COMMISSION OF THE EUROPEAN COMMUNITY

JANUARY - JUNE 1995

SIX-MONTHS PROGRESS REPORT
ON THE ACTIVITIES OF THE PARTICIPANTS TO
THE PROJECT N° TS3*-CT94-0285:

CONSERVATION, GENETIC IMPROVEMENT AND SILVICULTURE OF RATTAN SPECIES IN SOUTH EAST ASIA

Project conducted by

CIRAD-Forêt (France), FRIM (Malaysia), Forestry Department (Sabah, Malaysia),
ICSB (Sabah, Malaysia), Royal Botanical Garden (United Kingdom)

November 1995

SIX-MONTHS PROGRESS REPORT: JANUARY - JUNE 1995

1. Introduction

Rattan is a forest product with a high value for local economy of South East Asia. The rattan trade represents $ 5 billions, 90 % of which being concentrated in Indonesia and Malaysia. In spite of this, the knowledge about rattan biology, silviculture and the geographic partitioning of genetic diversity is still very limited. In 1994, a number of public and private organisations working in the region decided to join their research efforts on these topics within the present project, supported by the "Science and Technologies for Development" programme of the EEC . The list of the organisations involved is the following:

1) CIRAD-Forêt, HQ in France, Regional Office in Sabah, Malaysia
2) Forest Research Institute Malaysia, Malaysia (FRIM)
3) Forestry Department Sabah, Sabah, Malaysia (FD)
4) Innoprise Corporation Sdn Bhd, Sabah, Malaysia (ICSB)
5) Royal Botanical Garden, United Kingdom (RBG)

The Official Commencement Date of the EEC project was the first of October 1994. The associated contracts between CIRAD-Forêt and the other participants were signed from December 1994 to April 1995. This six-months progress report refers therefore to a period from January 1995 and June 1995.

According to the decisions taken during the First Workshop among Participants to the EEC Project on Rattans (Tawau, 23-27 January 1995, related in a previous document), the major activities during the first six-months period were subdivided among research, documentation, purchase of new equipments, recruitment of researchers, participation in international congress, and seed collections. These activities are briefly resumed in the following paragraphs and detailed in the participants' papers.

2. Partners activities

Activity reports by FRIM (Malaysia), Royal Botanical Garden (UK), Forest Research Centre of the FD (Malaysia), ICSB and CIRAD-Forêt are given in appendix 1 to 6.

Two Research Assistants were appointed, one by FRIM and one by the Royal Botanical Garden, to carry out the specific activities to be undertaken within the present project, mainly: seed collection, storage, processing and testing. Other research assistants and researchers must be recruited soon by FRIM. New equipments were acquired by the Royal Botanical Garden (one programmable freezer) and CIRAD-Forêt (Fish-eye for light measurements).

The Royal Botanical Garden prepared two documents, that were distributed among participants: a guidance note on the seed collection and dispatch methods for rattans (appendix 7) and a description form for living collections of rattan species (appendix 8). CIRAD-Forêt distributed among participants a recommended protocol for tissue storage for isozyme analysis (appendix 9).

Each participant started his seed collection activities as it was established during the First Workshop (Tawau, 23-27 January 1995). However, collection of rattan species masting in October-December had to be delayed to the next fruiting season. Efforts to forward seeds to the Royal Botanical Garden for analysis failed to their purpose because of the Custom restrictions in Malaysia. The Representative Officer of CIRAD-Forêt in South-East Asia, Mr P.Y. Durand, tried to negotiate with the Malaysian Customers the possibility of overcome these restrictions, but without success until June 1995.

INBAR Expert Consultation Meeting in Los Banos, Philippines, from 8 to 11 May 1995 were attended by Mr D. Alloysius (ICSB) and Dr M-C. Bon (CIRAD-Forêt). They presented the activities of ICSB and CIRAD-Forêt on rattan conservation and genetics, silviculture, and tissue culture. The manuscript of the communication of Mr Alloysius and Dr Bon is given in appendix 10.

Conclusions

The EEC financing has permitted to the collaborative programme on rattans to be started in good conditions and to obtain some important results in the following fields:

1) resource conservation

2) floral biology and phenology

3) study of the genetic diversity organisation

4) vegetative and sexual propagation

Some delay were generated by the absence of the coordinator, but this did not impeded the individual research of participants to go on successfully. The arrival of the new coordinator is planned for July or August.

APPENDIX 1

FOREST RESEARCH INSTITUTE MALAYSIA

Half-yearly Report (June/95)

Project:

Conservation, Genetic Improvement and Silviculture of Rattan Species in South East Asia.

Report:

The Project Conservation, Genetic Improvement and Silviculture of Rattan Species in South East Asia which was supposed to start in February only started on 1/4/1995. This was agreed at the January Steering Committee meeting. This project concentrate on six species of ***Calamus*** ,as follows:

i) Calamus manan
ii) Calamus palustris
iii) Calamus ornatus
iv) Calamus tumidus
v) Calamus scipionum
vi) Calamus caesius

The scope of study to include

a) Genetic conservation
i) Phenological observation
ii) Pollinators
iii) Seed collection
iv) Seed Germination Test
b) Silviculture
v) Nursery work
vi) Planting (*ex-situ* conservation)

STAFF RECRUITMENT

One ARO (Assistant Research Officer) was recruited on 1/4/1995. He was a Forestry graduate with 3 years experienced in Rattan Silviculture and Ecology Unit, FRIM in Rattan Inventory Study. One RA (Research Assistant) will be recruited by 1/7/1995 to assist the ARO and one RO (Research Officer) will be recruited by the middle of August,1995.

STATUS OF PROJECT (APRIL - JUNE, 1995)

The team (Dr. Aminuddin Mohamad, Nur Supardi Md. Noor and ARO) discussed on how to locate the area/plot where the selected six species to be observed. These selected species should be in the "Ecological Zone" in Peninsular Malaysia. The plot/area should be accessible from the

main road for Phenology observation and they are located in three zones for planning the observation trips as follows:

1) North Zone - (Perak, Kedah, Perlis)
2) South Zone - (Negri Sembilan, Johore, Southern Pahang)
3) East Zone -(Selangor, Pahang, Kelantan & Terengganu)

LOCATION OF ZONES

See appendix 1.

A three-foot PVC pipe sprays on the top with luminous orange paint was staked near the selected rattan.The rattan of clustering habit was labelled with a self tying plastic tag, on every stem for observation.

PARAMETER OBSERVED

See appendix 2.(Phenology Form).

CEC CONTRIBUTIONS

The disbursement (40%) of the fund only arrived in the late June. Purchasing and payment of the staff will be from this fund.

Appendix 1.

North Zone

North Zone		Species under observation					
STATE	LOCATION	*Calamus manan*	*Calamus palustris*	*Calamus ornatus*	*Calamus tumidus*	*Calamus scipionum*	*Calamus caecius*
Perak	G. Mesah (Gopeng)		*(4)				
	Kg.Enggor (K.Kangsar)		*(7)				
	Anak Kurau (Taiping)					*(7)	
Kedah	Bt.Larik		*(4)				
	Kg.Padang		*(4)				
	Kg.Bukit		*(2)				
	KM8,Bkt. Kayu Hitam		*(7)				
Perlis	Mata Ayer		*(7)				
East Zone		Species under observation					
STATE	LOCATION	*Calamus manan*	*Calamus palustris*	*Calamus ornatus*	*Calamus tumidus*	*Calamus scipionum*	*Calamus caecius*
Pahang	Frasers Hill			*(3)			
	Merapoh		*(5)				
Kelantan	----						
Terengganu	Dungun (Bkt.Besi)	*(7)		*(4)	*(3)		

Appendix 1. (Continued)

South Zone		Species under observation					
STATE	LOCATION	*Calamus manan*	*Calamus palustris*	*Calamus ornatus*	*Calamus tumidus*	*Calamus scipionum*	*Calamus caecius*
Negeri Sembilan	Hutan Rekreasi Serting Hulu	*(1)		*(3)			
	H.S. Serting	*(1)		*(5)		*(4)	
Johor	Bkt.Soga	*(1)					*(3)
	Air Terjun Desaru	*(2)					
	H.Rekreasi Panti				*(1)	*(1)	
	Sg.Dohol					*(7)	
	Sg.Sedili Besar				*(1)		
	Mersing				*(1)		
Southern Pahang	Bandar Muadzam Shah					*(2)	

Appendix 2.

Conservation, Genetic Improvement & Silviculture of Rattan Species in South East Asia
FRIM/CEC PROJECT

SPECIES:
LOCATION:
STATE:
ZONE:

	Day / Month/ Year							Day / Month/ Year							Day / Month/ Year							Day / Month/ Year							Comment		
TREES	T	FL	FL	FR	FR	FR	FR	T	FL	FL	FR	FR	FR	FR	T	FL	FL	FR	FR	FR	FR	T	FL	FL	FR	FR	FR	FR	Soil	Asp.	LI%
		b	bl	b/y	g	m	bl		b	bl	b/y	g	m	bl		b	bl	b/y	g	m	bl		b	bl	b/y	g	m	bl			
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T- Terminal

FL- Flowerings
- b- bud
- bl- blooming

FR- Fruitings
- b/y- bud/young
- g- green
- m- mature
- bl- black

APPENDIX 2

Activity report on Rattan Seed Conservation Studies: June 1995

Hugh W. Pritchard
Seed Conservation Section, Royal Botanic Gardens Kew,
Wakehurst Place, Ardingly, West Sussex RH17 6TN, UK.

Personnel

Hugh Pritchard attended the planning meeting for the STD3 Rattan Programme in Tawau from 23 to 26 January 1995.

In February, a meeting was held with the Finance Section at Kew to finalise the budget and approval given for the appointment of a Scientific Officer on a 33 month fixed term contract.

The research assistant post was advertised in the journal New Scientist on 4 March 1995. Applications were screened by the Selection Board (comprising: Mr Roger Smith - Head of Seed Conservation; Dr John Dransfield - Herbarium, Kew; and Dr Pritchard) on 17 March 1995 and a shortlist of candidates drawn up from more than 75 applications. Interviews were held on 31 March 1995.

Mr Ryan Davies took up appointment as research assistant from 9 May 1995.

Equipment

Following the approval of the budget in February, part of the programmable freezer was purchased in March 1995 (an Elonex computer and general software, liquid nitrogen dewar, travel cart and delivery pump).

The main part of the freezer (controller, chamber, baskets and specialist software) was ordered from Planer Products Ltd on 21 June 1995. Delivery is expected in July 1995.

Research activities

The guidance notes on the collection and dispatch of seeds was prepared and circulated in May 1995 to the three Malaysian Centres involved (Sandakan FRC, FRIM and Luasong FC) in the programme.

In the absence of any rattan seed supplies to date, Mr Davies has been primarily involved in conducting a detailed literature survey on the germination and storage of rattan and other palm species seed. A potentially suitable medium for the *in vitro* germination of palm embryos has been identified from published work and used to germinate embryos of a *Hyphaene* palm collected in Namibia by one of the Seed Conservation Section's staff. Seeds of *Washingtonia* have also been sown to validate suitable environmental conditions for germination.

Mr Davies attended a internal meeting on palms at Kew in May 1995.

APPENDIX 3

STD3 Rattan Project - Mid-year progress report, Forest research Centre, Forestry Department, Sabah.

1) Exploration of the resource - Biodiversity

- a preliminary survey at the east coast of Sabah, particularly Lahad Datu and Tawau was conducted. The objective of this survey is to attain more information on the distribution of *Calamus subinermis* and rattan diversity in the east coast of Sabah.

2) Conservation of the resource

- The emphasis was on ex situ conservation of *Calamus subinermis* in the east coast of Sabah. Living collections (wilding collection) of this species was carried out during the first survey in October 1995. Two provenances with two progenies were collected. Only one wilding of each progeny was able to collect. Nevertheless, four wild species were identified and collected.

3) Plant improvement

- a) Phenology - continue assessing the existing phenology research on four commercial species i.e. *Calamus manan*, *Calamus subinermis*, *Calamus caesius* and *Calamus trachycoleus* in five plantation areas namely Sepilok, Kolapis A, Segaliud Lokan, Berthala Island (natural stand of *C. subinermis*) and Sejati Plantation. The production of new fronds was observed at bi-monthly intervals in some stems on several sites.

- b) Breeding population - continue assessing the existing provenance and progeny trials of *Calamus subinermis* in three contrasting areas namely Kolapis A, Segaliud Lokan and Sook. These trials were assessed twice a year to determine their growth performance.

4) Silviculture

- a) Spacing trial of *Calamus subinermis* - continue assessing the existing trial. The objective of this trial is to determine the best planting density and design for the optimum yield of *Calamus subinermis*. Single and quadruple row system is implemented. Six different spacing with 4 different canopy gaps were practised. This trial is assessed once a year to determine their growth performance.

- b) Seed technology - no further research is carried out beside the germination and pretreatment test on *Calamus subinermis*, particularly on Berhala Island provenance.

- c) Harvesting technique - the two recommended study sites i.e. Sejati Plantation and Jeroco Plantation do not intend to harvest their cane in this year.

- d) Pest and disease - only one new pest for *Calamus manan* in Sejati Plantation was documented besides those reported in Insect Pest of Rattan in Sabah (Chung, 1995). An unpublished short report on the occurrence of this pest (*Xyloborus perforans*, Coleoptera: Scolytidae) is produced. The identification of the specimens is yet to be confirmed by the British Museum.

APPENDIX 4

STD3: CONSERVATION, GENETIC IMPROVEMENT AND SILVICULTURE OF RATTAN SPECIES IN SOUTH-EAST ASIA.

PROGRESS REPORT
JANUARY - JUNE 1995

BY

INNOPRISE CORPORATION SDN BHD (ICSB)
LUASONG FORESTRY CENTRE
TAWAU, SABAH, MALAYSIA

1.0 INTRODUCTION

The STD3 Project was officially started in January 1995, after the first meeting which was done in the last week of January, 1995. This report summarizes the progress of activities which were delegated to ICSB, as one of the Contractor.

2.0 ACTIVITY REPORT

2.1 Taxonomy and inter-specific variation

An effort had been made in February 1995 to send 6,000 *C. caesius* fresh fruits to Kew but failed due to Custom restriction.

2.2 Intra-specific conservation

Several collection trips have been done to collect *Calamus caesius* and *C. subinermis*. The summary of collected planting materials is presented in Table 1.

Table 1: Collection of rattan planting material by ICSB

Species	Date of collection	Location	No. of progeny/ bulk	Type of material
C. caesius	08 - 12 Feb 1995	Ranau, Kota Belud	3 progenies	Seeds
C. caesius	17 - 25 Feb 1995	Ranau, Kota Belud	14 progenies	Seeds
C. subinermis	21 - 24 May 1995	Kunak, Silam	2 progenies	Seeds and wildings
C. subinermis	06 - 12 Jun 1995	Kota Marudu, Tandek, Pitas	7 progenies and 1 bulk	Seeds and wildings

Contact has been made with Sarawak Forest Department concerning rattan seed collection trip in Sarawak but no further steps taken due to limited information given by the respective personnel. Another alternative is to contact directly to any individual/group who interested to assist the collection mission. Contact is yet to be done.

2.3 Conservation plots establishment

No formal activity.

2.4 Provenance/progeny trials for major species

Site preparation for planting more trials is on going. Trials or resource stands of *C. ornatus* and *C. optimus* are expected to be planted on August 1995.

2.5 Phenology, floral biology and breeding system

A preliminary study of *C. subinermis* floral morphology and control pollination is completed. Detail report will be prepared.

2.6 Physiology and selection criteria

No formal activity

2.7 Seed technology, pest and disease

An effort had been made in February 1995 to send 6,000 *C. caesius* fresh fruits to Kew for seed research but failed due to Custom restriction.

2.8 Plantation and harvesting techniques

Growth assessments were made for *C. manan* under logged-over forest, *C. manan* under *Gmelina arborea* stand and *C. scipionum* under logged-over forest.

Yearly assessment for yield study in commercial plantation is in progress.

3.0 FUTURE ACTIVITY

- Field trips will be arranged to collect more materials of *C. caesius* and *C. subinermis*.
- New field plantings will be done for priority species.
- Study of reproductive biology of *C. manan* and *C. subinermis* will be completed where possible.
- Cane maturation studies will be made for *C. manan* and *C. caesius*.

APPENDIX 5

SIX-MONTHS PROGRESS REPORT
(January 1995 - June 1995)

EEC PROJECT:

CONSERVATION, GENETIC IMPROVEMENT AND SILVICULTURE OF RATTAN SPECIES IN SOUTH EAST ASIA

CONTRACT N° TS3*-CT94-0285

by

CIRAD-Forêt
TAWAU, SABAH

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1. Introduction

The activities to be carried out by CIRAD-Forêt within the present project are: 1) to study, conserve and improve the genetic resources of rattans, and 2) to obtain a scientific and technical knowledge in order to optimize the development of this crop. The contribution of CIRAD-Forêt was developed within the context of the Plant Improvement and Seed Production (PISP) and of the Plant Biotechnology Laboratory (PBL), two cooperative programs established in collaboration with Innoprise Corporation Sdn Bhd.

The activities of the PBL are reported on a separate paper. We relate here only the activities conducted within PISP. The PISP research related to the EEC project focused mainly on the rattan floral biology, field planting and growth assessment in planted areas. Seed collection activity did not started since now for two main reasons: i. seed production was weak in this period, and ii. it is impossible, for the moment, to export seeds towards Royal Botanical Garden, Kew, due to Custom restrictions.

2. Rattan floral biology and controlled crosses

In the framework of the STD3 project, a research programme on floral biology and pollination of rattan (*Calamus* spp.) started in October 1994. Both ICSB (Mr D. Alloysius) and CIRAD-Forêt (Dr M-C. Bon, Mr D. Bonal, Mr M. Chauvière) have research officers involved in this program. This should lead us to a better understanding of the characteristics of the male and female rattan inflorescences, how they evolve until pollination, fecundation and fructification.

We focused our research on *Calamus manau*, chosen as a model species both because flowering plants were available in the research plots of the Luasong Forestry Centre (ICSB) and for the high economic value of its products. The observation of the flowers started in October 1994. Since inflorescences were at least 6-7 m high, we decided to construct a scaffold allowing us to observe flower *in situ*. In order to study the technique for controlled crosses, we also installed a number of pollination bags and collected and stored rattan pollen for artificial pollination.

The flower observations allow us to collect important information on flower phenology, architecture and functions. This study will be continued until at least one biological flowering cycle will be concluded (from flower initiation to fruit). In contrast, the technique for the controlled crosses is still too rudimentary, and we were not able to avoid the development of fungi inside the pollination bags. Further studies are needed, which could take in account: 1) the use of a lighter material for the bags, allowing it to dry faster after the rains, and 2) the position of the bags in relation to the canopy cover, which shades the flowers.

3. Field planting of provenance/progeny tests and conservation stands

The activity of PISP in field planting began in 1991. Some new field trials relevant to this project were established end of 1994. The species planted were *Calamus manan* and *C. subinermis*. These trials consisted of all plantable progenies of both species which were collected in 1991-1993 by Innoprise Corporation Sdn Bhd (Tawau, Sabah) and the Forestry Research Centre (Sepilok, Sabah). The list of trials is given in table 1.

Table 1 - Provenance / Progeny trials / Seedstands

Species Planted	Trial n°	Date of planting	N° of progenies	Total plants	Area (ha)
C. manan	Prog 9	Nov 94	7	210	0.26
C. manan	Res 9	Nov 94	6	300	0.38
C. subinermis	Prog 8A	Nov 94	72	432	0.54
C. subinermis	Prog 8B	Nov 94	72	432	0.54
C. subinermis	Prov 1	Dec 94	6	420	0.63
C. subinermis	Res 4	Dec 94	74	394	0.49

Note: Prog stands for progeny tests, while Prov and Res stand for provenance tests and resource conservation stands respectively. The progeny tests were designed in such a way that they will be easily transformed in seed orchards, once the relevant genetic information has been obtained.

4. Growth assessment

Growth assessments were conducted for the progeny trials that have been established in previous years by the collaboration CIRAD-Forêt / ICSB. Similar measures were taken in a number of plots established in the plantation area, in order to study the yield that is possible to realise in routine conditions.

In the three-year-old progeny tests of *C. caesius* it was possible to detect significant differences among families for the growth. This first indication of intraspecific genetic variation of the growth in a *Calamus* species keeps up the interest of the genetic improvement programme undertaken by PISP.

In contrast, in the three-year-old progeny tests of *C. subinermis* and *C. manan*, it was no possible to detect significant differences among families neither in growth nor in survival. The lack of observable differences in growth was due to the fact that many plants were still in the rosette stage, i.e. most of the individuals have not yet started the cane elongation. It was possible to observe that the duration of the rosette stage is more dependent on environmental conditions than on genetic factors. It is worth noting that rattan plantations are established in line planting under a logged-over natural forest, and that such a mode of culture is affected by a large micro-environmental heterogeneity. The lack of differences among families in survival was due in part to the fact that this latter was always very high (>90%).

More efforts will be undertaken to obtain a better control of environmental variation in plantations, and to understand the physiological effects of the environmental conditions on the growth. Further progeny tests will also be planted under *Acacia* or *Gmelina* production stands. In these stands, the environmental heterogeneity is largely reduced, in comparison to natural forests, by cultural practices and by the fact that the support trees consist of a homogeneous material (only one species, with known pedigrees).

APPENDIX 6

EEC CONTRACT N°: TS3*-CT94-0285 (DG 12 HSMU)

PROJECT TITLE: CONSERVATION, GENETIC IMPROVEMENT AND SILVICULTURE OF RATTAN SPECIES IN SOUTH EAST ASIA

CONTRACTOR: CIRAD-Forêt, Plant Biotechnology Laboratory, Tawau, Sabah, Malaysia

CONTRIBUTION/OBJECTIVES:

- **Evaluation of the genetic diversity within and among rattan populations of *Calamus manan*, *C. subinermis*, *C. caesius*, and *C. trachycoleus* using isozyme markers**

- **Study of patterns of gene flow within rattan populations using isozyme markers**

REPORTING PERIOD: 1/01/1995 TO 30/06/1995

Development of isozyme electrophoresis technology for rattan species

Rattan leaf tissue is used for isozyme analysis in preference to seed because it is abundantly available from any individual irrespective of the sex and period.

As requested by the partners of the STD3 rattan project, a simple protocol for collecting and dispatch of rattan leaf samples for isozyme analysis has been established in order to be able to use the material for collection monitored through a long period (table 1).

Table 1. Isozyme studies on rattan species: Recommended protocol for tissue storage.

1. Collection with scissors of a portion of leaf (30 cm long), avoiding leaf which has been badly damaged by herbivores or fungi.

2. Leaf is wiped clean of surface dirt, rinsed with water, wrapped in moistened toilet paper (not dripping) and stored in plastic bag to reduce wilting.

3. All plastic bags are packaged inside a polystyrene box preferentially with frozen synthetic ice packs. The excess air is pressed form the packets.

4. As far as possible, at the field station, the plastic bags should be refrigerated (4 to 6°C) for up to one week until they could be mailed.

5. Nevertheless, samples can be held also in this polystyrene box without frozen synthetic ice packs in a ventilated area for up to 3 or 4 days until they could be mailed. But it is absolutely necessary to control the moisture of the toilet paper inside the plastic bag.

6. Samples with their plastic bag should be mailed to Tawau as soon as possible.

N.B. The desiccation of leaves with silica gels does not preserve the enzyme expression at a level adequate for electrophoresis.

Two electrophoresis systems i.e. starch and acrylamide gel electrophoresis were used for the selected enzyme systems :

- Adenylate kinase (AK), Alcohol dehydrogenase (ADH), Esterase (EST), Glucose-6-phosphate dehydrogenase (G6PDH), Hexokinase (HK), Isocitrate dehydrogenase (IDH), Phosphoglucomutase (PGM), Phosphoglucoisomerase (PGI), Nicotinamide adenine dinucleotide dehydrogenase (NADH-DH). Shikimate dehydrogenase (SDH).

Since seeds from controlled crosses were not available, open pollinated progenies from different provenances were used to infer the genetic control of these 10 enzyme systems. The number of putative loci scored were 13 and 16 for *Calamus manan* and *Calamus subinermis* respectively.

The study of genetic diversity was based on single rattan progeny and started with *Calamus subinermis* and *Calamus manan*. The evaluation should be done on the populations from the collection established at Luasong Forestry Center and all the additional provenances which are planned to be collected under the current project in 1995 and 1996.

Sampling and enzyme extractions have been done for the populations listed in table 2. Young leaves from individual rattan plants aged 2 to 5 years located in the nursery or in plantations were used.

Table 2: Details on the rattan source

Location	Latitude(N) (deg.min.)	Longitude(E) (deg.min.)	No of sampled progenies	Origin
Calamus manan				
Kalimantan*	nd	nd	15	Plantation
Brumas (Sabah)*	4°35'	117°40'	18	Plantation
Jeroco (Sabah)*	5°20'	118°35'	15	Plantation
Kepong (Selangor)	3°11'	101°42'	6	Wild
Bukit Kancing (Selangor)	3°09'	102°03'	1	Wild
Bukit Tampuai (Selangor)	2°56'	102°05'	1	Plantation
Bukit Lanjar (Selangor)	3°14'	101°32'	1	Wild
Kg Jelu (Pahang)*	3°47'	101°21'	1	Plantation
Pemerawas (Pahang)*	3°50'	102°00'	1	Wild
Trenggun (Pahang)*	4°15'	102°00'	4	Plantation
Kg Lalang (Pahang)*	4°12'	102°04'	1	Plantation
Kemabul (Pahang)*	3°30'	102°15'	4	Plantation
Sungai Pandan (Pahang)*	nd	nd	4	Wild
Labis (Johore)	2°19'	103°03'	2	Plantation
Gunong Tiong (Johore)	2°25'	103°17'	1	Wild
Sg Tong (Trengganu)	5°14'	102°49'	1	Wild
Tasek Kenyir (Trengganu)	5°03'	102°34'	2	Wild
Kg Humid (Kelantan)	4°48'	101°40'	1	Wild
Calamus subinermis (from Sabah only)				
Brumas	4°35'	117°40'	14	Plantation
Putatan	5°50'	116°00'	7	Wild
Kuala Penyu	5°30'	115°30'	25	Wild
Pulau Tiga	5°45'	115°40'	10	Wild
Pulau Gaya	6°00'	116°10'	13	Wild
Penampang	5°50'	116°10'	23	Wild
Tamparuli	6°10'	116°20'	13	Wild
Kota Belud	6°30'	116°30'	12	Wild
Tuaran	6°10'	116°20'	16	Wild
Kinarut	5°50'	116°10'	6	Wild

* Populations taken into consideration for the estimation of within and between population genetic diversity for *Calamus manan*. For *Calamus subinermis*, 3 populations have been considered: Brumas; Putatan, Penampang and Kinarut; Tamparuli and Tuaran.

Study of genetic diversity

Only part of the populations listed above have been analysed for 10 enzyme systems to assess genetic diversity. The populations taken into consideration for the preliminary genetic diversity study were:

- for *Calamus manan*
  - * Kalimantan
  - * Brumas
  - * Jeroco
  - * Pahang

- for *Calamus subinermis*
  - * Brumas
  - * Putatan, Penampang and Kinarut
  - * Tamparuli and Tuaran

The results showed that both *Calamus* species exhibited a high level of genetic diversity. *C. manan* seemed to exhibit a deficit of heterozygotes while *C. subinermis* seemed to be in Hardy-Weinberg equilibrium.

Genetic variation has been observed among the populations of *C. manan* but not among the populations of the West Coast of Sabah of *Calamus subinermis*.

From these preliminary surveys, some recommendations can be given. Emphasis has to be put on the collections of:
- additional provenances in order to survey the total distribution area of the relevant species, from Sumatra for *Calamus manan*, and from the East Coast of Sabah for *Calamus subinermis*.
- additional progenies with the aim to complete some provenances already prospected.

Future experiments will consist in drawing a more complete picture of the genetic diversity of these two species with a entire survey of the existing collection whilst trying to pursue the collections.

Study on the pattern of gene flow

The study of the gene flow will be launched on plots selected for the floral anatomy and the reproductive biology of C. manan and C. subinermis. Mapping of the plot has been done. The number and the position of male and female rattan plants within the plot have been recorded.

APPENDIX 7

NOTES ON RATTAN SEED COLLECTION AND DISPATCH

PERMISSION It is essential that you obtain permission to export seed to the UK from the appropriate authority in Malaysia.

COLLECTION AND PACKAGING These requirements vary for the different parts of the project:

1) **Screening for seed storage responses** - small samples of fruits are needed of a broad range of *Calamus* species and species of related genera.

o Target is >50 mature fruits from 1 infructescence of each species. If this is not possible, collect very small numbers of fruits from the infructescences of different plants within the same locality on the same day. Please note the number of individuals the fruits came from. Combine the harvested seed into one seed lot. N.B. As few as 20 fruits collected would be utilisable.

o A reasonable quantity of the harvested fruit from each species must be retained in Malaysia for the development of the Living Collection.

o Herbarium vouchers of the collection should be made and lodged in:
(1) the country of origin; and
(2) at Kew (forward to Dr John Dransfield)

o Collected fruits should be cleaned, washed and wrapped loosely in moist, not soaking, paper tissue. Enclose sample in polythene bag. Put holes in bag. Pack in cardboard box with crumpled newspaper in order to provide a source of air for respiration. Finally, wrap box in paper and put holes through both.

o For details of dispatch, see DISPATCH.

2) **Seed processing and long-term storage work** - large samples of the four main rattan species are required.

o Target size of collection is >5000 fruits.

o Preferable to harvest a number of mature infructescences from one individual;
Alternatively, harvest from a number of individuals within the same locality. Record the number of individuals sampled.

o There is no need to collect an herbarium voucher specimen.

o Do not clean the fruits.

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o Put the fruits, still attached to the infructescence, in a polythene bag, with holes, and pack in wrapped cardboard box as described above.

o For details of dispatch, see DISPATCH.

DISPATCH

o Label box: "Tree seed of no commercial value for research only" and "PERISHABLE SEED"

o Consign to:
Irene Wong
O.A.S. Airfreight Systems
Block A, Lot 1 & 2
Bonded Cargo Agents Building
Subang, Kuala Lumpur Int Airport
47200 Subang, Selangor, Malaysia
Tel: 60 3 746 1700
Fax: 60 3 746 1232

Forward to:
MATRIX, London Heathrow Airport
FAO: Dr H. W. Pritchard/Ryan Davies
Royal Botanic Gardens Kew
Wakehurst Place
Ardingly
West Sussex RH17 6TN
UK

o From East Malaysia, take to airport and put on first flight to Kuala Lumpur (for onward passage to London). From Kuala Lumpur region, contact O.A.S. Airfreight Systems and they will call and collect the consignment. Minimum delay is essential so that the seeds arrive in good condition.

NOTIFICATION

o Please notify O.A.S. that you have sent a package to them.

o Also, send details of the AIRWAYBILL NUMBER, and FLIGHT NUMBER if possible, to me on either:

Fax No: +44 181 332 5069
Tel No: +44 181 332 5084
e-mail: h.pritchard@rbgkew.org.uk

COSTS

o Consignments collected and sent from the Kuala Lumpur region by O.A.S. will be paid for in the UK on receipt.

o The cost of sending consignments from East Malaysia to O.A.S., Kuala Lumpur, must be paid for locally (in Tawau and/or Sandakan). Thereafter, the onward flight costs to the UK will be paid for in the UK on receipt.

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APPENDIX 8

DESCRIPTION FORM FOR LIVING COLLECTIONS OF RATTAN SPECIES

DATE OF COLLECTION:
ORGANIZATION: NAME OF COLLECTOR: NUMBER:

1 GENERAL PLANT FEATURES

1.1 NAMES

Scientific name:
Vernacular name: Language:

1.2 SITE AND LOCATION

State District Locality

Altitude Longitude Latitude

1.3 HABITAT

Frequent / Frequent in patches / Infrequent
Primary Forest / Secondary Forest / Plantation
Slope (bottom / top)

2 PLANT

Solitary / Clustering
If clustering, diffuse / compact
If diffuse, with visible stolons / without stolons
In each case, approximate number of vertical stems
Acaulescent Flowering Fruiting

2.1 STEMS

Estimated length of longest stem Diameter without sheaths
Internode length in mature cane Diameter with sheaths

2.3 CLIMBING ORGANS

Cirrus / Flagellum / Neither

2.4 LEAF SHEATH

Colour

2.5 SPINES

Present / Absent Colour
Scattered / Grouped / Whorled

2.6 KNEES

Present / Absent

2.7 OCHREA

Present / Absent

2.8 LEAVES

Length of leaves without sheath Length of petiole
If present, length of cirrus

2.9 LEAFLETS

Number of leaflets on one side Arrangement: Regular / irregular
Grouped / not grouped
Fanned / not fanned

Colour of surfaces (same / different)

2.10 INFLORESCENCES

Overall inflorescence length Number of partial inflorescences
Flowers (Present / Absent)

2.11 FRUITS

Colour for the majority of the fruits

APPENDIX 9

Plant Biotechnology Laboratory
CIRAD-Forêt, Tawau, Sabah

Isozyme studies on rattan species:

Recommended protocol for tissue storage

1. Collection with scissors of a portion of leaf (30 cm long), avoiding leaf which has been badly damaged by herbivores or fungi.

2. Leaf is wiped clean of surface dirt, rinsed with water, **wrapped in moistened toilet paper (not dripping)** and stored in plastic bag to reduce wilting.
One plastic bag per individual plant with proper label (name of species, provenance, progeny).

3. All the plastic bags are packaged inside a polystyrene box preferentially with frozen synthetic ice packs. The excess air is press from the packets.

4. As far as possible, at the field station, the plastic bags should be refrigerated (4 to 6°C) for up to one week until they could be mailed.

   Nevertheless, samples can be held also in this polystyrene box without frozen synthetic ice packs in a ventilated area for up to 3 or 4 days until they could be mailed. **But it is absolutely necessary to control the moisture of the toilet paper inside the plastic bag.**

5. Samples with their plastic bag should be mailed to Tawau (M.-C. Bon, CIRAD-Forêt / ICSB, PO Box 60793, 91017 Tawau, Sabah) as soon as possible.

N.B. The desiccation of leaves with silica gels does not preserve the enzyme expression at a level adequate for electrophoresis.

APPENDIX 10

JOINT RATTAN RESEARCH BETWEEN INNOPRISE CORPORATION SDN BHD (ICSB) AND CIRAD-forêt IN SABAH, MALAYSIA

BY

DAVID ALLOYSIUS (ICSB) AND
DR. MARIE CLAUDE BON (CIRAD-forêt)

ABSTRACT

A joint rattan research between ICSB and CIRAD-forêt was started in 1989. Among the major research fields are rattan conservation and genetic improvement, rattan silviculture, rattan tissue culture and rattan genetic marker investigations. This paper presents the latest status of the research collaboration.

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MAY 8-12, 1995
LOS BANOS, PHILIPPINES

1.0 INTRODUCTION

In 1989, a Memorandum of Understanding (MOU) for collaboration in research was signed between Innoprise Corporation Sdn Bhd (ICSB), the holding company of Sabah Foundation, and CIRAD-forêt (formerly CTFT), the Forestry Department of the French Centre for International Cooperation in Development-Oriented Agricultural Research for tropical and subtropical zones. ICSB is currently involved in the management, utilization and development of a forest concession of 972,804 ha in the State of Sabah, Malaysia, and in the development of commercial forest and agriculture plantations. Whereas, CIRAD-forêt is a French State-owned industrial and commercial body which has been involved in tropical forestry and wood technology development projects and consultancy for over thirty years.

Under the principal MOU, two Supplementary Memorandum of Understandings (SMOUs) were sequentially signed for two separate projects, namely Plant Improvement and Seed Production (PISP) Project in 1989 and Plant Biotechnology Laboratory Project (PBL) in 1991.

2.0 PLANT IMPROVEMENT AND SEED PRODUCTION (PISP)

The PISP Project was started in June 1989 and has the following short-term objectives:

- To develop a plant-improvement strategy for rattans, high-value timber species and industrial timber species.
- To establish a seed/planting material production programme for rattans, high-value timber species and industrial timber species to meet the seed and other planting material requirements of ICSB.
- To develop the technical capability in plant improvement and seed/other planting material production of ICSB.

Since then, the rattan research was started jointly with the commercial rattan plantation project which was started earlier in 1987 and currently being implemented in Luasong Forestry Centre (LFC), located about 100 km from Tawau, Sabah, Malaysia.

There are two major aspects of rattan research under PISP, mainly for upgrading the quality of rattan plantation in LFC:

2.1 Conservation and Genetic Improvement

In rattan generally, there is still lack or no research in genetic improvement. In any breeding programme, a broad base population is essential in order to be able to capture as much as possible genetic gain for future generations. When the PISP project was first formulated, there was no collection of rattan either *in situ* or *ex situ* which could be used as a base population in the planned genetic improvement programme. Hence, the main task of PISP was to initiate broad genetic collections of rattan particularly for the main commercial species like *Calamus manan, C. subinermis, C. caesius, C. trachycoleus* and *C. merrillii.*

Seed collection

Seed collection operations were conducted since 1989 to gather materials from wild and also established plantations, around Malaysia. During each seed collection operation, mature fruits were collected and separated according to mother plants. These collections were purely progeny collections and also known as Individual seedlots of particular species. Normally about 200 fruits were collected from each mother plant, and if possible collection were made from about 25 to 30 mother plants per location (in fact it is very difficult to find 25 to 30 plants with fruit in a given area, especially from wild populations!). The collected progenies were raised accordingly and detailed records regarding the collection time, location, individual plant measurement and any relevant information are being maintained in LFC. The list of collected material so far is presented in Table 1. There were some occasions where plenty of fruits came to LFC's Commercial Nursery from ICSB's fruit suppliers. These fruits were actually for the commercial planting operation, but if they came from known provenances, samples were taken randomly and maintained as bulk seedlot for the PISP Project.

Table 1: List of collected material for PISP Project

SPECIES	TYPE OF COLLECTION		ORIGIN
	INDIVIDUAL	BULK	
C. manan	166	6	WEST MALAYSIA, KALIMANTAN
C. subinermis	182	13	SABAH
C. caesius	146	13	SABAH, SARAWAK
C. trachycoleus	31	NIL	KALIMANTAN
C. optimus	2	NIL	SARAWAK
C. ornatus	23	NIL	SABAH

Field Planting and Assessment

Rattan fruits cannot maintain their viability if stored for long periods, thus any collected fruit has to be sowed immediately. This problem restricts the possibility of having even-age plants for high number of progenies, which is crucial for any field evaluation trials such as progeny or provenance trials. Other related problems which equally contribute to difficulty of having even-age plants are lack of manpower to conduct seed collection simultaneously in all areas and also differences in fruiting seasons for a particular species. Due to this, comprehensive evaluation trials involving all the collected materials cannot be done in one time.

For the PISP Project, all progenies collected in approximately the same time were planted in statistically well-designed plots. These research plots known as Seed Stands or Trial Plots will be used as base populations and breeding populations,

after some manipulation, for the rattan genetic improvement programme in LFC. The plots also serve as gene banks for conservation of particular species. Yearly growth assessments were conducted in all the plots and pre-detection of superior plants will be done as the beginning of the selection activity. The list of seed stands/trial plots currently available in LFC are presented in Appendix 1 - 3.

Phenology and Reproductive Biology studies

A good understanding of the biology of sexual reproduction of rattans is necessary for success of the breeding programme. In relation to this, rattan phenology and ontogeny studies were started since 1991 in well-established plantation such as in SAFODA's (Sabah Forestry Development Authority) Sg. Pin Plantation near Batu Puteh, Kinabatangan, Sabah. Recently, a programme to study the floral biology of rattans and the possibility of control pollination was initiated in LFC.

Wild Rattan Collection

To complement to the conservation activity, a Wild Rattan Collection was established in LFC. In this area, different rattan species were planted and up to now twenty species are available in the plot. The list of species currently maintained in the plot is shown in Appendix 4. The plot will also be used as study field for rattan identification courses by ICSB or other interested parties.

2.2 Silviculture

Due to lack of manpower, this important field was slightly left behind in the running of the PISP project. Nevertheless, some studies were conducted to study the growth pattern of rattan and to determine fertilizer regimes for rattan in the nursery and in the field. Besides that, rattan yield study was started in the established plantation in LFC. For the yield study, 30-plant plots were demarcated inside the LFC Plantation area and yearly assessment were being conducted since 1991. There are all together 19 plots for *Calamus caesius*, 21 plots for *C. trachycoleus* and 13 plots for *C. subinermis*.

3.0 PLANT BIOTECHNOLOGY LABORATORY (PBL)

The main objectives of this common Research & Development oriented unit are to support Tree and Rattan Improvement and Planting Programs. Special attention has therefore to be devoted to the most rational ways to use biotechnologies to achieve this goal, being quite conscious of the respective limits of the conventional methods of tree improvement and vegetative propagation on one side, of tissue culture (cost) on the other side, as far as plant propagation is concerned.

Since late 1992, two main fields of activities have been developed within the "Plant Biotech" unit to fulfil the above mentioned objectives, namely:

* Tissue culture;

* Genetic marker investigations,

3.1 Rattan Tissue Culture

Guidelines

Rattan micropropagation which can be carried out either from seeds or young germinations, or from mature selected individuals appears very helpful as regards the following aspects:

1. Germplasm or gene pool conservation of the most important/endangered rattan species or populations, that can be subsequently used for breeding programs using long term preservation methods like cryoconservation, or short term preservation methods like dehydration or storage at low temperature. Furthermore, due to its possibilities to maintain contamination-free vegetative organs alive and even growing in a very space-restricted environment, tissue culture is a very judicious way to transfer worldwide vegetative plant material, with limited quarantine problems.

2. Mass propagation of precious genotypes - for instance within-species genetically superior genotypes issued from special crosses, or quantitatively limited from a highly desirable species or variety -, either as a mixture ("Bulk propagation"), or as clones. Furthermore, tissue culture must be rightly considered as the only means to clone single stem rattan species like the highly valuable *Calamus manan*.

3. In the same way as for other species, tissue culture propagated rattans can be produced continuously all over the year, regardless of the *in situ* fruiting period. In addition, and especially for cloning programs, it can be very beneficial to have access to some aspects of the genetics of rattans such as the evaluation of site-genotype interaction and the understanding of clonal behaviour.

Owing to the strategic importance of the rattans for ICSB, the species selected by the company to be micropropagated so far are large diameter canes, namely *Calamus manan* (Rotan manau), *Calamus subinermis* (Rotan batu), *Calamus merrillii* (Rotan Palasan). Micropropagation through axillary budding will be preferably adopted when the purpose in view is to clone proven superior genotypes. Micropropagation through adventitious budding or somatic embryogenesis can be considered in the case of very juvenile genotypes, unselected individually, and eventually extended for single stem palm species in which leaf, root or maternal inflorescence tissues have been successfully utilized to mass propagate asexually mature selected plants. So far this methodology appears as the sole means to propagate vegetatively single stem species like *Calamus manan*, taking into account such species have only one shoot meristem susceptible to be excised which is the terminal one, resulting then to the death of the mother plant.

Shoot Proliferation Method from juvenile materials

For the three species, Shoot Proliferation Method has been carried out by introducing in vitro germinated excised embryos as proposed by Aziah and Manokaran (1985) and Umali-Garcia (1985) onto Murashige and Skoog basal medium (1962) supplemented with BAP. Pilot systems for mass producing through tissue culture *Calamus manan*, and *Calamus subinermis* plantlets have been successfully established involving the handling of several thousands of shoots and leading to the transfer of several hundreds of rooted shoots for acclimatization to outdoor conditions.

As the period for germination could be long, for *Calamus subinermis* particularly and the availability of seeds sporadic, Shoot Proliferation Method has been applied to nursery seedlings or wildings with a proper disinfection method.

Organogenic callus formation

It seems highly risky and not appropriate for the future of the selected plant material to restrict our tissue culture procedures to the shoot tip only, definitely unique for *Calamus manan* in the same way as for many palm species.

So, with a view to clone mature selected plant from the wild without damaging it, we started some experiments of organogenic callus induction involving other vegetative parts of the plant than the shoot apex or the apical portion including the unique meristem - leaf portions and root tips from nursery seedlings, and root portions collected from mature rattans in the field.

The results obtained so far indicated that *Calamus merrillii* explants display greater potential for shoot proliferation and callus induction than *C. manan* and *C. subinermis* submitted to the same experimental conditions.

3.2 Genetic Marker Investigations

Access to genetic markers appears obviously quite beneficial for plant improvement and propagation of superior quality planting material, as illustrated by the possibility to investigate the following fields:

i) **Taxonomy**, with special concern for:
   - identification of clones, species, hybrids, seed lots;
   - authentication of controlled crosses;
   - study of species relationship in complex taxa.

ii) **Population structure**, including:
   - geographical variations;
   - provenance variations;
   - introgression;

iii) **Reproductive characteristics**, involving the study of mating systems and outcrossing behaviour in natural populations and in seed orchards.

Since January 1995, we have been working within the framework of a EEC funded project (STD3) focused on Conservation, Genetic Improvement and Silviculture of rattans covering the whole Malaysia. This project associates The Royal Botanic

Kew Gardens (UK), Forest Research Institute of Malaysia, Forest Research Center of Sandakan (Sabah). Within this project, and as a prerequisite for development of conservation and genetic improvement strategies, basic understanding of patterns of genetic diversity within and among populations and gene flow should be provided also by genetic markers.

In our context, genetic markers have been deliberately restricted to isozymes, which is the easiest way to obtain results at the lowest costs. The assessment of genetic diversity should be done on the commercially most important and endangered species, *Calamus manan* and *Calamus subinermis* .

Genetic diversity of *Calamus manan* and *C. subinermis*

The investigations on genetic diversity surveyed almost the whole collections of *Calamus manan* and *Calamus subinermis* which were established in the framework of provenance and progeny trials under the management of the PISP. One plant per progeny was sampled. Locations of the sampled populations are mapped in Figure 1.

Leaf tissue was used for isozyme analysis in preference to seed because it is abundantly available from any individual irrespective of sex and period. Young leaves from individual rattan plants aged 2 to 5 years located in the nursery or in plantations were used. A simple protocol for collecting and dispatching of rattan leaf samples for isozymes purposes has been established in order to be able to use the material from collection monitored through a long period.

* Genetic variation within population

The results showed that both *Calamus* species exhibit a high level of genetic diversity He=0.47. It is surprising that the diversity of the narrowly distributed *C. subinermis* is of the same order as the diversity of *C. manan* whose distribution is much larger. The diversity in the *C. manan* populations may therefore be reduced artificially by a two step sampling procedure - only part of the range of *Calamus manan* has been surveyed in the present analysis, no material from Sumatra was available and - *C. manan* " populations" were mainly collected in plantations. *C. manan* seems to exhibit a deficit of heterozygotes while *C. subinermis* seems to be in Hardy-Weinberg equilibrium (Bon et al. 1995).

* Genetic variation among populations

Genetic differentiation has been observed among populations of *C. manan* but populations from the West Coast of *C. subinermis* do not show genetic differentiation which should be confirmed for populations from the East Coast. (Bon *et al.* 1995)

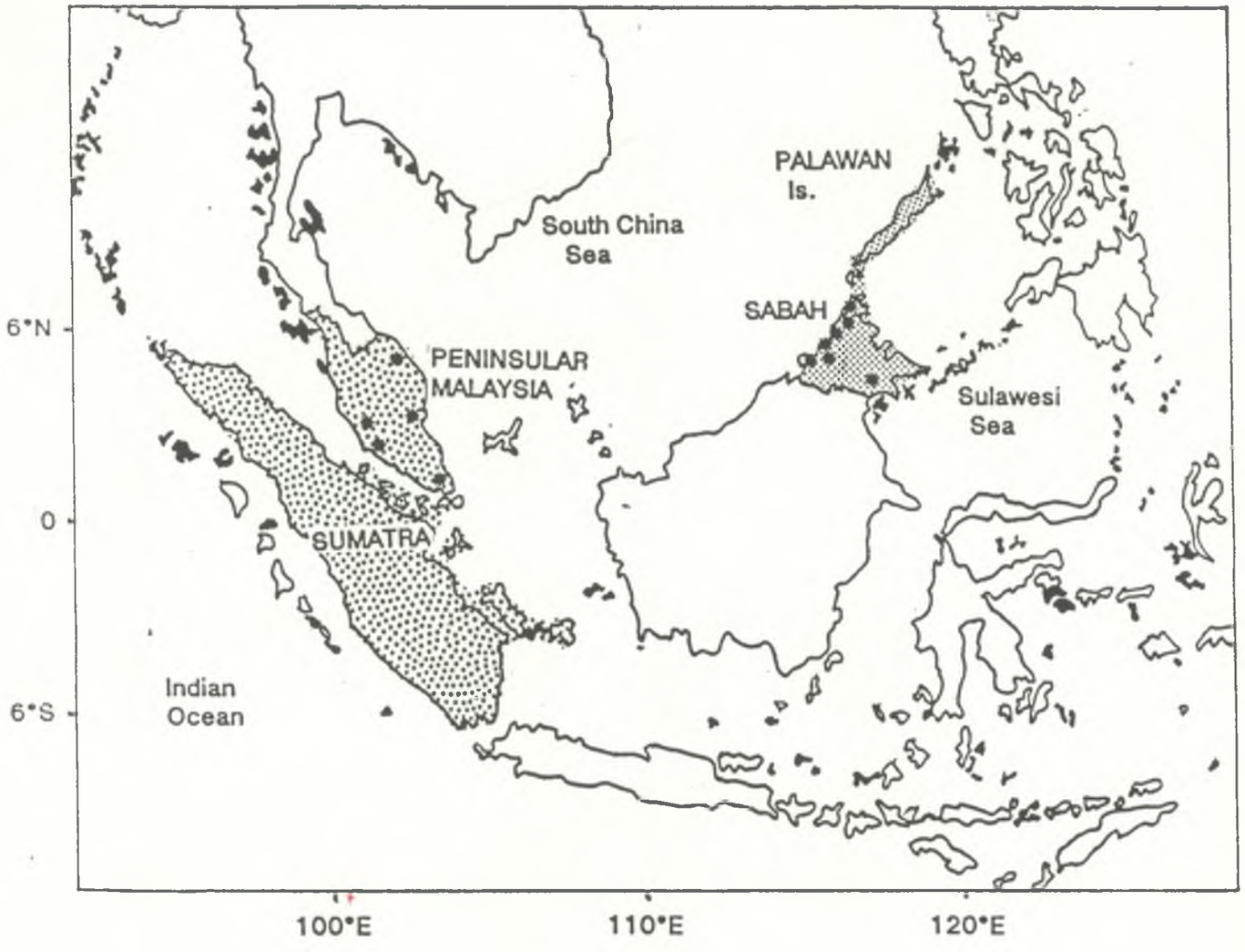

Figure 1. The native range of Calamus manan and Calamus subinermis and the location of sampled populations *.

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List of *Calamus manan* seed stands/trial plots under PISP in LFC, Tawau

TRIAL NO.	DATE PLANTED	NO. OF PROGENY	TOTAL PLANTS	PLANTED AREA (HA)
CMB1	FEB 92	5	100	0.20
CMB2	FEB 92	4	104	0.20
CMB3	FEB 92	3	90	0.10
CMB4	JAN 93	20	1000	1.25
CMB5	JUN 94	20	400	0.50
CMB6	JUN 94	6	180	0.22
CMB7	JUN 94	9	180	0.22
CMB8	JUN 94	30	300	0.38
CMB9	NOV 94	7	210	0.26
RESOURCE 1	JUN 94	6(BULK)	197	0.25
RESOURCE 2	JUN 94	14	256	0.32
RESOURCE 3	JUN 94	8	244	0.31
RESOURCE 4	JUN 94	12	310	0.39
RESOURCE 5	JUN 94	17	170	0.21
RESOURCE 6	NOV 94	6	300	0.38
TOTAL			4041	5.19

List of *Calamus subinermis* seed stands/trial plots under PISP in LFC, Tawau

TRIAL NO.	DATE PLANTED	NO. OF PROGENY	TOTAL PLANTS	PLANTED AREA (HA)
CSB1	JUL 91	5	75	0.10
CSB2	JUL 91	3	165	0.20
CSB3	DEC 91	6	240	0.30
CSB4	DEC 91	5	150	0.19
CSB5	FEB 93	14	700	0.90
CSB6	JUN 94	6	180	0.22
CSB7	JUN 94	30	450	0.56
CSB8A	NOV 94	72	432	0.54
CSB8B	NOV 94	72	432	0.54
CSC1	DEC 90	6	420	0.63
RESOURCE 1	JUN 94	4 (BULK)	200	0.25
RESOURCE 2	JUN 94	9	170	0.21
RESOURCE 4	DEC 94	74	394	0.49
TOTAL			4008	5.13

List of *Calamus caesius* seed stands/trial plots under PISP in LFC, Tawau

TRIAL NO.	DATE PLANTED	NO. OF PROGENY	TOTAL PLANTS	PLANTED AREA (HA)
CCB1	MAY 91	43	645	1.00
CCB2	MAY 91	35	525	0.80
CCB3	JUN 91	25	625	0.90
CCB4	SEP 91	10	400	0.60
CCB5	DEC 91	40	600	0.90
CCB6	DEC 91	35	700	1.10
CCB7	DEC 91	33	660	1.00
CCC1	MAY 92	9	270	0.30
RESOURCE 1	JUN 91	60	300	0.45
RESOURCE 2	SEP 91	10	50	0.08
RESOURCE 3	DEC 91	40	200	0.30
TOTAL			4975	7.43

List of other rattan species seed stands/trial plots under PISP in LFC, Tawau

SPECIES	TRIAL NO.	DATE PLANTED	NO. OF PROGENY	TOTAL PLANTS	TOTAL AREA (HA)
C. trachycoleus	CTB1	DEC 90	31	2480	3.72
C. merrillii		MAY 92	BULK	142	0.21
C. pogonacanthus	CPD1	DEC 90	1	92	0.14