Triangle Banana Exploration Report, Central Maluku and Lesser Sunda Islands, Indonesia.
16 February – 6 March 2013.

Catur Hermanto[1],Agus Sutanto[2], Edison HS[2], Riska[2], Alfons[3], Evert Hosang[4], Jeff Daniells[5] and Yusdar Hilman[6]
[1]AIAT, Medan, [2]ITFRI, Solok Sumatra, [3]AIAT Ambon, [4]AIAT Timor, [5]Agri-Science Queensland, [6]ICHORD, Jakarta

Acknowledgements

We are very thankful to Emeritus Professor Edmond De Langhe for his guidance and inputs from survey planning until the taxonomic deduction, and to all team members for working together during the mission. The team worked particularly well together and we all enjoyed this 'adventure' mission immensely. The collecting mission was largely the result of priorities determined at the first meeting of MusaNet, with planning by the Conservation Thematic Group, notably driven by the MusaNet coordinator Dr Nicolas Roux of Bioversity International. Funding was made available by the Roots, Tubers and Bananas CGIAR Research Programme via Bioversity International.

Queensland DAFF is thanked for Jeff Daniells' participation including special thanks to Associate Professor Andre Drenth, University of Queensland for his support. Thanks are also given to the Indonesian Agricultural Agency for Research and Development and all related institutions for the support and assistance during the surveys.

Agus Sutanto, *Indonesian Tropical Fruit Research Institute (ITFRI)* and Jeff Daniells, *Queensland Department of Agriculture, Fisheries and Forestry (DAFF)*

CONTENTS

Introduction **4**

Objectives of Mission **4**

What We Collected **4**

Fruit Market Visits **8**

Banana Pests and Diseases **8**

Preliminary Deductions **8**

Future Missions **9**

References **9**

Introduction

At the inaugural *Musa*Net meeting held in Montpellier in 2011 the 'Genetic diversity, taxonomy and characterisation' thematic group recommended as highest priority the exploration and collection of Musa germplasm within the triangle East Kalimantan - Maluku- Lesser Sunda Islands of Indonesia. This region was expected to be particularly rich as it is just to the east of the 'Wallace Line' and is recognized as a transition zone for flora in south east Asia. We report here on the second collecting mission in this triangle which took place in Central Maluku and Lesser Sunda Islands from 17 February – 4 March 2013.

The collecting team consisted of Agus Sutanto (Indonesian banana taxonomist), Edison (Indonesian tropical fruit taxonomist), Riska (Indonesian Plant Pathologist) and Jeff Daniells (International banana taxonomy authority). Regional AIAT officers that accompanied us were Alfons (Ambon, Central Maluku) and Evert Hosang (Timor).

Objectives of Mission

The main objective of our mission was to locate and collect 'new' banana germplasm (wild and cultivated) that could be utilized by banana breeding programs around the world to develop hybrids with stable resistance to major banana diseases.

More detail is provided in the report for the first collecting mission in October 2012. As for the first mission where possible, 3 additional suckers were left with AIAT. On this mission additional suckers were to be planted in regional collections in Makariki (Seram) and Kupang (NTT). Such regional collections should prove valuable in the banana conservation effort given the serious banana diseases present in Indonesia but which are variable in their distribution. No cigar leaf samples were preserved in DNAGard during this mission because of an ongoing impasse with international freight companies such as DHL and FedEx refusing to transport fluids.

What We Collected

We dug suckers of 16 'varieties' and collected seeds from 7 specimens – see list below. Bunch photos of each of these are included in the main part of this report. Minimum descriptor photos of each and general passport data for these are available separately from Bioversity International [http://www.bioversityinternational.org/fileadmin/bioversity/publications/pdfs/1440_Methodologies%20for%20the%20Assessment%20of%2022%20crops.pdf?cache=1312394634)]. We have also prepared 2 working documents – 'The banana varieties of Central Maluku – A work in progress' and 'The banana varieties of Sumba & Flores – A work in progress' which include colour photographs of all varieties seen (not just those collected) as well as brief classification information. These are meant to be working guides to assist banana variety identification in those regions – giving something back to the regions visited.

Table 1. List of banana germplasm collected

Genome	Name[5]	Code	Classification	Other[4]
Eumusa AA	No name available	AMB[2] 005	2x[3]	
	Muku Bugis	SUM 002	2x	
	Wahtu	SUM 003		
	Mu'u Seribu	SUM 004	2x	
	Mu'u Pundi	Sup[1].008	Sololi Bilie???; 2x	
AAA	Pisang Dingin (ITFRI)	Sup. 002	Yangambi km5; 3x	Cigar leaf only
	Makasar Putih	Sup. 003	Green Red; 3x	Cigar leaf only
AAB	Local name?	Sup. 001	Roti; 3x/4x	Cigar leaf only
	Candi (East Java)	Sup. 007	French Plantain	Cigar leaf only
ABB	'Kepok'	SUM 001	Bluggoe Subgroup; 3x	
Wild				
acuminata	No name available	AMB 002		Seed sampled
acuminata	No name available	AMB 003		Seed sampled
acuminata	No name available	AMB 004	2x	Seed sampled
acuminata	Utang/Biji	AMB 007	2x	Seed sampled
acuminata	Utang/Biji	AMB 008	2x	Seed sampled
acuminata	Local name? Utang/Biji?	Sup. 004		Seedlings & cigar leaf only
acuminata	Utang/Biji	Sup. 005		Seed sampled
balbisiana	Mu'u Popot (Sikka) Kalo Butti (Wanggameti)	Sup. 009	2x	Seed sampled
Australimusa				
	Tongka Langit/Uta Matarina Lante	AMB 001	Fe'i; 2x	
	Tole Mata Lala	AMB 006	Fe'i; 3x	
Ensete	Mu'u Baki (Sikka) Kalo Humbul (Wanggameti)	Sup. 006	*glaucum;* 2x	Seeds sampled

[1] Supplementary – not fully characterized as already held/previously in Solok

[2] AMB = Ambon, the code used for Ambon and Seram accessions; SUM = Sumba, the code used for Sumba and Flores accessions

[3] Ploidy (2x etc.) confirmed by flow cytometry analysis at the International Banana Genotyping Centre in the Czech Republic

[4] Suckers and cigar leaves collected unless otherwise indicated

[5] 'Pisang' is commonly used when referring to bananas throughout Maluku and the Lesser Sunda Islands. However, 'Uta' is the traditional name used in Ambon/Seram, 'Mu'u/Muku' are the traditional names (Sikka district/Ende district) used in Flores and 'Kalo' is the traditional name used in Sumba, and 'Biu' in Bali.

Notably we have collected suckers and seed of at least 2 distinct wild populations of *M. acuminata* from Seram [clusters AMB 002-004 & AMB 007; AMB 008; Sups. 4 & 5]. Of special mention is AMB 003 from Manusela National Park which had a huge 19-hand pendulous bunch with good finger length. The second cluster had previously been collected by ITFRI in 1996 (Edison *et al*. 1996) but were subsequently lost from the W. Sumatran collection at Solok. Refer to Nasution (1993), these accessions were classified as *M.acuminata* spp. *acuminata*. No *Musa acuminata* were found elsewhere on this mission. The number of individual *Musa acuminata* plants seen on this mission was quite modest particularly in comparison to the vast numbers located in North Sulawesi last October.

Once again on this mission, our collecting of seed and suckers of wild species on this mission was greatly limited by availability of mature bunches and access to plants including suckers because of the generally very steep jungle terrain. Much more collection mission time would need to be available and with considerable additional assistance to locate and recover a greater range of specimens perhaps better representing the population.
Wild stands of *Musa balbisiana* and *Ensete glaucum* were located in both Sumba and Flores. These were presumably once cultivated specimens which have become 'naturalised' in the areas in which they were growing. No particular variation was apparent in these wild stands which looked much the same as those seen elsewhere in Indonesia.
DNA profiles should confirm this to be the case – leaf samples from the Solok collection will be sent to IBGC for comparative purposes. One isolated cultivated plant of *Musa balbisiana* was located between Masohi and Tehoru [Seram]. *Musa balbisiana* was very commonly cultivated in our brief travel in Bali. The leaves are used for various aspects of cooking and food preparation and the immature fruit are an important ingredient in the Indonesian salad Rujak.

We collected 5 diploids [4 already confirmed from IBGC] but most of these were a surprise (except for AMB 005) as we were expecting them to be AAB based on plant morphology. Notably AMB 005 had abundant pollen so this may be of particular interest.
We collected 2 remarkable Fe'i bananas from Seram – Tongka Langit and (Tole) Mata Lala. Mature bunches were in the range of 20-30 kg. Tongka Langit was seen regularly but we only saw a couple of plantings of Mata Lala. We also collected Tongka Langit from Ambon. Fe'i bananas were not seen elsewhere on either this or the first mission last October. However, Tongka Langit is sometimes occasionally seen in other parts of Indonesia. What is interesting about these 2 Fe'i bananas is that neither have been reported from the island of New Guinea. Tongka Langit actually looks similar to some Tahitian Fe'i such as A'Ata (see MacDaniels 1947). Tole Mata Lala may also have French Polynesian connections.

We located a French Plantain near Denpasar (Bali) but we were not permitted to collect from what was just one small clump. A similar cultivar occurs in Java and according to the owner, it had been brought from Probolinggo, East Java. No other French Plantains were seen on this mission, and unlike the situation in North Maluku last October, nor were there any possible progenitors of Plantains present. Horn Plantain was relatively common in Ambon and Seram. Once again we did not encounter any cultivars from the Maoli/Popoulu Subgroup.

The following table is a list of all the varieties we encountered in the different locations to put our collecting efforts into context. Similar information was collected in the first Triangle Mission. Local names are included where available helping to enrich our knowledge of bananas in Indonesia. These tables are by no means complete since our visits were relatively brief but give an approximate snapshot of what is present in the different locations. Interestingly the most popular cultivars do vary between regions and certain cultivars appear to be absent from some regions. E.g. the relatively popular cultivar Barangan was plentiful in Sumba and Flores but not to be seen in Ambon, Seram or Bali. Cultural background of the peoples will play its part in influencing what is present where but other factors are likely to be important also and is worthy of further study.

Table 2. Banana varieties seen in Central Maluku (Ambon/Seram) and Lesser Sunda (LS) Islands/Bali

Genome/Subgroup	Ambon	Seram	Sumba(LS)	Flores(LS)	Bali
Eumusa AA					
Sucrier	Langsat	Mas	Mas	Muku Ngawu	Mas
Pisang Jari Buaya					
Inarnibal	40 hari/Nona	Nona			Sasih
(Muli Kuning)″	No local name	Matahari			
(Double bunch)″		7 bulan			
(Rose)?	Uta Kosine/Jarum				
(Mas Manado)?	Jarum	Jarum			
(AMB 005)?		No local name			
(Ketip)?					Ketip
(SUM 003)?				Muku Wahtu	
(Bilie; Sup. 008)?				Mu'u Pundi	
(SUM 004)?				Mu'u Seribu	
(SUM 002)?				Muku Bugis	
AAA					
Gros Michel	(Uta) Meja	Meja	Ambon	No local name	Ambon
″					
(Dwarf) Cavendish	Royal	Kapal	Cavendish	No local name	Hijau?/Lumut
(~Williams) ″		Eksport		No local name	
″		No local name			
Red	Makasar Merah/Uta Naulu	Makasar Merah	Tembaga Merah	Muku Api	Tembaga/Udang
(Green Red)″	No local name	Makasar Putih	Tembaga Hijau	No local name	
(Yangambi km5) Ibota	Susu Ternate	Ternate			
Lakatan			Barangan	Barangan	
?					Kayu
AAB					
(1 hand)Plantain	No local name	No local name			Kebyar/Agung
(2-3 hands)″		No local name			Tanduk
(French Plantain)″					Candi (East Java)
Pisang Raja	Raja/Haruku	Raja/Haruku	Raja		Raja/Sari
Mysore	Susu Ternate	Susu Ternate			
Silk	Susu	Susu	Susu	No local name	Susu
Pisang Nangka					Nangka
(Goroho Merah)?	No local name	No local name			
(Roti)?		No local name			
(Seribu)?		Seribu			
ABB					
Pisang Awak	Abu-abu Ternate	Abu-abu Ternate		No local name	No local name
Bluggoe		No local name	Kepok		No local name
(Silver Bluggoe)″		No local name	No local name		
(Kepok)Saba	Abu-abu	Abu-abu	Manggarai/Marmi Goreng	Mu'u Lela	Gedang Saba
Budless Kepok/Saba	Abu Lepas Jantung				
Big Kepok/Saba	Dewaka/Jawaka	Dewaka			
(Puju)″		Abu-abu			
(Long Kepok)″		Abu-abu		No local name	Gedang Saba
(Ash Kepok)″		Abu-abu			
(rounded finger tips)″				No local name	
Pelipita					
Wild					

Genome/Subgroup	Ambon	Seram	Sumba(LS)	Flores(LS)	Bali
acuminata		Utang/Biji			
acuminata ssp. *zebrina*					No local name
balbisiana		P. Sayar	Kalo Butti	Mu'u Popot	Batu
Australimusa					
	Tongka Langit	Tongka Langit			
″		Tole Mata Lala			
Rhodochlamys					
laterita					No local name
Ensete					
glaucum			Kalo Humbul	Mu'u Baki	

? = no subgroup recognized; ″ = ditto;

Fruit Market Visits

Once again visits to the fruit markets gave a quick overall impression of the important/popular varieties in a particular region. As previously not all varieties seen in a region were located in the markets. Comparisons we made with what was in the markets and those overall seen growing in the region showed that those in the market represented between 33% and 70% of the overall varieties. As already noted the most popular varieties varied between regions but in general the most popular varieties were Kepok Kuning, Raja, Berlin, Berangan, Ambon and Mas Manado.

Banana Pests and Diseases

Five *Foc* (vascular strands) samples were collected during the mission by Riska which were taken to Solok for 'plating of cultures' and then for VCG analysis. Samples were obtained from Raja Serai/Silk, Raja, Kepok and Awak on this mission. All isolates have been plated or cultured. However, the isolates collected from Kepok and Awak did not grow. Under the VCG analysis, two isolates were confirmed as TR4 and one isolate was unsure. From discussion with owners of *Foc* diseased bananas it was apparent that people's knowledge of this disease was very limited which may represent an opportunity for the local AIAT to extend information to reduce the spread and impact of this major banana disease.

Preliminary Deductions

The two missions of the Triangle Banana Exploration have collected a rich mix of diversity potentially of great value to banana breeding efforts around the globe. The exploration has also drawn attention to the following:-

(i) Information obtained on wild Eumusa in the triangle indicates the need for a complete rethinking of the phytogeography of *Musa acuminata*.

(ii) Further explorations in this same region by specifically trained local scientists should lead to valuable additional amplification of the Musa diversity knowledge.

(iii) The obvious variation seen within the Australimusa species *Musa lolodensis* suggests the need for broader study of this Musa section in general.

(iv) The discovery of French Plantain-like edible AA and its prospects for the generation of African Plantains in the region.

(v) The very likely existence of local edible AB in Eastern Indonesia and association with the origins of balbisiana hybrids in SE Asia and Melanesia.

Future Missions

This was the second collecting mission in the triangle following mission 1 in October 2012. The great challenge on these missions remains to quickly locate the existing diversity and collect and characterize 'new' germplasm. With so much ground to cover and much time spent travelling and getting local approvals etc. any improvement in the efficiency of this process would be useful. The regional support provided by AIAT staff Alfons and Evert was valuable but it is the general lack of banana specialist knowledge in a region which handicapped how much can be achieved in the very short period of time available.

We anticipate that additional useful germplasm could be located if more time were available for collecting. From the maps it can be clearly seen that we hardly scratched the surface of the islands we visited, which are quite large (e.g. Flores is about 350 km long) and with roads that can be particularly poor. We suggest that the local AIAT be encouraged to build on their existing field collections by gathering accessions during their work activities. We will provide AIAT with current lists of cultivars for a region and colour guides to identification as well as pest/disease precautions to pay attention to during the collecting process and additional basic training in photographic characterization. External funds directed via ITFRI will be needed to drive the process. 'Diversity Fairs' could be one of a number of ways to help in the further discovery process.

References

Edison, H.S., Sutanto, A., Hermanto, C., Razak, N. and Uji, T. (1996) The exploration of Musaceae in Maluku Islands 18 November – 14 December 1996. [Travel report available from Bioversity International]

MacDaniels L.H. (1947) A study of the Fe'i banana and its distribution with reference to Polynesian migrations. Bernice P. Bishop Museum Bulletin 190.

Itinerary

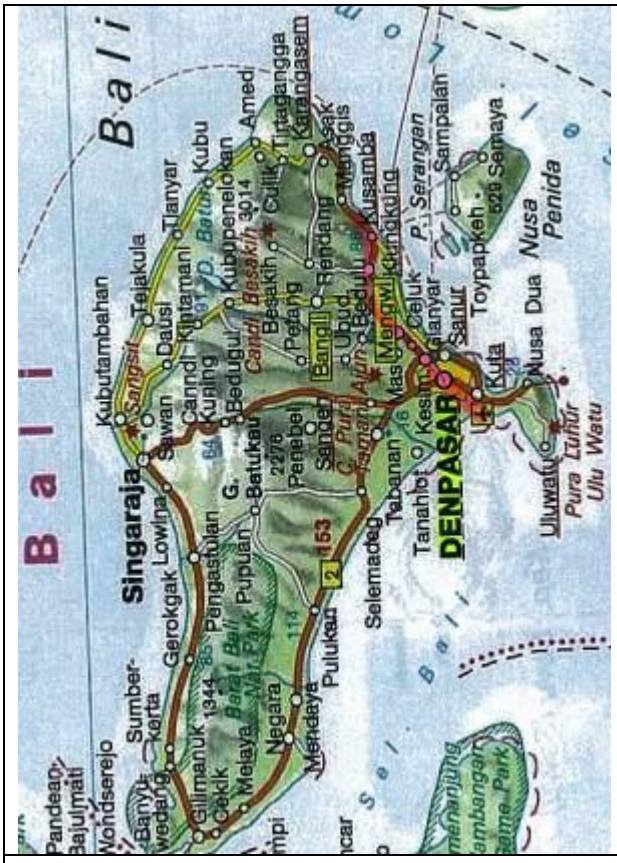
Date	Activities
Saturday 16 February	[JD only] Travel Innisfail – Cairns – Sydney - Jakarta
Sunday 17 February	Travel Jakarta- Ambon; collecting Ambon
Monday 18 February	Coordination AIAT Ambon; Travel Ambon – Masohi, Seram
Tuesday 19 February	Travel Masohi – Wahai; collecting Manusela Nat. Pk.
Wednesday 20 February	Travel Wahai – Masohi; collecting
Thursday 21 February	Return Travel to Tehoru collecting
Friday 22 February	Travel Masohi to Ambon collecting
Saturday 23 February	Airfreight suckers to Solok ; collecting Ambon
Sunday 24 February	Redrafting Triangle Mission 1 Report
Monday 25 February	Travel Ambon to Waingapu, Sumba
Tuesday 26 February	Coordination AIAT Sumba; collecting Sumba
Wednesday 27 February	Collecting Sumba; Travel to Denpasar, Bali
Thursday 28 February	Airfreight cigar leaves Czech Rep.; collecting Bali
Friday 1 March	Travel Denpasar to Maumere, Flores
Saturday 2 March	Return Travel to Kelimutu collecting
Sunday 3 March	Maumere collecting
Monday 4 March	Travel Maumere - Jakarta
Tuesday 5 – Wednesday 6 March	[JD Only] Travel Jakarta – Sydney – Cairns - Innisfail

Collecting regions – ‘circled’ in red

Ambon/Seram collecting route in pink

Sumba collecting route in pink

Flores collecting route in pink



Bali collecting route in pink

AMB 003 *Musa acuminata*

AMB 002 *Musa acuminata*

AMB 003 *Musa acuminata*

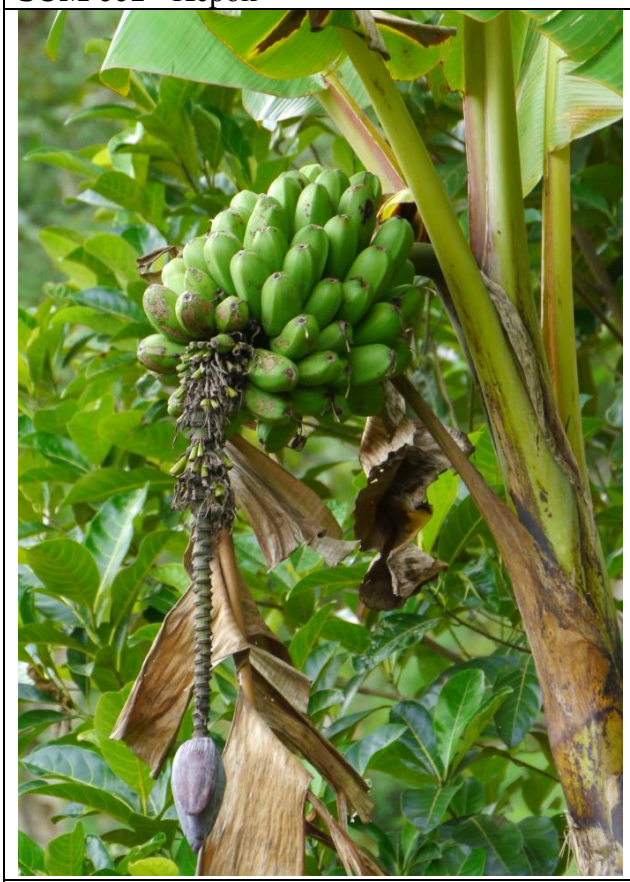
AMB 004 *Musa acuminata*

AMB 005 No name available

AMB 006 Tole Mata Lala

AMB 001 Tongka Langit Alifuru

	
AMB 007 *Musa acuminata*	**AMB 008** *Musa acuminata*
	
Sup. 005 *Musa acuminata*	**Sup. 006** Mu'u Baki / Kalo Humbul

	
SUM 001 ‘Kepok’	**Sup. 007** French Plantain/Candi (East Java)
	
SUM 002 Muku Bugis	**SUM 003** Muku Wahtu

	
SUM 004 Mu'u Seribu	**Sup. 008** Mu'u Pundi
	
Sup. 009 Mu'u Popot / Kalo Butti (*M. balbisiana*)	Fusarium wilt in Flores – present but not well understood -