

Morphological Variations of Wild Banana, *Musa acuminata* Colla in Lower Northern Thailand

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ABSTRACT

This research was conducted in seven study sites, scattered in the lower northern Thailand during 2001-2007. Three hundred and thirty six of wild banana samples were collected along line transect and classified according to the classical taxonomy into 7 groups. Group 1 was ssp. *malaccensis* with some shared characters of ssp. *siamea* and ssp. *burmanica*. Group 2 was called “Mae Wong Form”, because of dominant and unique characters such as the prominent 1/3 bright light green or viridescent on the bract external face and strongly convoluted bract tips. This group was different and relatively isolated from ssp. *malaccensis*. However, it indicated some hybrid characters of ssp. *burmanica* x *siamea* x *Musa rubra*. Group 3 clearly pronounced the typical characters of ssp. *malaccensis*. Group 4 showed all major characters of ssp. *malaccensis*, but also shared some characters with *M. rubra*. However, there were new characters of glossy pink purple on the bract external face and bright orange red on the bract internal face, which were visibly at the first observation. Group 5 was ssp. *siamea*. However, variations of male bud forms were found in three populations. Siamea’s male bud form was 71.1%, while Tavoy’s and Selangor’s male bud forms were 28.9%. These were different from the typical. Group 6 was identified separately away from *M. acuminata* due to the prominent erect rachis position. Finally, Group 7 was the typical ssp. *burmanica*. Variations of *M. acuminata* in this area were larger than the former scientific recorded. All sample groups could be new promising genetic materials for breeding program due to their vigorous growth and some useful agronomic characters.

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Key words: banana, *Musa acuminata*, morphology, classification, taxonomy

Introduction

Banana, (*Musa auminata* Colla) is one of the most important crops for the world food security (Sharrock and Frison, 1998; Anon, 2003) and one of the most common fruit crops in Thailand. The high demand of new genetic materials for crop improvement and breeding for higher fruit quality, pest and disease resistance are increasing (Schoofs *et al.*, 1999; Sharrock and Frison, 1998). These stimulated the survey and exploration of *M. auminata* in Southeast Asia (Valmayor, 2001), the centre of distribution of this species. Morphological variations (Figure 1) and classification of this wild banana in northern Thailand were called for more information since the works of Cheesman (1948a), Simmonds (1956) and De Langhe *et al.* (1998), who indicated the major gaps of *M. acuminata* variations and diversity explorations, and subspecies' distribution. The aims of this research were to classify the samples of *M. acuminata* collected from lower northern Thailand as well as to gain the new information in banana research. Reproductive fertility and agronomic

characters of these new genetic materials were essentially required from global banana breeding program (Anon, 2003).

Materials and Methods

1. Seven reserved forests as study sites, within seven provinces of lower northern Thailand, (Figure 2) were randomly selected. All wild banana samples were collected along line transect surveys which cut through different forest types (Krebs, 1999). Taxonomy, classification and laboratory works were carried out at the study sites, Bangkok Herbarium, Mae Fah Luang University and Naresuan University.

2. All details and data were studied according to classical taxonomy, description, identification, and classification techniques of the *Musa* (Cheesman, 1947a, b; 1948 a, b; 1949 a, b; De Langhe *et al.*, 1998; Anon, 1997; Simmonds, 1956; Simmonds and Shepherd, 1955; Simmonds and Weatherup 1988; Valmayor, 2001) (Figures 2 and 3)

Results and Discussions

1. Exploration and survey results

Three hundred and thirty six of wild banana samples were collected only from six study sites (Figure 2 and Table 1) *M. acuminata* wase not found in Nakornchai-

bowon Forest Park, Phichit province due to small secondary forest size (1.728 km²) where surrounded by agricultural farmland.

2. Classical taxonomy and classification

All samples were morphologically identified according to the classical classification into 7 groups (Table 2). The general appearance of plants in Group 1 was similar to the ssp. *malaccensis* (Ridl.) Simmonds. The ssp. *malaccensis* identical characteristic was the creamy compound tepal, lobe of compound tepal; yellow or orange, male bud; advance blooming like a top, and more or less acute (Cheesman,

1948a). Some shared characters of ssp. *siamea* Simmonds, and ssp. *burmanica* Simmonds were no visible of wax or shiny on pseudostems, no visible of wax on leaf blades, and margin of petiole almost erect. Colour on the bract external face was purple and colour on the bract internal face was red-purple. Group 2 was generally presented different characters from ssp. *malaccensis*. These characteristics were male bud form, slightly horizontal bunch position, yellow or lutescent colour on the internal face of bract, and the bract convolute at apex (Cheesman, 1948a). However, the samples in this group have various dominant characters and were vary different from ssp. *banksii* (F.v. Muell.)

Table 1. Sampling locations and sample number from the seven study sites

Study sites	Sample	Total number
Umphang Wildlife Sanctuary, Tak province	up1- up58	58
Thung Salaeng Luang National Park, Phitsanulok province	tl1 – tl55	55
Mae Wong National Park, Nakhon Sawan and Khampheng Phet provinces	mw1 – mw59	59
Phu Hin Rong Kra National Park, Phitsanulok province	ph1 – ph61	61
Lumnamnan National Park, Uttaradit province	ln1 – ln55	55
Namnaow National Park, Phetchabun province	nw1 – nw48	48
Nakohn Chaibowon Forest Park, Phichit province	-	-
Total	-	336

Simmonds and ssp. *malaccensis* in the paper of Cheesman (1948a) and Simmonds (1956) De Langhe *et al.*, (1998). The interesting characters were pink purple on external face of bract, strongly convolute of bract, prominent 1/3 bright light green or viridescent on the bract external face or tip of male bud. The local called "Mae Wong Form", which indicated hybrid characters of ssp. *burmanica* x *siamea* x *M. rubra*. Group 3 indicated very waxy on pseudostems and leaf blades, black purple large blotch on petiole and margin curve inward, and slightly hair peduncle. These were the typical characters of ssp. *malaccensis*. The bunch position was hanging at angle 45° and rachis was at an angle. Male bud was advance blooming like a top and more or less acute. Colour on the bract external face was red-purple (reddish purple) and colour on the bract internal face was orange red (light red). Compound tepal of male flower was cream and lobe of compound tepal was bright yellow (Cheesman, 1948a; Simmonds, 1956).

Group 4 also pronounced characters of large brown blotch on petiole base, and slightly hair on peduncle, which were similar to ssp. *malaccensis*. The bunch position was hanging at angle 45°. Com-

pound tepal of male flower was creamy and lobe of compound tepal was bright yellow. Apex shape of fruit was bottle-neck with partially fuse pedicel (Cheesman, 1948a, Simmonds, 1956). However, there were some characters significantly different from ssp. *malaccensis*. They were glossy pink purple on the external face of bract, orange red on the internal face of bract, little wax on pseudostem, ovate male bud, and yellow compound tepal, which had never been recorded. However, red of bract internal face and bright yellow on lobe of compound tepal characters of Group 4 were similar to ssp. *burmanica*.

In contrast, absent of wax on leaf blades and large brown blotch at petiole base characters were different from ssp. *burmanica*. Peduncle was slightly hairy with bunch hanging at angle 45° position. In addition, ovate male bud was more or less acute. Bract external face was pink-purple and yellow compound tepal. Some characters were similar to *M. rubra*.

Group 5 indicated an absent or slightly waxy on pseudostem with 2-5 m high which were the common characteristics of ssp. *siamea*. Leaf blades were not glaucous beneath and petiole was rather slender with well-developed erect margins.

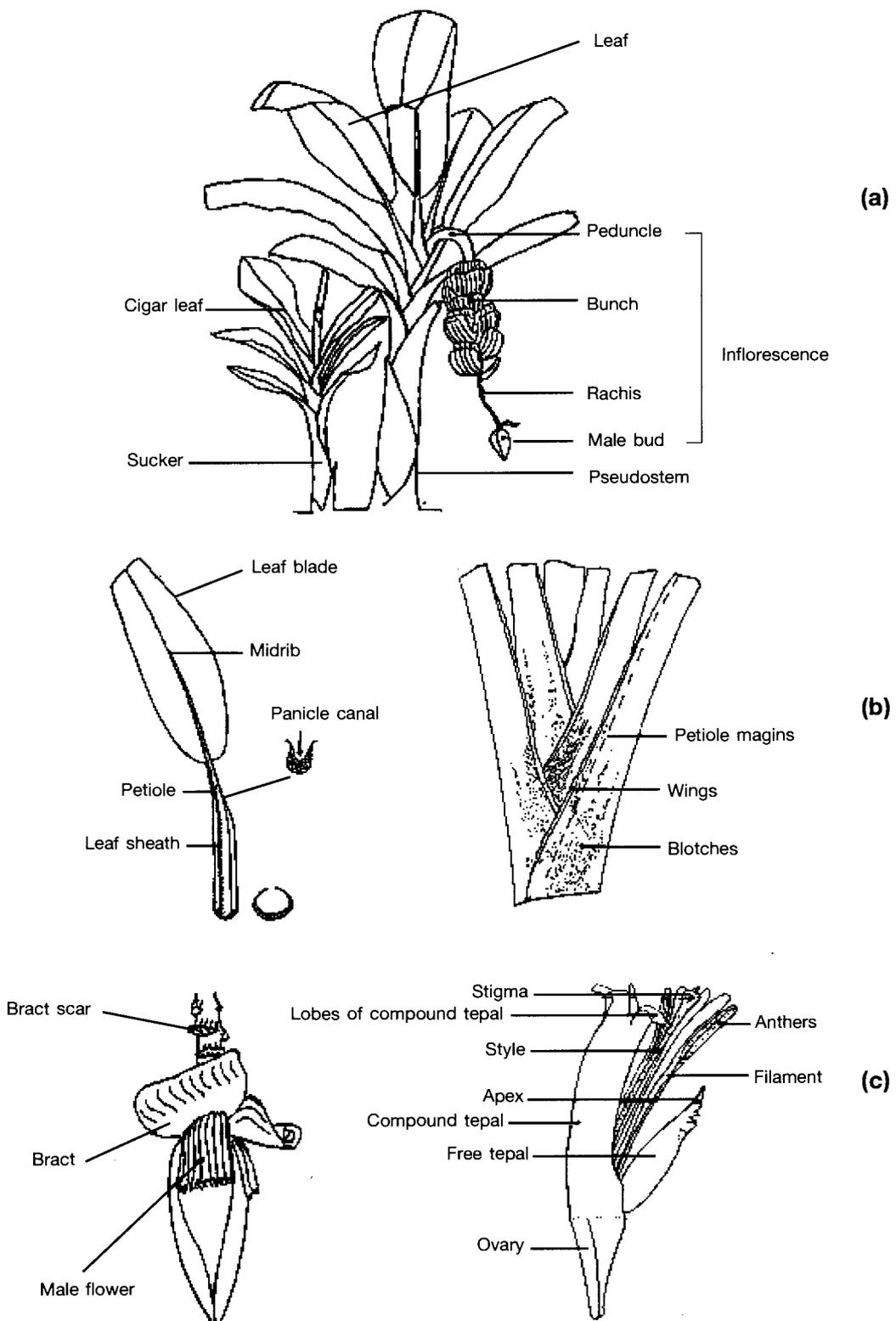


Figure 1. Banana morphological characteristics: (a) petiole/midrib/leaf, (b) pseudostem and (c) male bud and flower (Anon, 1997)

Table 2. The members in seven groups of wild bananas in the lower northern Thailand

Group	Sample	Total
1	up5, up10, up16, mw2, mw12, mw16, mw33, mw35, mw38, mw41, ph2, ph5, ph30, ph31, ph33, ph34, ph43, ph47, ph48, ph50, ln21, ln22, ln23, ln27, ln30, ln46, nw7, nw22, nw24	29
2	mw10, mw50, mw51, mw52, mw53, mw54, mw55, mw56, mw57, mw58, mw59, nw41	12
3	up25, up26, up27, up28, up29, up30, up31, up32, up33, up34, up35	11
4	up37, up40, up41, up42, up43, up44, up45, up46, up47, up48, up49	11
5	up1, up2, up3, up4, up6, up7, up8, up9, up12, up14, up19, up20, up22, up23, up24, up38, up39, tl1, tl2, tl3, tl12, tl15, tl16, tl17, tl18, tl20, tl21, tl22, tl23, tl24, tl25, tl26, tl27, tl28, tl29, tl30, tl31, tl32, tl33, tl34, tl35, tl36, tl37, tl38, tl47, tl53, tl55, mw1, mw3, mw4, mw5, mw6, mw7, mw8, mw9, mw11, mw13, mw14, mw15, mw17, mw 18, mw19, mw20, mw21, mw22, mw23, mw24, mw25, mw26, mw27, mw28, mw29, mw30, mw34, mw36, mw37, mw39, mw43, mw44, mw45, mw46, mw47, mw49, ph1, ph4, ph6, ph7, ph8, ph9, ph10, ph11, ph12, ph13, ph14, ph15, ph16, ph17, ph19, ph20, ph21, ph22, ph23, ph26, ph28, ph29, ph37, ph38, ph41, ph49, ph51, ph52, ph53, ph54, ph61, ln1, ln2, ln4, ln5, ln6, ln9, ln10, ln11, ln12, ln13, ln14, ln15, ln16, ln17, ln18, ln19, ln20, ln24, ln25, ln26, ln28, ln29, ln31, ln32, ln33, ln34, ln35, ln36, ln37, ln38, ln39, ln40, ln41, ln42, ln45, ln47, ln48, ln49, ln50, ln51, ln52, ln53, ln54, ln55, nw1, nw4, nw5, nw8, nw9, nw12, nw13, nw14, nw18, nw19, nw20, nw23, nw25, nw26, nw27, nw28, nw33, nw34, nw35, nw37, nw39, nw40, nw42, nw43, nw 44, nw45, nw46, nw47, nw48	187
6	up36, up50, up51, up52, up53, up54, up55, up56, up57, up58	10
7	up11, up13, up15, up17, up18, up21, tl4, tl5, tl6, tl7, tl8, tl9, tl10, tl11, tl13, tl19, tl27, tl39, tl40, tl41, tl42, tl43, tl44, tl45, tl46, tl48, tl49, tl50, tl51, tl52, tl54, mw31, mw32, mw40, mw42, mw48, ph3, ph18, ph24, ph25, ph27, ph32, ph35, ph36, ph39, ph40, ph42, ph44, ph45, ph46, ph55, ph56, ph57, ph58, ph59, ph60, ln3, ln7, ln8, ln43, ln44, nw2, nw3, nw6, nw10, nw11, nw15, nw16, nw17, nw21, nw29, nw30, nw31, nw32, nw36, nw38	76

Red purple bract was imbricate and tined with yellow at the tip. Bunch position was slightly horizontal. However, variations of male bud forms were found in three populations, some plants with male bud characters different from the typical characters of ssp. *siamea*. These variations comprised of 71.1% of Annam's male bud form, 25.9 % of Tavoy's male bud form and 3 % of Selangor's male bud form. These forms were previously mentioned as the major identical characters of ssp. *siamea* ssp. *burmanica* and ssp. *malaccensis*, respectively (Cheesman, 1948a; Simmonds, 1956).

Group 6 presented interesting characteristics of pale orange-yellow of compound tepal and orange lobe of compound tepal. However, the erect rachis position, and pink purple colour of the bract external face were highly significant characters different from the species' characters of *M. acuminata*. (Cheesman, 1948b, 1949c and Simmonds, 1956). These characters and information were the reasons to reject this group of samples out of the species' criteria of *M. acuminata*. In addition, the erect rachis position and pink purple colour of the bract external face characters were similar to *M. velutina* Cheesman and *M. laterita* Wendl. Et Drude. This sample

should be the hybrid of between species.

Finally, group 7 indicated the reddish brown large blotch at petiole base and pale green or yellowish midrib which were the characters of ssp. *burmanica*. Petiole was relatively stout with well developed erect margin. Male bud was in advanced blooming and acute. Purple bract was usually distinctly imbricate at the tip, and red purple or light red on internal face.

The morphological characters of each group and identification key were presented in the Table 3. Drawing of the prominent characters in each wild banana group was shown (Figure 2).

Conclusion

There were 3 subspecies with new characters and 4 new promising groups. Group 1 was ssp. *malaccensis* with shared characters of ssp. *siamea* and ssp. *burmanica*. Group 3 was the typical of ssp. *malaccensis*. Moreover, group 4 was ssp. *malaccensis* (Ridl.) Simmonds with new characters of glossy pink purple colour of the bract external face and orange red colour of the bract internal face. While, some characteristics were closed to *M. rubra*. These phenomena may explain those interesting characters of other subspecies probably to

Table 3. Identification key of seven wild banana groups

1. Rachis position; erect	Group 6
1. Rachis position: at an angle, horizontal, and falling	2.
2. Male bud shape: intermediate, colour on the bract apex; large bright yellow, colour on the bract internal face; yellow, colour on the bract external face: pink-purple	Group 2
2. Male bud shape: like a top and lanceolate	3.
3. Male bud shape: advance blooming like a top, more or less acute	4.
3. Male bud shape: like a top and lanceolate, varies in size	5.
4. Pseudostem: very wax, petiole canal; curve inward, colour on the bract external face: red-purple, colour on the bract internal face; orange-red, compound tepal: cream, lobe of compound tepal; bright yellow	Group 3
4. Pseudostem: shiny or no visible sign of wax, petiole canal; erect, colour on the bract external face; purple, colour on the bract internal face; red-purple, compound tepal; cream, lobe colour of compound tepal; yellow or orange	Group 1
5. Male bud: like a top (ovate) and more or less acute, colour on the bract external face: pink-purple, colour on the bract internal face; orange-red	Group 4
5. Male bud: like a top and lanceolate, varies in size	6.
6. Colour on the bract external face; deep purple, blotch colour on petiole base: black-purple	Group 5
6. Colour on the bract external face: purple, blotch colour on petiole base; brown-purple	Group 7

be pronounced by hybridization, that needs to be solved. Group 5 was ssp. *siamea*. Except, the variations of three male bud forms were easily recognized as the new adding recognition data to this subspecies, that have never been reported. before Group 7 was ssp. *burmanica*. Group 2 was presented various characters which were

different from the former subspecies of *M. acuminata* namely pink purple of the bract external face, strongly convolute of bract, prominent 1/3 bright light green or viridescent colour on the bract external face or tip of male bud. These were characters indicating the new form. The erect rachis position and pink purple of the bract exter-

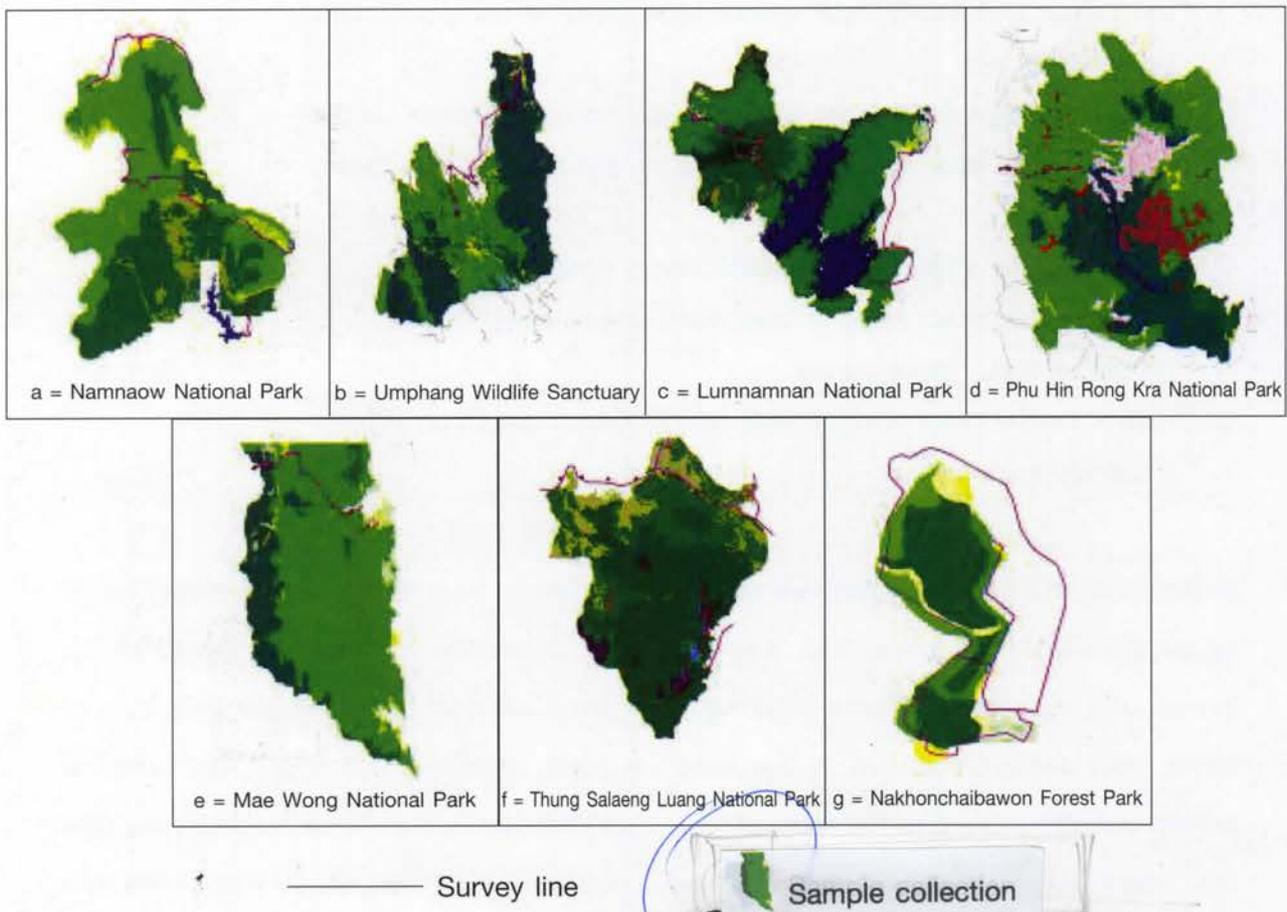
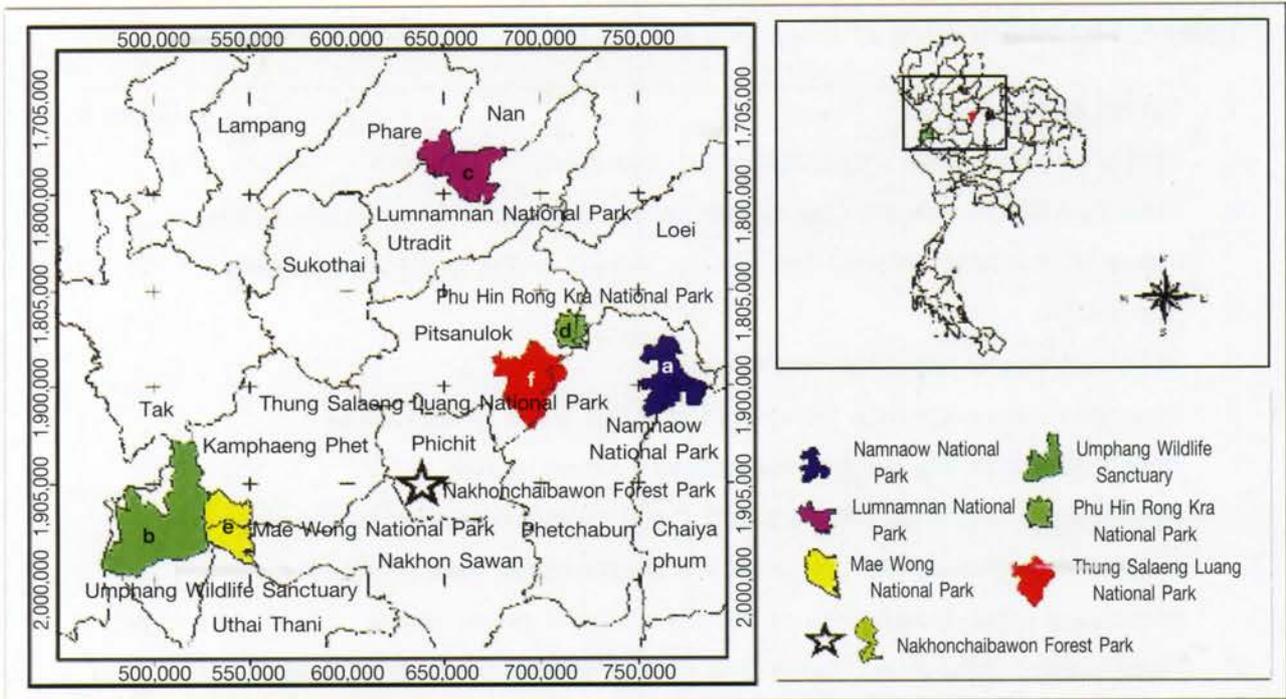


Figure 2. The seven wild banana (*M. acuminata*) study sites in lower northern Thailand

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Character	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Pseudostem							
Petiole canal							
Male bud							
Hand							

Figure 3. Morphological characteristic comparison of seven wild banana groups and three male bud forms of Group 5: In10, nw34 and

mw37

Remarks: the objects in these pictures were not in the same scale

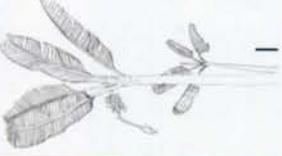
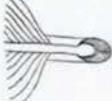
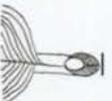
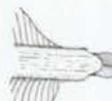
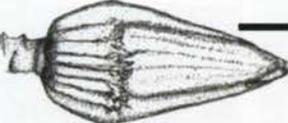
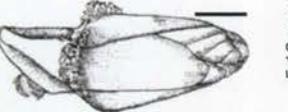
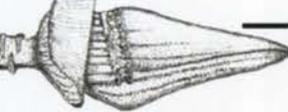
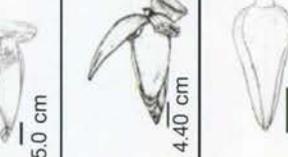
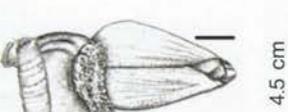
Character	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Pseudostem	 38.53 cm	 22.55 cm	 35.9 cm	 21.25 cm	 40.5 cm	 8.42 cm	 33.81 cm
Petiole canal	 3.16 cm	 2.95 cm	 2.75 cm	 2.05 cm	 2.0 cm	 2.03 cm	 2.55 cm
Male bud	 3.38 cm	 5.18 cm	 2.3 cm	 7.24 cm	 5.0 cm  4.40 cm  5.0 cm	 3.07 cm	 4.5 cm
Hand	 2.23 cm	 2.09 cm	 2.7 cm	 1.0 cm	 2.0 cm	 1.125 cm	 1.75 cm

Figure 3. (continued) Morphological characteristic comparison of seven wild banana groups and three male bud forms of Group 5: In10, nw34 and mw37.

nal face characters in Group 6 were significantly different from the species characters of *M. acuminata*. These were the reasons to reject this group out of this species. In addition, this group should be relatively closer to *M. laterita* Cheesman and *M. velutina*. In contrast, absent of rhizome and pink purple of bract external face were highly significant characters different from both species. These may indicate hybridization between species. This means that the further research should be needed and focused on the investigation on classification, numerical taxonomy, cytology (Argent, 2001; Jong and Argent, 2001), bio-systematic, or molecular of Group 1, 2 and 6 as new forms, subspecies, species or new hybrids. These indicated variations and diversity of this species that after the higher number of samples and more unique locations have been explored, which introduced better understanding on larger biodiversity complexity.

Acknowledgements

The successful of this study was fully supported by Naresuan University, Mae Fah Luang University, Kasetsart University at Kamphaengsaen Campus and Prof. Dr. Visuit Baimai. Special thanks are also to Mr. Surin

Kang-Kun and Mr. Rathakat Somthai for their productive companion during the survey.

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