbrication subtending the male bud (vs. the bracts imbricate at the tip in M. basjoo).

Based on the diagnostic character of rhizomatous suckering, Musa itinerans var. formosana is morphologically close to M. itinerans Cheesman, which is also native to China (Liu, 2001). The relationship to M. itinerans is supported by phylogenetic analyses of the banana family based on evidence from the ITS region of ribosomal DNA (rDNA) and chloroplast (trnL-F) DNA (Liu et al., 2010). Therefore, the combination for M. formosana was proposed as M. itinerans var. formosana by Häkkinen et al. in 2010.

The complex Musa itinerans is a highly polymorphic species and several varieties have been reported (Häkkinen et al., 2008, 2010). However, the general morphology of M. itinerans var. formosana is quite stable and the principal diagnostic characters are as follows: the inflorescences are in compact bunches with purplish red pericarps, the male buds are ovate-lanceolate and variegated with purplish red pigmentation, and the young leaves are usually reddish green abaxially (Chiu et al., 2004; Chiu, 2005). During our field collections over the past 10 years, several populations that lack variegated pericarps and have yellowish green bracts subtending the male buds were found in northeastern Taiwan. For other characteristics, these populations were similar to those of M. itinerans var. formosana, yet with the principal difference being the lack of variegation, with the pale green pericarps and yellowish green bracts of male buds. These two characters have been stable in each population observed in the field as well as throughout their conserved repository at Taiwan Agricultural Research Institute (TARI) during a 9-year period of observation. Based on detailed morphological comparison involving the relevant literature, and the close similarity of the DNA sequence for the ITS region of rDNA between populations (Chiu, 2005), we treat these nonvariegated populations as clone of the nonvariegated populations of M. itinerans.


Figure 1. A–B. *Musa itinerans* var. *chinensis* Häkkinen. —A. Male bud yellowish green with purple-red streaks and one fruit finger with pale-green pericarp and fertile male flowers. —B. Inflorescence with pale-green pericarps and yellowish green bracts with purple-red streaks. C–D. *M. itinerans* var. *formosana* Häkkinen & C. L. Yeh. —C. Inflorescence with yellowish green bracts variegated with purple-red streaks and pink-red pericarps if ovaries were fertilized or pale green pericarps if ovaries were not fertilized. —D. The basal nodes of the inflorescence, bearing female flowers with yellow-green bracts streaked with purple-red. E–H. *M. itinerans* var. *kavalanensis* H. L. Chiu, C. T. Shii & T. Y. A. Yang. —E. Plants in the field, from Nioudou, Yilan Co., the type locality. —F. Inflorescence in field. —G. Plants under cultivation at TARI. —H. Developing inflorescence at TARI. All photos were taken by H. L. Chiu.


Notes. Musa itinerans var. formosana is distributed across the entire island of Taiwan as well as its offshore islands in subtropical and tropical areas at altitudes from 200 to 1200 m, along roadsides, in river valleys and ravines, and on gentle or steep slopes. Large populations often occur in valleys or along rivers. It can withstand frost or snow when this occurs. Where frost kills the leaves, the pseudostem remains alive and new leaves emerge as temperatures rise. However, M. itinerans var. chinensis occurs only occasionally among the populations of variety...
formosana, and its chromosome number of $2n = 22$ was determined by Chiu et al. (2010).

The pigmentation of *Musa itinerans* var. *formosana* on young leaves, pericarps, and bracts of male buds is developmentally uniform, but varies in the intensity and area of coverage in variegated streaking. The extent of streaking on the pericarps and bracts of the male buds can range from minimal to entirely covering the surface, and the pigmented intensity on the pericarps may be light initially and then darken with maturity. The principal difference between variety *formosana* and variety *chinensis* is the purplish red streaking on the pericarps only. In contrast, the pericarps of variety *chinensis* remain pale green even

Figure 3. Isotype of *Musa itinerans* var. *kavalanensis* H. L. Chiu, C. T. Shii & T. Y. A. Yang (Chiu 1, sheet 5 of 5, TNM).
at maturity. This variegation or its absence was a stable character throughout the field investigations. Otherwise, it is hard to distinguish variety *chinensis* from variety *formosana* at vegetative stages.


Haec varietas a *Musa itinerante* Cheesman var. *formosana* (Warb. ex Schum.) Häkkinen & C. L. Yeh pericarpio atque bracteis fertilibus omnibus non rubro-variegatis differt.

Plants freely stoloniferous, developing long rhizomes 15 cm or more from the parent plant, position vertical, up to 5 suckers; mature pseudostems 2.5 m tall or more, to 4 m, 28–44 cm diam. at base, green with varying development of red-brown pigmentation according to age and exposure; the pseudostem covered with varying amounts of dead brown leaf sheaths, the underlying color light green with large red-brown blotches, shiny; sap watery. Leaf sheaths and petioles devoid of wax; leaf blades developing on the fourth, fully unfolded leaf basipetally from the plant apex, ca. 175–220 \( \times 47–59 \) cm, bases obtusely rounded to oblique, entire, the apex obtuse, lateral venation pinnate and parallel, midrib usually prominent, blades often tearing between the lateral veins, yellowish green to green on both surfaces, glabrous; petioles 30–40 cm, usually green, caniculate with the canal wide, margins narrow, membranous and erect, not clasping the pseudostem. Inflorescence at first semi-erect to horizontal and then falling vertically downward; peduncle ca. 55–80 cm, robust, pale green to rusty brown, densely puberulent; sterile bracts 2, bracts deciduous at opening of the first flowers; basal flowers bisexual, the others male; spathe long-lingulate, 31.7 \( \times 11.4 \) cm wide at center, apex convolute, bracts yellowish green, revolute and lifting one at a time after flowering, with the subsequent 1 to 2 bracts acropetally revolute, lifting before the older bract is deciduous; bract scars prominent. Flowers 11 to 13 per bract, biseriate, ovary inferior, pale green, glabrous, ca. 4.6 cm, markedly 5-angled, locules 3, ovules disposed in 4 rows; compound tepals ca. 4.8 cm, with 2 prominent thickened keels, ribbed at the dorsal angles, with 5-lobed, pale yellow apex, free tepals translucent white, ca. 3.2 cm, oblong-acuminate, smooth; stamens 5 with sterile pollen, ca. 5.2 cm, filaments white; another pale yellow; style straight, ca. 4.1 cm, creamy white, stigma capitate, grayish black after pollination. Male buds lanceolate, 15.8 \( \times 7.5 \) cm, pendulous, bracts yellowish green on both sides, convolute at the tip; bract lifting sequentially as 1 bract at a time, lifting and revolute, similar to those subtending the lower flowers; bract scars prominent. Male flowers 14 to 15 per bract, in 2 rows, falling with the bract, compound tepals usually 5-lobed, ca. 4.5 cm, pale yellow, central lobes smaller than the outer lobes; free tepals translucent white, ca. 2.2 cm, oblong-acuminate, stamens 5, filaments white, ca. 4.3 cm; fertile gynoecium 1, style straight, stigma cream, ca. 4.3 cm, ovary arched, pale green, glabrous, 1.1 cm. Fruits bunch nearly horizontally, compact, with 3 to 10 hands per bunch. Individual fruit usually negatively geotropic, ca. 6.7–8.5 \( \times 2.5–2.8 \) cm in diam., ca. 21–38 g in weight, straight, slightly ridged, obscurely 5-angled at maturity, apically blunt with persistent floral remains; fruit pedicels 1.1–1.4 cm, pale green, minutely puberulent; immature pericarp whitish green, minutely puberulent, becoming pale green and splitting lengthwise occasionally at maturity, dull yellow at full ripeness, not strongly aromatic, sweet and sour taste; seeds small, dark brown, warty, ca. 2.1 \( \times 4.1–4.8 \) mm diam., irregularly angulate-depressed, 100 seeds with a weight of 2.9 g.

**Etymology.** The epithet of the new variety honors the traditional name of the aboriginal people in Yilan County (the Kavalan).

**Distribution and habitat.** The known populations of *Musa itinerans* var. *kavalanensis* occur in mountainous areas at elevations from 220 to 820 m, along the 202 logging track (Yingshih village) on gentle slopes and the roadside of Prov. 7 Highway (Nioudou village), Yilan County, which is located in northeastern Taiwan. No individual or population of variety *kavalanensis* has been found within the distributional areas of either *M. itinerans* var. *formosana* or variety *chinensis*.

**IUCN Red List category.** *Musa itinerans* var. *kavalanensis* was investigated by the authors in Taiwan from 1999 to 2010. For its conservation assessment, IUCN Red List categories were applied (IUCN, 2001). These native banana populations occur mainly in open places in mountainous areas at Nioudou and Yingshih villages, Yilan County, at altitudes from 220 to 820 m. Both observed and conserved materials of *M. itinerans* var. *kavalanensis* and variety *formosana* were occasionally seen as growing sympatrically. However, no obvious hybrids were observed in those populations. This taxon is of minimal conservation concern and should be considered Least Concern (LC).
A new variety of *Musa itinerans* was described recently as variety *hainanensis* Hakkinen & X. J. Ge by Hakkinen et al. (2010), with pale green pericarps equipped with yellowish green bracts of male buds. The distinguishing characteristics of *M. itinerans* var. *kavalanensis*, variety *hainanensis*, and variety *formosana* are provided in Table 1.


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### Table 1. Diagnostic morphological characters of the three varieties of *Musa itinerans* Cheesman in Taiwan and Hainan.

<table>
<thead>
<tr>
<th>Character</th>
<th>var. <em>formosana</em></th>
<th>var. <em>hainanensis</em></th>
<th>var. <em>kavalanensis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height</td>
<td>to 3 m</td>
<td>to 4 m</td>
<td>to 4 m</td>
</tr>
<tr>
<td>Rhizome length</td>
<td>0.3–1 m from parent plant</td>
<td>0.5–2 m from parent plant</td>
<td>0.3–1 m from parent plant</td>
</tr>
<tr>
<td>Number of suckers</td>
<td>to 5 (rhizomatous)</td>
<td>to 5 (rhizomatous)</td>
<td>normal (intermediate)</td>
</tr>
<tr>
<td>Leaf habit</td>
<td>normal (intermediate)</td>
<td>normal (erect)</td>
<td>light-green</td>
</tr>
<tr>
<td>Underlying color of the pseudostem</td>
<td>light-green</td>
<td>light-green</td>
<td>light-green</td>
</tr>
<tr>
<td>Pigmentation of the underlying pseudostem</td>
<td>red-brown to black blotches</td>
<td>large black blotches</td>
<td>red-brown blotches</td>
</tr>
<tr>
<td>Sap consistency</td>
<td>watery</td>
<td>milky</td>
<td>watery</td>
</tr>
<tr>
<td>Petiole margins</td>
<td>erect</td>
<td>spreading</td>
<td>erect</td>
</tr>
<tr>
<td>Leaf size</td>
<td>180 × 52 cm</td>
<td>250 × 50 cm</td>
<td>175–220 × 47–59 cm</td>
</tr>
<tr>
<td>Color of adaxial surface of leaf</td>
<td>green</td>
<td>dark green</td>
<td>green</td>
</tr>
<tr>
<td>Peduncle color</td>
<td>pale green to rusty brown</td>
<td>green to rusty brown</td>
<td>pale green to rusty brown</td>
</tr>
<tr>
<td>Basal flowers</td>
<td>8 to 12 in two rows on average, bisexual</td>
<td>15 in two rows on average, bisexual with androecium reduced</td>
<td>11 to 13 in two rows on average, bisexual</td>
</tr>
<tr>
<td>Male bud shape and size</td>
<td>ovate-lanceolate, 13 × 7 cm</td>
<td>ovoid, 12 × 7 cm</td>
<td>lanceolate, 15.8 × 7.5 cm</td>
</tr>
<tr>
<td>Color of the external face of the bract</td>
<td>yellowish green with purple-red streaking apically</td>
<td>pale yellow, tinted with green</td>
<td>yellowish green</td>
</tr>
<tr>
<td>Male bract lifting and dehiscence pattern</td>
<td>lifting one bract at a time, revolute</td>
<td>lifting two bracts at a time, revolute</td>
<td>lifting one bract at a time, revolute</td>
</tr>
<tr>
<td>Male flowers per bract</td>
<td>12 to 17 in two rows</td>
<td>17 in two rows on average</td>
<td>11 to 13 in two rows</td>
</tr>
<tr>
<td>Number of fruits</td>
<td>3 to 11 hands, 8 to 12 fruits per hand on average</td>
<td>9 hands, 15 fruits per hand in two rows on average</td>
<td>3 to 10 hands, 11 to 13 fruits per hand on average</td>
</tr>
<tr>
<td>Fruit length and shape</td>
<td>7 cm, straight and ridged</td>
<td>6.5 cm, rounded</td>
<td>6.7–8.5 cm, straight and slightly ridged</td>
</tr>
<tr>
<td>Fruit pedicel</td>
<td>3 cm, pubescent</td>
<td>4.5 cm, pubescent</td>
<td>1.1–1.4 cm, minutely puberulent</td>
</tr>
<tr>
<td>Immature pericarp color</td>
<td>pale green tinted with purple-red spots</td>
<td>pale green</td>
<td>whitish green</td>
</tr>
<tr>
<td>Mature pericarp color</td>
<td>pale green tinted with variable purple-red streaks</td>
<td>dull black</td>
<td>pale green</td>
</tr>
<tr>
<td>Fruit at maturity</td>
<td>splitting lengthwise occasionally</td>
<td>splitting lengthwise</td>
<td>splitting lengthwise occasionally</td>
</tr>
</tbody>
</table>

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**KEY TO THE SPECIES OF *MUSA* AND VARIATIONS OF *M. ITINERANS* IN TAIWAN**

1a. Plants rhizomatous.

2a. Fertile bracts yellowish green; pericarps pale green, both lacking reddish variegation. .................. *Musa itinerans* var. *kavalanensis*

2b. Fertile bracts yellowish green, variegated with purplish red streaks toward apex.

3a. Pericarps pale green. .............. .............. .............. .............. .................. *Musa itinerans* var. *chinensis*

3b. Pericarps pale green, variegated with purplish red streaks. .................. .................. .................................... .................. *Musa itinerans* var. *formosana*

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**Note.** A new variety of *Musa itinerans* was described recently as variety *hainanensis* Hakkinen & X. J. Ge by Hakkinen et al. (2010), with pale green pericarps equipped with yellowish green bracts of male buds. The distinguishing characteristics of *M. itinerans* var. *kavalanensis*, variety *hainanensis*, and variety *formosana* are provided in Table 1.
Acknowledgments. We thank Tseng-Chieng Huang, Institute of Plant Biology, National Taiwan University, for the Latin diagnosis. We are also grateful to Markku Hakkinen (University of Helsinki), the well-known Musa taxonomist, for his valuable recommendations and information, and to Philip Markay for his excellent skills in the field.

Literature Cited


