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GENETIC RESOURCES OF (Elaeis oleifera (H.B.K.) Cortes IN THE BRAZILIAN AMAZON

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GENETIC RESOURCES OF (*Elaeis oleifera* (H.B.K.)Cortés[1]
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EMBRAPA/CNPSD

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Márcio de Miranda Santos[1], Edson Barcelos[1], José Carlos Nascimento[2]

1. Introduction

Since the late fifties, Brazilian governmental institutions in conjunction with primary sectors, have supported programs for the collection of genetic resources of *Elaeis oleifera* and its use in breeding programs for the production of hybrids from this American species and the African species , *Elaeis guineensis* Jacq. (CONDURU *et al.* 1983).

Brazil today has the first population of these inter-specific hybrids in the world, established in Belém in areas formerly belonging to IAN and IPEAN, presently renamed as CPATU-EMBRAPA (NASCIMENTO *et al.*1981). In view of the increasing interest in enhancing the genetic variability in the National collections of *Elaeis oleifera* germplasm, various expeditions for the collection of genetic material of this species were organized in the Brazilian Amazon, mainly after 1980, the year when the Oil Palm National Research Program of EMBRAPA was created (OOI *et al* 1981, ANDRADE 1982, PACHECO 1982 , SANTOS 1983 & BARCELOS *et al.*1984).

The purpose of this paper is to show the distribution and occurrence of *E.oleifera* genetic resources, presenting data indicating the existence in the Brazilian Amazon of excellent material bearing characteristics that furnishes promising results for the breeding program to produce hybrids for commercial usage.

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2. Occurrence and Distribution of *Elaeis oleifera* in Brazil

Native of South and Central America, the species *Elaeis oleifera* may be found in palm groves of Costa Rica, Panama, Nicaragua, Colombia, Venezuela, Surinam and Brazil (MEUNIER 1975, ESCOBAR 1981, RAJANAIDU 1982).

In Brazil, *E.oleifera* occurs in various localities of the Amazon, having been found until now in groves located in the State of Amazonas and Territory of Roraima (ANDRADE 1982, PACHECO 1982), as shown in Fig. 1.

In general, the species occurs in populations localized on fertile soils close to the margins of large rivers and their tributaries ~~and~~ in areas of firm land that are not subject to periodical flooding. In this case, the species is mainly associated with a highly fertile soil of antropogenic origin known as "indian black soil". This situation is observed in almost all the surveyed populations in primary and secundary forests or clear cut areas in the mid- Amazonas river, Madeira river and its tributaries as well as in part of the Solimões river. On the other hand, in the area of the BR-174 highway that links Manaus (AM) to Caracaraí (RR) and in some localities of the Solimões and Negro rivers, the characteristic populations are found in flooded areas following small creeks that penetrate the forest, known as "igarapés".

Occasionally, *E.oleifera* is found growing in highly fertile lowland soils situated at the edge of great rivers and subject to periodical flooding as occurs with some of the several populations found in the Solimões river and Manaus areas.

In view of this but mainly due to the strong association between the occurence of *E.oleifera* and "indian black soil, it has been suggested that the majority of the populations surveyed in the Brazilian Amazon have been formed from seeds introduced through migratory movements of indian populations that employed the *E.oleifera* seeds for the production of cooking oil and beverages. For these reasons, they cannot be considered of native occurrence. This fact may be further emphasized by the observation that the species distribution is more intense in the State of Amazonas, gradually decreasing as one moves ~~east~~ west to ~~west~~ east, where the same pattern is observed for the indian presence in the past or today. Thus in the immediate area of the town of Parintins, on the mid-Amazonas river, ~~[illegible] the population [illegible]~~ this species is no longer found. In addition, the general uniformity ~~of~~ FOR the material found at the majority of the localities visited, could suggest~~s~~ that this species is not native of this region. ~~But~~ Its natural occurrence could be a consequence of the ~~dissemination~~ dispersion starting from populations localized close to the Brazilian border and characterized by growing in permanently or periodically flooded areas and following "igarapés" of areas ~~normally~~ situated in the primary forest. The center or centers of dispersion could also be in the brazilian territory with the dispersion taking place by the local indian populations. This explains better the hight variability ~~for~~ specific caracteristics found in few populations.

3. Characteristics of Collected Material

3.1. Vegetative Development

Some important differences were observed concerning the vegetative development of the surveyed oil palms. The most significant may be the fact that the height of palm trees belonging to populations visited along the BR-174 highway in the north of Amazonas State is consistently inferior to that observed for *E.oleifera* populations of other regions when subjected to the same environmental conditions. Vigorous palm trees with excellent production of leaves and bunches are found in areas of secondary jungle and mainly in areas deforested for agricultural purposes. This is in contrast with those trees found under forest which then show few elongated fronds and low bunch production, possibly due to the shading they are subjected to. According to data collected during the 1982 survey, conducted conjointly by the Empresa Brasileira de Pesquisa Agropecuária - EMBRAPA and the Institut de Recherche pour les Huiles et Oléagineux - IRHO, of 299 leaf measurements, the length of the foliar rachis varied from 3.93 to 6.47 meters and the length of the petiole between 0.63 to 2.76 meters, which permit fronds with more than 9 meters of length in the extreme cases observed. Independent of the habitat were they may be growing, it is always possible to find plants with the characteristic prostated trunks of *E.oleifera* (See Table 1).

3.2. ~~Characteristics of the~~ Bunch and fruit quality

Under this item we discuss only characteristics with a greater relative weight in breeding programs.

A great variation has been observed in the bunch weight. Among 205 bunches collected in 1982, the weight varied between 0,9 and 18 kg with an average of 6,7 kg. (Table 1). Barcelos *et al* 1984 observed a variation of 0,66 kg to 13,26 kg among 64 samples. Very small bunches can be found along the BR-174 highway and in some localities of the mid-Amazon~~as~~ river. Significant differences for this characteristic were not seen for bunches sampled in the other regions surveyed.

Extremely low values have been observed for the percentage of bunch stalk (penduncle)material collected in Brazil. Ooi *et al* (1981) emphasized this characteristic, pointing out that in some bunches this was as low as 6%. This was confirmed later by Andrade(1982),Pacheco 1982 and Barcelos & Santos(1984)who found even lower values. The variation observed in the bunches sampled between 1932-84 was in the range of 1,8% and 26,81% (Table 1).

The of the most noteworthy characteristics at the material collected variation observed for the percentage, in weight, of normal fruits,with values that for which varied between 11,2% and 90,5% (Table 2). Similarly, the values measured for the percentage of parthenocarpic fruit fluctuated between 0,0% and 45,7% (Table 2). Bunches collected at many localities did not present parthenocarpic fruit. This fact together with the pattern of formation of fruits in the bunches which showed their bases and those of the spikelets with a majority of normal fruit,led to the observation that there was a rich insect fauna that visits female flowers, being responsible, in part, for the good conformation of the bunches of some of the populations visited (LUCCHINI *et al* 1984).

Ooi *et al* 1981 pointed out some advantageous generalities in 19 bunches collected in 3 different regions of the Brazilian Amazon, important for plant breeding. The results of subsequent PROSPECTIONS ~~surveys~~ confirmed that some samples collected in Brazil has characteristics never before seen in other regions of America.

The values observed for the average weight (g) of normal fruit varied between 3,4 and 14,7 with an average of 8,3,considering 253 bunches collected between 1982 and 1984 in different parts of the State of Amazonas.

Another notable fact was that of the 245 bunches analysed during the 1982 collection ~~survey~~, 45 presented values for the percentage of mesocarp in the fruit superior to 50% while the average was 46% (Table 2). The values found for these characteristics were in some cases superior to 60%, according to Ooi *et al* 1981, who found values equal to 60,1% and 62% among 19 samples analysed. In 1984 Barcelos *et al* observed that among 64 samples, the average for this characteristic was 45,54%.

Concerning the percentage of shell on the fruit, in some samples the values were very low. The variation was between 10,8% and 56,9% for 175 samples (Table 2).

Another characteristic of obvious importance for breeding in this species is the percentage of oil in the dry pulp. The samples collected in 1982 in different regions of the State of Amazonas revealed promising values although they were extremely variable. The range of variation for this characteristic was 16,1 to 57,2% among 171 analyses performed (Table 2).

The percentage of insaturation verified in 167 samples of oil analysed varied between 60,0% and 77,7%, with an average of 70,1% which is in agreement with results obtained by other authors studying materials collected in other countries (MAC FARLANE *et al* 1975).

4. Conclusions

The ~~surveys~~ PROSPECTIONS for the collection of *E.oleifera* germplasm organized regularly by EMBRAPA have contributed significantly to a better definition of the areas of occurrence of this species, permitting a greater elucidation of the distribution of these natural populations in the Brazilian territory.

Results of the analysis performed with genetic material of *Elaeis oleifera*, collected in palm groves from the Brazilian Amazon, put in evidence the excellent qualities of this germoplasm in the majority of characteristics important for breeding purposes. Results of breeding programs for the production of commercial hybrid ~~commercial~~ material between this species and ~~dendê~~ oil palm (*Elaeis guineensis*) are highly promising.

At present 17 lines of *E.oleifera* are planted at the CNPSD's Urubu River experimental Field Station, 140 Km from Manaus. There are more than 192 lines (about 7000 individuals) in nursery that will be taken out for planting in the field in 1985 where they will be conserved.~~and~~ evaluated, and

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TABLE 01 - Plant size and bunch quality characteristics of *Elaeis oleifera* collected in palm groves of Brazilian Amazon.

	frond		bunch			
	rachis length (m)	petiolo length (m)	weight (Kg)	stalk (%)	normal fruits %	Parth. fruits %
Mean	3.9	1.5	6.7	10.6	57.9	9.5
Range	1.9 - 6.5	0.6 - 2.8	0.9 - 18.0	1.8 - 26.8	11.2 - 90.5	0.0 - 45.7
Number of observations	299	299	205	252	235	157

TABLE 02 - Fruit quality characteristics of *Elaeis oleifera* collected in the Brazilian Amazon.

	weigth (g)	mesocarp %	shell %	oil/mesocarp %	unsaturarion %
Mean	8.3	46.0	41.1	42.8	70.1
Range	3.4 - 14.7	14.6 - 62.3	10.8 - 56.9	16.1 - 57.2	60.0 - 77.7
Number of observations	253	245	175	171	167

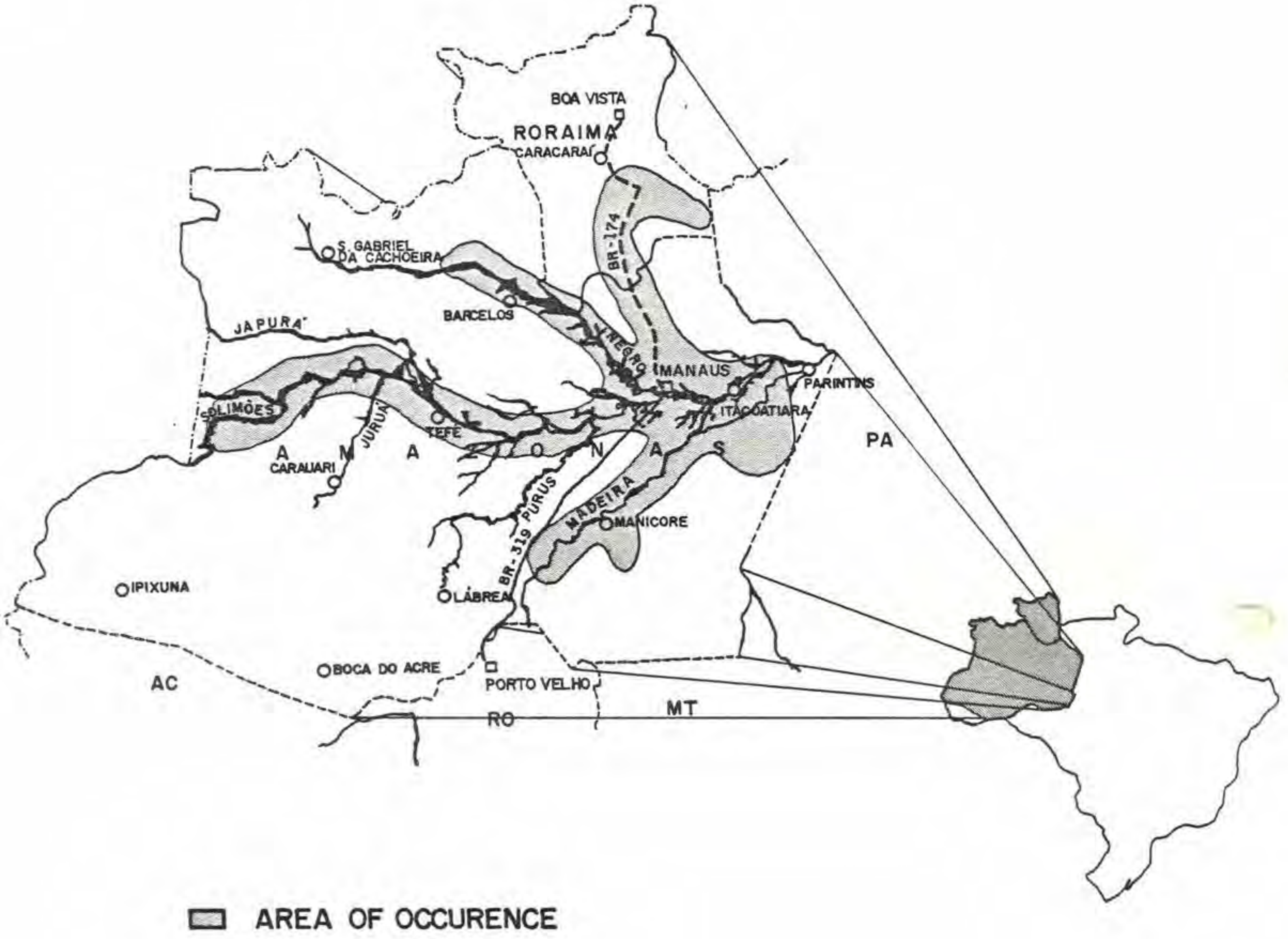

FIG. 1 - CONFIRMED OCCURENCE OF *Elaeis oleifera* IN BRAZIL

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Sabah Breeding Programme (SBP)

by

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organised by
International Society for oil Palm Breeders (ISOPB)
Palm Oil Research Institute of Malaysia (PORIM)

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Abstract

The Sabah Breeding Programme shows that Banting *duras* (ex Chemara ex Serdang palms - 5, 7 and 23) had high yields. They have also performed extremely well when crossed to WAIFOR *teneras* especially WTI (32.3005). These *duras* had good yields when selfed or crossed with other palms.

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Sabah Breeding Programme (SBP)

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Introduction

Mr. C.W. Hartley, as a consultant to the Sabah Government, initiated a breeding programme aimed at producing high yielding planting material suitable for the Sabah agroclimatic conditions.

Breeding materials for this Sabah Breeding Programme were obtained through an exchange scheme, organised between 4 Malaysian and 3 African participants. The programme contained African tenera selections crossed with Malaysian Deli dura selections as well as Deli dura selfs and crosses. Similarly African teneras were selfed and crossed.

The Malaysian participants were Chemara, HMPB, Socfin and the Federal Department of Agriculture (now the trials are managed by PORIM). The West African participants were the Nigerian Institute for Oil Palm Research (formerly WAIFOR), Unilever Nigeria and Unilever Cameroons.

In this paper, we attempt to describe the performance of the SBP material planted at Ulu Dusun, Guthrie, HMPB and Socfin. We consider this paper as an introduction to SBP and more detailed papers will be produced in due course.

Materials and Methods

The Malaysian participants contributed the Deli dura material. The origin of the Deli dura population could be traced back to four palms in the Bogor Botanical Gardens in Java (Figure 1). In addition, Chemara also contributed teneras of mixed Deli dura and Congo origins (Figure 2).

The breeding scheme intended for the the programme at its inception was the Reciprocal Recurrent Selection (RRS). The RRS originated from maize breeding research and is adapted in oil palm breeding. Basically it involves the repeated selection of parents based on the performance of progeny test cross. RRS in oil palm breeding is outlined in Figure 3.

The system practised in IRHO and other West African organisations closely follows the RRS system and is referred to as RRS in this communication. The choice of parental families, is based on DxT progeny test crosses evaluated in replicated trials.

Another method, practised in most oil palm organisations in Malaysia, is shown in Figure 4. Crosses within the respective populations are planted in replicated trials. Dura mother palms are selected on family and individual performance. The pisifera parents are selected on their sib tenera performance, and on DxP progeny test results. This system, apparently, avoids the effects of inbreeding depression by obviating the use of selfs.

The scheme adopted by Ulu Dusun is a combination of both systems. As problems such as pollination and germination have sometimes hindered planting of crosses, the progeny testing is also backed up by comparison of the parental families through replicated trials. This has turned out to be a more flexible system. In many cases where we had DxT progeny test results, selection is practised as per RRS. In their absence, family and individual selection were carried out; followed by DxP progeny testing.

The RRS programme has certain useful features; namely one generation cycle is saved by planting both the parental crosses and the test crosses simultaneously. Moreover, some specultative combination of DxD and TxT crosses are planted and where selected, will save another generation time. Furthermore, in the Sabah Programme, same crosses were planted by other participants, some in widely different environments, thus providing additional genetic information from genotype x environment studies.

SITES

1. Ulu Dusun

A total of 17 trials were planted mostly between 1966-1970. The trials were arranged as single palm plots with 50 replicates each. In trial 1-11, 6 years of yield data were collected whilst 4 years data are available from trial 12. Most of the palms in these trials were also analysed at least thrice each for bunch analysis.

2. Banting

The trials, labelled PT 27, PT 28 and PT 30, were planted between 1966-67. Twenty five progenies were planted in RCBD of 6 replicates and 12 palms/plot. Five years of yield records were collected between 1970-75 and bunches analysed during the period 1971-75.

3. Chemara

The SBP material at Chemara was planted, between 1967-68, in trials GB 30 and GB 41. They were planted in RCBD of 4-5 replicates and 16 palms/plot. A total of 65 progenies were tested, 53 in GB 30 and 12 in GB 41. Seven years of yield records were collected in the latter while 5½ years records are available from GB 30. Bunches were analysed for oil content between 1973-77.

4. Socfin

The trials were planted in block 20C and 19D in 67 and 69 respectively Three to four years yield data were collected between 1973-76 and bunches analysed during 1974-76.

We attempted to assemble the yield and bunch analysis data of all the common progenies planted at Ulu Dusun, Banting, Chemara and Socfin. The data were analysed for progeny and site differences. There were however certain shortcomings in the analysis. No adjustments were made for differences between trials and years. It was not possible to test the interaction item because of insufficient data.

Results and Discussion

Table 1 shows the performance of teneras in DxT progeny testing. Two of the crosses are extremely out-standing viz. DT 34 (BD6b x WT1) and DT 33 (BD5a x WT1). In addition DT 65 (DA(D)7a x URT1) and DT 43 (JLD5a x WT3) have performed rather well. WT1 is the palm 32.3005 of Waifor (now Nifor). It is of Umahia DxP from Calabar. The Banting palms B6b and BD5a are derived from Serdang avenue palms (5, 7, 23 via Chemara). JLD5a is derived from JL 4096 whilst DA(D)7a derives from 4/38.4. In the case of teneras, URT1 originates from 378/2 whilst WT3 comes from 4.838 (a cross between Aba dura and Cameroon tenera)) (see below).

Dura 631.838 (Aba Dura)   Tenera 3/1355
| |
Dura 2.3242 planted in 1941 x pisifera 1.2592B
|
4.838 (T)

In Table 2, the duras of families DT 34 and DT 33 are clearly the highest yielding.

Table 3 shows the selfs of the duras that were involved in the progeny testing (DxT), DS 122 (BD6B) was the highest yielder, showing little inbreeding depression. URD5a behaved similarly but to a lesser extent. However the yield of DS 121 (BD5a) was low even though in the progeny testing (DxT) it was promising.

Table 4 and 5 show the performance of duras and teneras in the tenera selfs. In general, the performance of the selfs is poor possibly due to inbreeding depression. Some of the teneras e.g WT1 which had combined well in the DxT progeny testing showed poor results in the tenera selfs. In the selfs, URT1 is quite promising and it also combined well with some duras in the DxT progeny testing.

Table 6 shows the performance of some of the speculative crosses planted in the SBP which could be utilized for a 2nd cycle of dura selections. It is worth noting that progeny DD 201 was promissing. This progeny was created by two outstanding palms, viz. BD6b and BD5a. These had combined well with WT1 in DxT crosses, as discussed earlier.

Tables 7 and 8 show the performance of duras and teneras in TxT crosses. The teneras of family TT 517 involving URT1 x 2 were the best. The duras of this family it maybe noted were also extremely outstanding.

A number of DxP crosses were planted at Ulu Dusun and Banting. For FFB the yield of DP 312 appeared good.

Conclusion

The Sabah Breeding Programme contains valuable breeding material which could be used to produce high quality seeds. Since the selfs of outstanding duras and teneras are planted along with their DxT crosses, it will provide an opportunity to test the efficiency of the RRS breeding scheme. A number of speculative crosses (DxD and TxT crosses) are yielding extremely well and these can be used in the next cycle of breeding.

Akcnowledgement

The authors wish to thank their respective organisations for permission to present this paper.

Table 1: Performance of teneras in D x T crosses

Items	df	FFB MS	O/B MS	O/P MS
Treatment (T)	23	1135.50**	5.18**	109.69**
Site (S)	1	4953.20**	164.28**	3.52 NS
S x T	23	155.37	1.32	17.52

	Treatment		FFB Mean	O/B Mean	O/P Mean
1	DT26	BD4b x LCT3	143.05	26.50	37.5
2	DT34	BD6b x WT1	191.20	29.40	56.0
3	DT33	BD5a x WT1	184.90	27.80	51.0
4	DT45	BD5a x WT4	146.95	26.10	38.0
5	DT46	BD6b x WT4	132.45	28.35	36.5
6	DT74	BD8b x URT3	160.10	26.45	42.0
7	DT11	URD1a x LNT3	133.35	29.35	39.5
8	DT15	URD1a x LNT4	108.70	25.55	27.5
9	DT12	URD2b x LNT3	113.70	27.50	30.5
10	DT28	URD4b x LCT3	152.90	27.25	41.5
11	DT38	URD6b x WT2	130.80	30.10	39.0
12	DT42	URD6b x WT3	144.40	27.45	39.5
13	DT67	URD7a x URT1	144.85	28.10	40.5
14	DT68	URD8b x URT1	150.85	27.70	42.0
15	DT79	URD7a x URT4	152.85	26.60	40.5
16	DT80	URD8b x URT4	141.90	28.30	40.0
17	DT13	JLD1a x LNT4	103.80	24.40	25.0
18	DT47	JLD5a x WT4	106.40	28.85	30.5
19	DT44	JLD6b x WT3	149.25	28.60	42.5
20	DT43	JLD5a x WT3	171.05	26.40	45.0
21	DT48	JLD6b x WT4	129.75	29.00	37.5
22	DT75	JLD7a x URT3	146.65	31.15	45.5
23	DT71	JLD7a x URT2	103.70	30.45	27.0
24	DT65	DA(D)7a x URT1	167.55	28.55	48.0
		Overall mean	142.13	27.91	39.27
		SE. Treatment mean	8.81	0.81	2.96

Note: Ulu Dusun and Banting (2 sites)

Table 2 : Performance of duras in D x T trials

Source	df	FFB ms
Treatments (T)	17	996.04**
Site (S)	1	5172.01**
S x T	17	200.82

	Treatment		Mean
1	DT 26	BD4b x LCT3	159.15
2	DT 34	BD6b x WT1	180.40
3	DT 33	BD5a x WT1	173.60
4	DT 45	BD5a x WT4	159.00
5	DT 46	BD6b x WT4	153.40
6	DT 74	BD8b x URT3	174.30
7	DT 15	URD1a x LNT4	121.85
8	DT 12	URD2b x LNT3	104.95
9	DT 11	URD1a x LNT3	132.45
10	DT 28	URD4b x LCT3	176.10
11	DT 38	URD6b x WT2	115.05
12	DT 42	URD6b x WT3	150.55
13	DT 67	URD7a x URT1	148.30
14	DT 79	URD7a x URT4	152.65
15	DT 80	URD8b x URT4	151.25
16	DT 75	JLD7a x URT3	130.90
17	DT 71	JLD7a x URT4	119.45
18	DT 65	DAD7a x URT1	149.30
	Overall mean		147.37
	S.E. of treatment mean		10.62

Note: Mean yield (FFB) of duras in D x T families planted at Ulu Dusun and Banting.

Tables 3: Performance of <u>duras</u> in <u>Dura</u> Selfs

Items	df	ms
Treatments (T)	7	698.87*
Sites (S)	1	286.46 NS
S x T	7	171.67

	Treatment		Mean
1	DS 106	BD 2b	148.6
2	DS 114	BD 4b	141.35
3	DS 121	BD 5a	137.45
4	DS 122	BD 6b	179.75
5	DS 129	BD 7a	126,40
6	DS 108	URD 2b	121.55
7	DS 123	URD 5a	161,00
8	DS 139	URD 9a	143.15

Overall mean = 144.91

S.E of treatment mean = 9.26

* Ulu Dusun + Banting (2 sites)

Table 4 : Performance of duras in tenera selfs

Items	df	ms
Treatment (T)	5	1260.59**
Sites (S)	1	2244.07**
T x S	5	94.63

	Treament	Mean
1	TS 419 URT3	111.90
2	TS 417 URT1	131.95
3	TS 407 LCT3	133.55
4	TS 406 LCT2	87.00
5	TS 409 WT1	98.95
6	TS 411 WT3	70.30

Overall mean = 105.61

S.E. of treatmean = 6.88

* Ulu Dusun + Banting (2 sites)

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Table 5 : Performance of teneras in tenera selfs

		FFB	O/B	O/P
Items	df	ms	ms	ms
Treatment (T)	5	645.18 NS	8.11 NS	40.33 NS
Sites (S)	1	5905.20**	99.19**	65.33 NS
S x T	5	357.74	9.87	30.73
Treatment		mean	mean	mean
1 TS 419 URT3		112.40	24.40	27.0
2 TS 417 URT1		126.25	26.65	33.5
3 TS 407 LCT3		119.75	24.85	29.0
4 TS 406 LCT2		83.40	26.40	21.0
5 TS 409 WT1		84.85	27.75	23.5
6 TS 411 WT2		109.85	22.1	24.0
Overall mean		106.08	25.36	26.33
S.E. of Treatment mean		13.37	2.22	3.92

Note (Banting and Ulu Dusun Sites)

Table 6 : ANOVA - Duras families (D X D)

Items	df	ms
Treatmenst (T)	7	1876.01**
Sites (S)	1	239.48 NS
S x T	7	97.45

	Treatment	Mean
1	DD 203 BD2b x 1a	174.75
2	DD 207 BD3a x 4b	89.60
3	DD 201 BD6b x 5a	170.30
4	DD 215 BD7a x 8b	167.95
5	DD 219 BD10 x 9a	148.70
6	DD 208 URD4b x 3a	174.15
7	DD 212 URD5a x 6b	143.4
8	DD 214 JLD8b x 7a	119.0

Overall mean = 148.48

S.E. of treatment $\bar{X}$ = 6.98

Note: Banting + Ulu Dusun (2 sites)

Table 7 : Performance of duras in T x T crosses

		FFB	O/B	O/P
Items	df	ms	ms	
Treatments (T)	5	1733.12*	19.09**	198.53**
Sites (S)	1	569.94 NS	15.19**	1.33 NS
S x T	5	194.32	.19	11.13
Treatment	Mean		Mean	Mean
1 TT519 URT3x4	141.00		18.80	16.50
2 TT517 URT1x2	192.25		23.40	45.00
3 TT520 URT1x4	151.10		21.50	32.50
4 TT506 LCT2x3	143.80		21.15	30.00
5 TT503 LNT3x4	100.40		14.80	15.00
6 TT509 WT1x2	137.30		17.70	24.00
Overall mean	144.31		19.56	28.85
S.E. of treatment mean	9.86		.31	2.36

Note: Ulu Dusun + Banting (2 sites)

Note: Planted at Ulu Dusun & Banting

Table 8 : Performance of teneras TxT Crosses

			FFB	O/B	O/P
Items		df	ms	ms	ms
Treatment (T)		9	1410.64**	7.81 NS	162.98**
Sites (S)		1	1956.24**	54.78**	1.80 NS
S x T		9	153.09	2.85	22.24
	Treatment				
1	TT 518	URT 2 x 3	119.25	28.65	34.5
2	TT 517	URT 1 x 2	177.05	29.60	52.5
3	TT 519	URT 3 x 4	147.7	25.40	37.5
4	TT 520	URT 1 x 4	146.55	28.30	41.0
5	TT 506	LCT 2 x 3	153.75	27.70	42.5
6	TT 505	LCT 1 x 2	118.05	28.80	33.5
7	TT 504	LNT 1 x 4	108.25	23.85	25.5
8	TT 503	LNT 3 x 4	93.00	24.55	22.5
9	TT 509	WT 1 x 2	143.20	26.60	38.0
10	TT 511	WT 3 x 4	103.20	25.70	26.5
		Overall mean	131.0	26.92	35.4
	S.E. Treatment mean		8.75	1.19	3.33

Table 9: Performance of teneras (D X P)

	df	FFB	O/B	O/P
Items		ms	ms	ms
Treatment (T)	4	649.20**	7.62 NS	35.75 NS
Site (S)	1	509.80*	22. 5 NS	.10 NS
S x T	4	38.28	4.13	20.85

Treatment				Mean	Mean	Mean
1	DP 307	BD5a x WP9		148.75	23.25	34.5
2	DP 308	URD6b x WP9		114.05	25.45	29.0
3	DP 312	URD7a x UR(P)5		161.00	25.35	40.5
4	DP 306	JLD66 x WP9		136.30	27.00	37.0
5	DP 310	JLD7a x UR P5		129.20	28.45	36.5
	Overall mean		=137.86		25.90	35.50
	S.E of treatment mean =		4.38		1.44	3.23

Note: Ulu Dusun + Banting (2 sites)

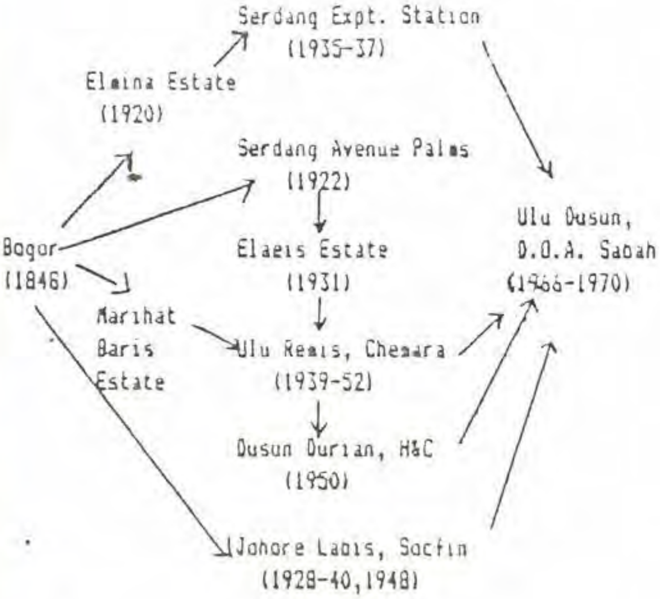

Fig. 1. ORIGIN OF DELI DURA FAMILIES IN THE SABAH BREEDING PROGRAMME

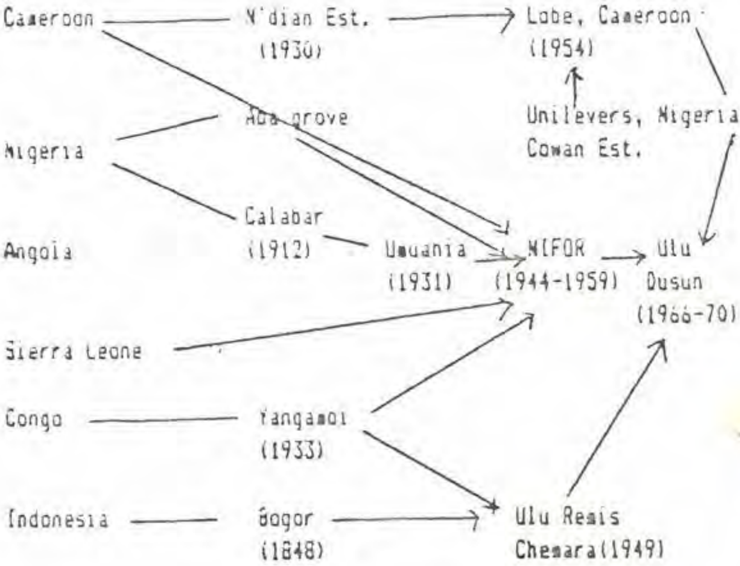

Fig. 2. ORIGINS OF TENERA FAMILIES IN THE SABAH BREEDING PROGRAMME

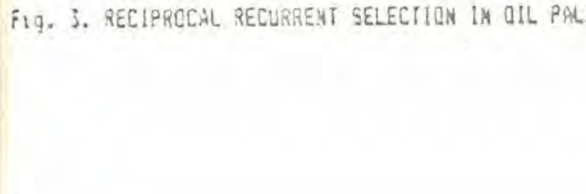

Fig. 3. RECIPROCAL RECURRENT SELECTION IN OIL PALM BREEDING

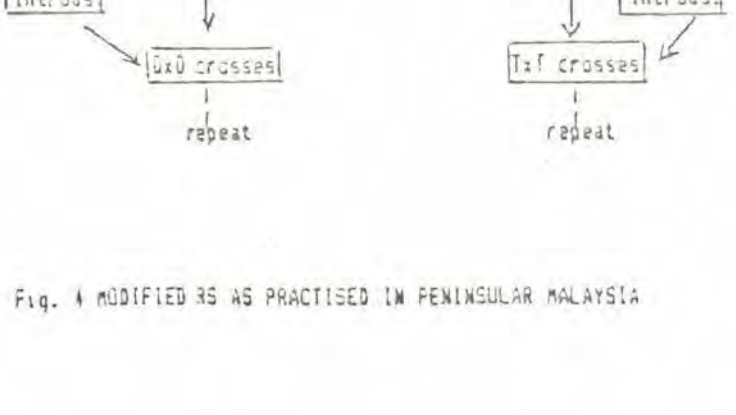

Fig. 4 MODIFIED RS AS PRACTISED IN PENINSULAR MALAYSIA

INTERNATIONAL

Workshop on Oil Palm Germplasm and Utilization

The Genatic Base of Oil Palm Breeding Populations

by

E A Rosenquist

organised by
International Society for oil Palm Breeders (ISOPB)
Palm Oil Research Institute of Malaysia (PORIM)

sponsored by
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For the ISOPB Workshop, Bangi 26 - 27 March

The Genetic Base of Oil Palm Breeding Populations

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E A Rosenquist

Introduction

In October 1984 I received a letter from the Secretary of ISOPB saying that the Society would like to request me to present a paper on the "Genetic Base of Oil Palm Breeding Populations" at a Workshop to be held in March 1985.

Much of my time between October and March was already committed to other projects and in practice the paper had to be written in under two weeks.

With the limited time available the scope has been restricted to listing some of the main oil palm breeding populations with a brief description of their origin. In general no attempt has been made to assess their characteristics.

Inevitably I have given more attention to the oil palm populations with which I have worked.

It has not been possible to verify accuracy in detail. During the course of the workshop I shall be most grateful to receive corrections.

The paper has been drafted as a communication to practicing Oil Palm breeders at the workshop. Oil palm jargon such as "ffb" and "O/B" has been used with no explanation. The paper is not suitable for publication in its present format.

Despite its limitations it is hoped that ISOPB members will find the paper useful.

Breeding Populations of restricted origin (BPRO)

It is possible to trace the origin of a number of oil palm breeding populations back to wild palms or to unimproved palms closely related to wild palms.

The breeding populations are frequently derived from rather few ancestral palms, frequently less than twenty. Although a breeding population may have been introgressed with other populations there remains a considerable number of breeding populations derived exclusively from a few ancestral palms.

This paper considers only breeding populations of restricted origin (BPRO) which are in at least the second legitimate generation. Some of the populations are in the fourth or fifth generation.

Some breeding populations of restricted origin have been introgressed with other BPRO: and although their genes survive the original BPRO has been lost. Whether or not it is desirable to make a positive effort to conserve BPRO's will be discussed at the end of the paper.

The list of BPRO's is certainly incomplete and in particular the IRHO breeding populations mainly in the Ivory Coast and the NIFOR populations in Nigeria are inadequately covered.

The attempt to survey E. guineensis breeding populations proved onerous enough and this paper makes no reference to E. oleifera.

Deli dura

The origin of Deli dura has been reviewed by many authors. Belgarric (1951) Toovey and Broekmans (1955) and more recently by Hardon and Thomas (1968).

Toovey quoting Hunger (1917) and Rutgers (1922) suggests that the four Bogor palms planted in 1848 come from the island of Reunion rather than from Mauritius which is geographically close by but is now a separate country. The oil palm is not indigenous in either country so the exact origin of the Bogor palms is in doubt.

There is however general agreement that the Deli population is descended from the Bogor palms. Belgarric (1951) states that there were trial plantings on estates from 1859 but these were abandoned although some palms remained as ornamentals especially on tobacco estates.

A population of palms derived from the orignal four in the Botanical Garden was planted in the Economic Garden at Bogor in 1878 and Hardon and Thomas (1968) indicate that trial plantings and ornamental avenues were established from 1884 using seed from these palms. This does not rule out the 1859 trial plantings described by Belgarric.

Development of Deli dura in Indonesia

A number of plantation companies started oil palm breeding programmes independently of each other. Marihat Research Station has produced a most valuable booklet on the history of oil palm breeding in Indonesia (Adlin Lubis 1984). He gives a diagram to indicate the evolution of Deli dura oil palm breeding in Indonesia (Fig. 1).

The diagram shows that many of the formal breeding programmes started after 1935, Hartley (1967 p. 17) states that in 1925 there were 30,000 ha of oil palms but by 1938 this had risen to over 90,000 ha. This means that when the formal breeding programmes started there were over 50 million oil palms in Sumatra. Although the genetic base was narrow the population available was large. Most Deli dura breeding programmes started by observing populations of several thousand palms on plantations.

A programme was started by a German Company (later P.T.P. Lama) on Marihat Baris. A diagram to illustrate the origin of various Marihat Baris Deli dura is taken from Adlin Lubis. (Fig. 2) Hartley (1967 p. 196) states that this programme started by yield recording 2000 palms which had been planted in 1915. Initially 15 palms were selected and self pollinated and their progenies planted at Sg. Panchur and Polonia.

A programme started by the Dutch company HVA gave rise to several populations including as an example Dolok Sinumbah. (Fig 3). This may be the programme mentioned by Hartley (1967 p. 196) that led to the selection of 50 palms from a population of 24,500.

Quite independently SOCFINDO established a Deli dura breeding programme in 1927 by planting legitimate progenies from selected palms at Mopoli. According to Belgarric (1951) these originated from the 1859 oil palm trials and are probably distinct from the material described by Adlin Lubis. By 1933 selfed progenies of selected palms were being planted at Bangun Bandar where breeding is still in progress. Belgarric refers to 17 selected Deli dura which originated from Bogor. It is almost certain that the Dabou population to be described came from SOCFINDO in Sumatra (Bredas 1969).

A Swiss company started planting Oil Palms on Gunung Melayu estate in about 1919. A selection programme which gave emphasis to a slow height increment and high oil in mesocarp was started later and legitimate progenies were planted in 1936/37. These were still yielding 18 tons p ha 42 years later. The original genetic blocks (1936 - 1942) contained about 2000 palms. From these 37 palms were selected for further breeding which is being continued by London Sumatra Indonesia on Bah Lias estate (Bah Lias Annual Report 1981 p 59).

Development of Deli dura in Malaysia

In 1933 there were only 25,000 ha of oil palms in Malaysia but there was much interest in the new culture and three organisations were operating breeding programmes - the Department of Agriculture at Serdang and on Elmina Estate, Oil Palms of Malaya (OPM) on Ulu Remis and Elaeis Estate and SOCFIN on Johore Labis estate. The evolution of these programmes is indicated in Fig. 4.

Department of Agriculture

Serdang Avenue Palms

In May 1922 the 86 "Serdang Avenue" Deli palms were planted on the Federal Experiment Station at Serdang. After yield recording to estimate the production of clean fruit a formal progeny trial to compare legitimate progenies was planted in Nov 1930 (Bunting, Georgi and Milsom 1934).

Legitimate crosses combining the best Serdang Avenue palms were planted on Elaeis Estate in 1931 and were later introgressed with Ula Remis selections to produce the Chemara Deli dura. In the later generations of material developed from this population genes of Serdang Avenue palms 5, 7 and 23 are found in many of the best progenies (Breure, Konimor and Rosenquist 1982).

Serdang Avenue progenies were also planted by NIFOR in Nigeria but of the 10 progenies none contained Serdang Avenue 5 or 23 and only two contained Serdang Avenue 7. Records of the Serdang Avenue plantings in Nigeria have been presented by Toovey and Broekmans (1955).

Two progenies at Lobe in Cameroon are derived from selections in the Serdang Avenue population at NIFOR. (Lb 140 ex S.Av. 65x7 and Lb 157 ex S.Av. 19x65) but apart from these I have no knowledge of any other survivors from the Serdang Avenue population which contributed much to the success of the oil palm in Malaysia.

Elmina selections

Jagoe observed 589 Deli palms in a 1920/21 planting on Elmina Estate in detail and in 1938 about 12 selfed progenies from selected palms were planted in replicated trials at Serdang (Bunting, Georgi and Milsom 1934). Leaf analysis of these progenies showed major differences between them (Coulter and Rosenquist 1958) and this study encouraged the introduction of leaf analysis in Malaysia.

Some crosses from selected palms in the 1938 planting were distributed to various plantation companies as part of a combined breeding programme. No results of this programme appear to have been published but it is known that several companies are using Deli palms of this origin for seed production (Arasu - personal communication).

The "dumpy" palm

One palm at Elmina was selected because of its short trunk and unusual conformation. It's selfed progeny was planted at Serdang in 1938. The progeny was uniformly dumpy. Compared with two other selfed progenies and two crosses the records showed

	E268 selfed	E268x E206	E206 selfed	E152x E206	E152 selfed
Yield kg/palm/an	100	NA	101	NA	64
Height to crown m	4.7	4.1	2.9	4.1	4.2
Girth at 1 m	2.5	2.5	2.7	2.2	2.1

The dumpy was multiplied by selfing and sib-crossing but these progenies gave poor yields (The Oil Palm in Malaya 1966 p 5). The poor yield was no doubt due to inbreeding depression.

Dumpy material was very widely distributed and two pure dumpy progenies which reached Lobe (Cameroon) in 1969 showed more resistance to vascular wilt in nursery tests than any other material. At Binga in Zaire a different dumpy progeny was field planted in 1973 and is showing exceptional wilt resistance. There have been no deaths among 72 palms despite an average of 16% deaths in the trial which compares 22 progenies in a randomised block design. Other material containing only 25% dumpy genes shows better than average wilt resistance. The dumpy is likely to find a place in the vascular wilt resistance breeding programme.

Although the pure inbred dumpy was not a success dumpy genes are found in the pisifera parents used for seed production by at least two organisations in Malaysia and one in Indonesia where RISPA distribute a strain described as Dumpy D x P.

The dumpy is a BPRO derived from a single palm but it should not be allowed to disappear.

Chemara (Guthrie Corporation)

In 1931 legitimate Serdang Avenue progenies were planted in rows on Elaeis estate and later 430 palms were recorded individually. Seed from Sumatra had been used to plant on Ulu Remis and from June 1934 several thousand palms were recorded. Those which failed to yield 200 kg per year for three years were discarded. Some 400 palms were recorded for longer periods.

Genetic blocks I and III were planted in unreplicated progeny rows from Sept. 35 to April 1939 and Genetic blocks IV and V were planted from Nov. 1939 to April 1941. In total these contained 338 progenies from 175 parents and a total of over 20,000 palms. Despite the war six years yield records were available from all those palms by the end of 1954. As a contribution towards increasing the yield of bunches this was a magnificent contribution.

Bunch analysis did not start until Nov. 1937 and by October 1939 bunch analysis data (6 bunches per palm) was only available for 62 palms. By this time the crosses with which to plant Genetic blocks I - V had already been made. A genetic block designed to improve oil to bunch was not planted because of the war (Chemara Annual Report 1957).

Furthermore, after the war it took some time to re-organise the bunch analysis laboratory. No bunch analysis was carried out on palms in the genetic blocks until 1954. From 1954 to 1956 the fruit to bunch and mesocarp to fruit was determined for most palms but oil in mesocarp estimation only re-started in 1957. (Chemara Annual Report 1957).

Palms with high oil-to-bunch have been carried forward into later generations by chance. More rapid progress could have been made if bunch analysis had been given more attention in the early years.

Toovey (1955) reported 44.0% oil in mesocarp for Deli palms as against 47.3 to 48.8% for local Nigerian palms both gowing in Nigeria. This emphasises the importance of giving attention to oil-in-mesocarp when selecting Deli palms.

Banting (HMPB)

Oil palm breeding started at Banting when twenty of the best Chemara D x D progenies were planted at Klanang Bharu in Oct. 1957. All except one contained genes from the Serdang Avenue progenies planted on Elaeis estate. When selecting these 20 progenies preference was given to parents which produced large numbers of relatively small bunches.

Further distribution of Chemera/Banting material

The BPRO created by Chemara in 1935 to 1941 is still being developed by both Chemara and Banting. In addition it has been further distributed as follows-

- to Pamol Estate (Kluang) and to Dunlop estates in collaboration with Chemara and Banting in a project known as the "Oil Palm Genetic Laboratory"
- though the OPGL to Lobe (Cameroon) and Binga (Zaire) in small quantities
- to Dami Research Station in Papua New Guinea where 12 progenies from Banting were planted in 1968
- to Costa Rica in small numbers
- from Dami to Colombia (still in nurseries)
- to IRHO in the Ivory Coast (Gascon, Noiret and Meunier 1976)

This list is almost certainly incomplete. The Chemara BPRO must be one of the largest and most widely distributed in the world. It is now breaking up into subunits as the various research stations follow their own selection procedures.

SOCFIN

SOCFIN in Malaysia imported Deli dura planting material from Sumatra and planted it at Johore Labis in the 1930's . It is possible that at least part of the material imported consisted of legimate crosses between selected palms that were part of the Mopoli and Bangun Bandar programme being carried out by a sister company in Indonesia.

The SOCFIN Deli dura breeding programme continued after 1945 and under the combined breeding programme material was exchanged with other companies in Malaysia.

IRHO introduced SOCFIN Deli dura to the Ivory Coast in 1950/54. The original import came from six palms on Johore Labis (Gascon et al 1976).

Progeny SOC1386 (JL1133 x JL1113) has been described by Berchoux and Gascon (1965) as having a small number of large bunches.

Dabou Deli dura

The RobertMichaux plantation was planted near Dabou between 1924 and 1930 using mainly Deli dura material probably imported from SOCFINDO in Sumatra. IRHO acquired control of the 2000 ha plantation in 1946 (Bredas 1969).

Over an area of 300 ha palms were observed from 1946 to 1950 and 250 were selected as seed bearers and their progenies were tested.

A hundred crosses between the best Deli dura parents were made and planted between 1955 and 1967. It is this population which Bredas (1969) describes. The Dabou Deli dura population is still of major importance to the IRHO programme.

Genetic base of Deli dura populations

Although it is believed that all Deli dura are descendants of only four palms the population had expanded to several million before systematic breeding programmes were started.

One programme has sometimes overlapped with another but it is suggested that the following could be considered as independent breeding populations of restricted origin.

Indonesia

Gunung Bayu	)	
Pabatu Blocks 87.88	)	Adlin Lubis
Dolok Sinumbah - Tinjowah - RISPA	)	
Pabatu Block 54	)	
Marihat Baris		
Mopoli/Bangun Bandar		Belgarric 1951-
Gunung Melayu		Bah Lias An Rep 1981

Malaysia

Sedang Avenue (D of A)	Hartley 1967
Elmina (D of A)	Hartley 1967
Ulu Remis	Chemara An Rep 1954
SOCFIN - Johore Labis	-

Ivory Coast

Dabou (from 1946)	Bredas (1969)

Most of these programmes started by the observation of several thousand palms growing on plantations. Within these populations a very restricted number of palms were selected for further breeding. There has only been limited introgression between the programmes.

The programmes have progressed with varying speed. Most have now reached the F3 or F4 and in many cases direct descendants of the original selections are still available.

The same selection criteria have not been used in all programmes and there could be substantial differences between the populations. There is a lack of comparative data.

The chances of finding substantial differences between the populations may be related to the residual variations within populations which will now be considered.

Characters of an advanced generation Deli dura BPRO

The purpose of this paper is to look at the genetic case of oil palm breeding populations and not to consider what has happened subsequently.

The following notes on Trial 210 at Dami Research Station in Papua New Guinea may however help to clarify the concept of a BPRO.

In trial 210 there are 24 D x D progenies planted with a commercial D x P as a control.

The ancestry of one progeny (DM 651) is illustrated in Fig. 5. in such a way that the pathways of descent can be seen so that the inbreeding coefficient can be calculated.

The estimate of the inbreeding coefficient depends upon the values assumed for the ancestral palms. In the figure the values proposed by Hardon (1970) have been used. On this basis the inbreeding coefficient is estimated at fx = 0.29.

In several of the BPRO's to be discussed there is evidence that selfed progenies of some palms show little inbreeding depression. Sensitivity to inbreeding depression varies from palm to palm. In trial 210 10 to 20% of the progenies with an inbreeding coefficient of about 0.30 have given a higher ffb yield than the D x P control in which there is no inbreeding at all. It is possible that over the generations Deli palms more resistant to inbreeding have been unconsciously selected.

Variability in trial 210 is considerable and for most parameters there are significant differences between progeny means. The trial was designed to improve growth characters of the population and one progeny combines very high oil yield with very small fronds. There is no doubt that progress can be made.

Experiments 73/36 and 73/37 at Binga (Zaire) contain progenies from a very wide range of origins. It is of some interest to compare the coefficients of variation in the two cases:-

Coefficients of variation

Expt	No of Progenies	ffb Yield	Oil to Bunch	Bunch Index	Petiole Cross-section	Frond Area
Dami 210	24	9	3	6	10	6
Binga 73/36	36	16	10	13	10	8
73/37	36	17	9	12	9	9

The Deli population at Dami has been intensively selected for ffb yield and oil to bunch over several generations. Indirectly over several generations and directly in the last generation there has been selection for bunch index. There has been no selection for petiole cross-section nor for frond area. The Deli population is less variable than the mixed population at Binga in respect of characters for which there has been intensive selection.

Although there is still useful variability in the advanced generation Deli dura material greater variability can be found in the African material.

The Dami Deli dura BPRO has been used as an example. Other advanced generation Deli dura BPRO are probably basically similar. As already stated there is a lack of data to compare the various Deli breeding populations and there has been limited introgression between them.

The Ekona population at Lobe (Cameroon)

The selection procedure to find the foundation stock for the Ekona population was very similar to that employed for the Deli dura population and it is therefore considered next.

The oil palm is of course indigenous in Cameroon but plots were being planted as early as 1903 (Farquhar 1913). By 1913 there was a well established plantation industry in Cameroon (Wright 1958). The German owned Ikassa estate was planted at about this time probably using seed from the Ekona area of Cameroon.

From 1912 to 1916 a plot of 800 palms was established at Calabar and subsequently observed and used for breeding purposes (Hartley 1967 p 213)

Unilever planted Ndian estate from 1928 and seed was obtained from Ikassa and the Calabar plots. Selection started at Ndian before 1933 but in that year fruit analysis started. Subsequently seed was produced from controlled pollinations to plant 40 ha on Ndian 70 ha on Cowan estate in Nigeria. In addition 800 selected palms were used to produce open pollinated seed for further areas on Cowan Estate which reached over 2500 ha (Green AH 1969 and 1973)

In 1948 a large scale programme for selection, breeding and wilt resistance was started using the palms on Ndian and Cowan estates. There were some Deli dura palms on both Ndian and Cowan but their identity is known and they have been excluded from the following account.

The populations at Ndian and Cowan under observation all come from selected palms at Ikassa (some legitimate, some open pollinated). Although a few palms may have originated from Calabar the majority were from the Ekona origin. It is certain that none of the palms originated in Zaire or the Ivory Coast and the "Ekona" population can be regarded as a separate BPRO mainly descended from wild palms in the Ekona area of Cameroon. The evolution of the Ekona programme is illustrated in figure 6.

When selection started in 1949 yield records were available from 35,000 palms growing under plantation conditions on Cowan and Ndian. It is this feature which makes them similar to the basic populations of Deli palms which have been described above.

Bunch analysis were carried out on high yielding palms and selection was primarily on the percentage oil to bunch. By 1951 the number of selected palms was reduced to 24 tenera and 18 dura details of which are given by Green (1973). By the end of 1951 a programme was planned using 19 tenera, 6 dura and 2 fertile pisifera. The programme started by producing crosses and then changed to self pollinations. From this programme 18 crosses and 5 selfs were planted on Lobe estate (Cameroon) in 1954/55 and a further 17 tenera and 5 dura selfs in 1957.

A point of interest is that 27 selfed F1 progenies gave ffb yields which ranged from well above the mean of the crosses to very low levels. Some of the parent palms were evidently rather resistant to inbreeding. As shown in Fig. 6. Selections in three F1 selfs have again been selfed and the F2 selfs are still yielding reasonably well.

Selections were made in the 1954/57 plantings and the next generation was planted at Lobe from 1966 to 1971. Data relating to pure Ekona progenies are summarised in Fig. 6 which also indicates their ancestry. The progenies which combine high yield and wilt resistance (nursery test) are Lb 130 158/376, 200 and 344. These are derived from only five ancestral palms. Palm 2/2311T transmits good ffb yield, very high oil to bunch and resistance to vascular wilt.

Progeny Lb 130 was included in the Sabah Breeding programme as TT 505. It gave the second highest yield of oil of the 17 progenies in the trial. As Bg 89N it gave the third highest oil yield of 16 progenies in Expt 70/09 and showed extreme resistance to vascular wilt in the field (1% loss against a trial mean of 18%). It also gave very high oil yields at Coto in Costa Rica as progeny CAM 236. Thus, a pure Ekona progeny has given yields equal to some of the best Deli x pisifera material.

This Ekona BPRO has been described in some detail because it may have an important role in the future of oil palm breeding.

The Yangambi population at Binga

History of Yangambi:

Beirnhaert (1933) described the early work at Yangambi in considerable detail. The following notes are based on Vanderweyen (1952) and Hartley (1967).

Ringoet introduced open pollinated progenies from selected palms in various parts of Zaire to Yangambi from 1922 to 1927. He restricted his choice to palms with a thin shell and a high percentage of mesocarp. The progenies were planted at high density to reduce the area required and subsequently thinned by cutting out dura and poor tenera.

The most notable introduction was from a palm in the botanic garden at Eala. This palm became known as "Djongo" (the best). Other introductions were from Yawenda, N'gazi and Isangi which are in the Yangambi area.

Beirnhaert studied those introductions and crosses between them were planted in late 1933 and 1934. One palm, with a short trunk (16R), was self pollinated but this was exceptional.

Seed from the Djongo palm at Eala was sent direct to Sungei Panchur in Indonesia and one of the surviving palms is SP 540 which will be discussed later.

Seed was also sent from Yangambi to Sumatra but the exact percentage is no longer known. Seed of known percentage went to the Ivory Coast where it has been developed as a breeding population. Seed from this BPRO also went to Sumatra as "Pisifera Yangambi" (Fig. 7).

Other seed from Yangambi was distributed to many reasearch stations world wide and Pisifera pollen from Yangambi went to Chemara at Layang Layang in 1947 and was crossed onto Deli dura and planted in Ulu Remis Genetic Block VI in 1949.

Unfortunately work at Yangambi was interrupted by political events and has not been resumed except on a small scale. Fortunately a large collection of Yangambi material has survivied at Binga.

History at Binga

Vanderweyen (1952) shows that Binga was a centre for prospection, a "centre d'acclimatement" and also a centre for seed production. This Yangambi substation is located on Binga plantation owned by "Societe de culture au Zaire" (SCZ). In 1968 a joint research scheme was started at Binga betwen SCZ and "Plantation Lever au Zaire (PLZ)". The "JRS" is still very active at Binga.

The "bloc d'acclimatement" at Binga was planted between 1950 and 1953. It included 33 progenies as listed by Guldentops (1979). Ten of those F2 progenies were used to produce seed for the F3 progenies. In addition pollen from three progenies at Yangambi were included in the crossing programme. Some of the F2 palms still survive.

Fig. 8 shows the lineage of 13 progenies selections in which were used to create the F3 generation. Hartley (1967) listed 21 Yangambi selections which were stated in 1941 to be among the best. Eight of these are in the ancestry of the Binga F3 as shown in Fig. 8.

The F3 generation was planted mainly in 1973/74 but a few progenies were planted as late as 1978. The number of F3 progenies descended from each of the F2 progenies is indicated at the bottom of Fig. 8. Most are crosses but there are a few selfs. The total number of pure Yangambi F3 progenies is about 50. There were 72 planting points per progeny and there are about 3000 surviving F3 palms (in 1984).

The study of the F3 progenies is not yet complete but already two parental palms of exceptional interest have been identified.

Palm Ybi 69 MAB is tested in 14 progenies and 13 of these have a wilt status better than the trial mean with 7 being significantly better. Yield and bunch data from 11 progenies are available. The mean oil yield of these is 14% better than control. This palm transmits a very high degree of resistance to wilt and a very good oil yield to its progenies.

The other parent palm of exceptional interest is Bg 312/3 which was a selection in progeny BGY3 (1342A x 2379D). The self of this palm is progeny Bg 143. This progeny is planted in an inbreeding experiment (73/40) in which the inbreeding coefficient varies from 0 to 0.75. The inbreeding coefficient of progeny 143 is estimated to be 0.56 but it has given the highest yield of oil of any progeny in the trial and also only 3.5% wilt losses against a trial mean of 30.2%. Palm 312/3 is resistant to inbreeding, and transmits high oil yields and wilt resistance.

A recognised defect of Yangambi material is its excessive vigour. The study of growth data of the 50 pure Yangambi progenies is not yet complete but it is already clear that there is considerable variation between and within the progenies and it should be possible to make progress in this direction in the next generation.

The average oil to bunch figures for pure Yangambi material is rather disappointing. Again there are exceptions but the highest oil to bunch figures are found in other origins.

It is planned to carry the Yangambi BPRO into another generation.

Yangambi populations elsewhere.

IRHO recieved pure Yangambi material and planted it in the International Experiment in about 1950. This line has been developed at La Mé but currently limited use is being made of the pisifera because they transmit excess vigour.

- IRHO distributed pure Yangambi material to Marihat (Fig 7) and also to IFA in Colombia (Fig. 8) where it was planted at El Mira in 1977.
- Pure Yangambi material was planted at NIFOR in 1959 (and perhaps on other occasions). Yangambi material reached Lobe both via NIFOR and via Yaligimba.
- The above list is probably incomplete. It is certain that the Yangambi BPRO is very widely distributed. The population descended from the 15 ancestral palms is large and widely dispersed.

Djongo and SP 540

[illegible]ala is a suburb of Mbandaka which is a town on the south bank of the river Zaire about half way between Kishasa and Kisangani. Before 1920 a botanic garden was planted at Eala. It was here that Ringoet selected the palm now known as Djongo (the best).

The manager of Boteka oil palm estate which is not far from Eala assured me in 1981 that there are still palms in the botanic garden at Eala but he did not know if the Djongo palm was still alive.

Open pollinated seed from the Djongo palm was distributed to at least three places:-

- to Yangambi by Ringoet (Vanderweyen 1952 and Hartley 1967)
- to Sungei Panchur in Indonesia by the Director of the Botanic Garden to APA, later AVROS and now RISPA or BPPM
- to Palmira (Colombia) in 1931 by Dr F Class, director of the Botanic Garden Brussels and in 1936 by Dr M Riveso (Breure 1983). In 1945 Dr M Patino planted T x T crosses at Calima where the BPRO probably survives.

At Sungei Panchur the famous SP 540 still survives. It was self pollinated to produce progeny Pol 820 which was planted at Polonia (Medan) in 1931. As shown in Fig. 9 this progeny was introgressed with a fertile pisifera from Bangun (Bogor Rejo) which was the descendant of an earlier importation from Africa.

The more important programmes within this BPRO are shown in the Fig 9 but this is incomplete.

In 1957 a T x P cross was planted at Banting and in 1968 sib crosses within the progeny were planted at Dami (PNG) (Breure et al 1982).

In 1973 RISPA repeated the selfing of SP540 (Progeny Ap 73/1391) and produced another generation of three progenies all of which were planted at Aek Panchur in 1973. Excess vigour is a defect of this BPRO but there are variations in the bunch Index of palms in the 1973 planting and selection of palms with better growth characters is in progress. A crossing programme has started.

Currently pisifera from this BPRO are being used for seed production by Marihat and RISPA in Indonesia by Bantang in Malaysia and by Dami in PNG.

Although excellent as a parent this BPRO gives comparatively low yields of bunches. The repeat self of SP 540 (AP73/1391) is particularly low yielding and suffers from inbreeding depression. There is much variation between individual palms in the SP 540 selfed progeny and it should be possible to find palms that are high yielding but with good growth characters.

This BPRO is likely to be important for many more years.

Origins from the IRHO programme

The IRHO assembled a very extensive collection of breeding populations in their International Experiment which was planted from 1950 to 1953 (Gascon et al 1976). The main collaborators were INEAC (Zaire), SOCFIN (Malaysia) and the IRHO stations at La M'e (Ivory Coast), Dobe (Dahomey) and Sibiti (Congo). Numerous papers have been published to give the results of the experiment and these are listed in Oil Palm Research (pp 124 - 125). On page 115 a list of "origins" recognised by IRHO is given. Several of these origins have already been considered.

A number of origins have been originated by the IRHO and some of these have been distributed to various countries. The following notes merely mention the existance of the BPRO's but give very limited detail.

La Mē

The La Mē population developed from 21 tenera mainly on Bret Plantation (especially from Bret. 10) which had been planted with seed from wild palms in the Ivory Coast.

A well known palm in this population is L2T whose selfed progenies have produced some outstanding pisifera. It is also the parent of the cross L2T x D10D described by Berchoux and Gascon (1965) and which has been planted in many countries.

The La Mē population has been distributed to many countries including Indonesia and Malaysia. It transmits good yield on palms with relatively short trunks.

Pobe

This population is derived from 14 tenera in Dahomey.

New populations: Yacoboue and Angola

Populations are being developed from two new origins. Meunier (1969) describes a prospection of wild palms in the Ivory Coast which resulted in the selection of 19 tenera at Yocoboue as the foundation for a new breeding population.

In 1970 a population derived from 14 tenera palms in Angola was planted and is being developed.

Dabou Deli dura

The Dabou Deli dura population which was developed by IRHO has already been discussed.

NIFOR Populations

The NIFOR breeding programme did not specifically attempt to keep base populations separate according to geographic origin (Hardon 1976 p. 18)

A number of origins are however recognised including Aba, Calabar, Ufuma and Benin in Nigeria. Two populations originating from Calabar are of interest.

Calabar 256D (see Hartley 1967 p 214)

The self of Calabar 256 was high yielding. A selection in the self was NF 3.417 which was again selfed to produce progeny Lb 051 which also yielded well. But other progenies derived from CA 256 do not appear interesting and have low oil/bunch.

Calabar D X P

Sparnaaij et al 1963 p 135 describe the Calabar plot planted in 1911 - 16 and the D x P crosses used to study shell inheritance and planted at NIFOR from 1952 to 1954. Selections from this D x P population include NF 5.1654, NF 6.594, NF 32.364, NF 32.2612 and NF 32.3005 which are of interest for the following reasons.

IRHO use some pisifera in the following crosses

NF 5.1654 x NF 32.364 = WA3
NE 6.594 x FF 32.364 = WA9

and this population has been introduced to Indonesia (Fig. 10) to be used for seed production.

In Sabah breeding programme some Deli x NF 32.3005 progenies did well at Banting and gave very high oil to bunch figures. One progeny gave the highest oil yield in the trial.

At Lobe the self of NF 32.368 is Lb 370 and the self of NF 32.3005 is available at Ulu Dusun and Banting as TT 409.

There is no BPRO but one could be created by crossing Lb 370 and TT 409. There is evidence that palms from such a BPRO would combine well with Deli dura.

The above account may not do justice to the work done at NIFOR but there is a shortage of information.

Minor BPRO's at Bing

These are some minorat Binga which may be of interest in the future.

Mayumbe - Nine crom this origin were planted in the "bloc d' acclimatement" follospection by INEAC between the mouth of the Zaire river and the Congo-le border. These palms are small. They were not used in the Binga breedinmme.

Brabanta - A plaat Brabanta (Near Illebo in the Kasa district of Zaire) was planted wlings from local wild palms. A number were selected and their legitimatees planted at Yaligimba. There are ten progenies of a second generation. Bunch yields are good but oil to bunch poor and there is not as muchnce to wilt as had been expected.

Pindi - The deve of this population is the same as the Brabanta population but origi Pindi plantation near Kikwit about 400 km east of Kin Shasa. There arenies at Binga.

Mongala - Binga isMongala river and a nearby district is Mongana. Part of Binga was planteded from wild palms in Mongana. A few were selected for inclusion in theprogramme. Palm 1080 Bi was an exceptional parent (now dead). There ise pure Mongana progeny (Lb 142) the bunch yield is average, it is wilt t but the progeny mean oil to bunch (tenera palms) is an outstanding 2eved by a very thick mesocarp and a very high oil content in the meshe fruit to bunch figure is little better than average.

Minor BPRO at Lobe

Bamenda - Blaak pd in the Bamenda highlands of Cameroon where the populations were of1 and rather isolated. About 25 open pollinated progenies (10 palms re planted at Lobe and records are available . The palms are low yield poor oil to bunch but they are very small and compact.

Discussion

The paper shows thate many "Breeding populations of restricted origin". Evidently these popuwill be introgressed to produce seed and to generate ortets.

Is it desirable thatO's should be improved generation after generation to conserve the purhe population? Or may it be sufficient to conserve the base population ervation" methods such as the retention of a few seed at random from crosses as possible? Perhaps both approaches are required.

Justification for cov improving a BPRO could include:

- the conservatgroups of genes or recessive genes transmitting special charach as disease resistance
- the greater c successful introgression if the populations to be crossed have hoved

If it is accepted that each BPRO should be further developed without introgression how big should each generation be? How many parents are required from each generation, what should the crossing programmes be and how many palms are required in each progeny?

Some of the BPRO's are very large indeed and some are spread over two or three countries. Would resources be more effectively used if the size of the big BPRO's was reduced and the resources released used to increase work on the small BPRO's?

Some of the small BPRO's are speculative and of limited immediate interest to the "commercial" research stations. In the longer term the small BPRO's are of vital importance. Would it be desirable and possible to organise some form of international collaboration to ensure that the small BPRO's are given sufficient attention?

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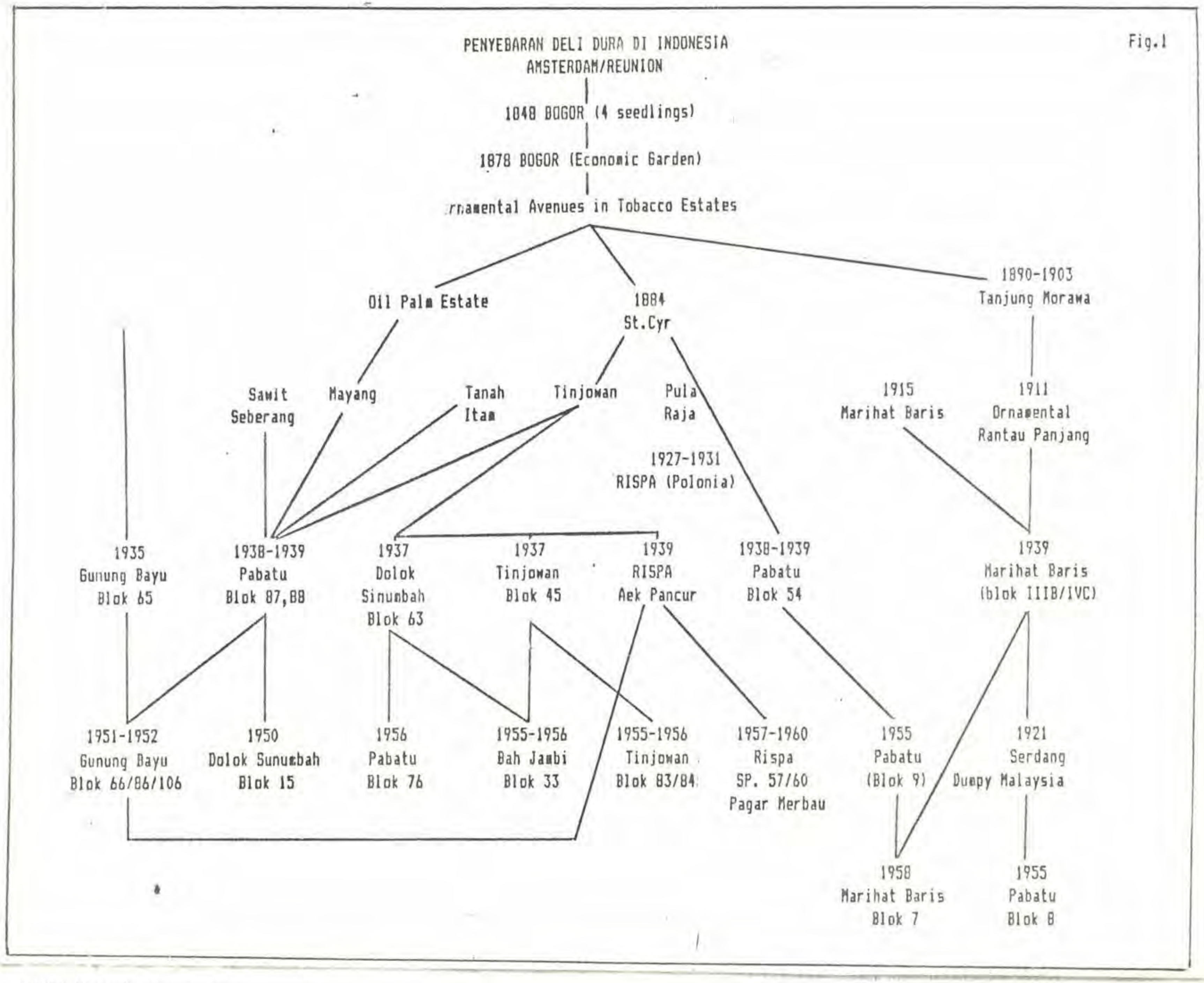


Fig.1

PENYEBARAN DELI DURA DI INDONESIA
AMSTERDAM/REUNION
1848 BOGOR (4 seedlings)
1878 BOGOR (Economic Garden)
rnamental Avenues in Tobacco Estates
Oil Palm Estate
1884
St.Cyr
1890-1903
Tanjung Morawa
Sawit
Seberang
Mayang
Tanah
Itam
Tinjowan
Pula
Raja
1915
Marihat Baris
1911
Ornamental
Rantau Panjang
1927-1931
RISPA (Polonia)
1935
Gunung Bayu
Blok 65
1938-1939
Pabatu
Blok 87,88
1937
Dolok
Sinumbah
Blok 63
1937
Tinjowan
Blok 45
1939
RISPA
Aek Pancur
1938-1939
Pabatu
Blok 54
1939
Marihat Baris
(blok IIIB/IVC)
1951-1952
Gunung Bayu
Blok 66/86/106
1950
Dolok Sunumbah
Blok 15
1956
Pabatu
Blok 76
1955-1956
Bah Jambi
Blok 33
1955-1956
Tinjowan
Blok 83/84
1957-1960
Rispa
SP. 57/60
Pagar Merbau
1955
Pabatu
(Blok 9)
1921
Serdang
Dumpy Malaysia
1958
Marihat Baris
Blok 7
1955
Pabatu
Blok 8

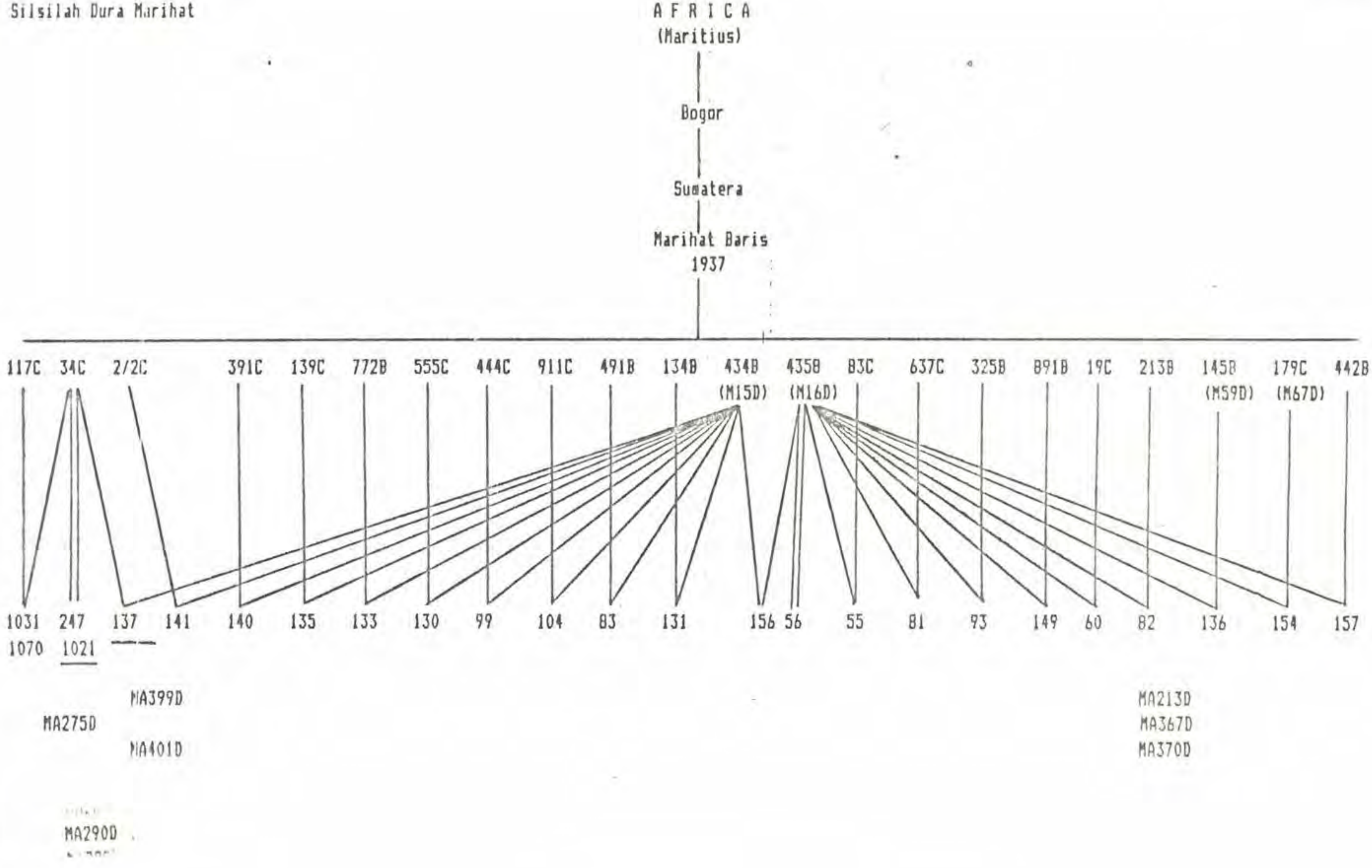
1938

M[illegible]ihat Baris Pabatu
Blok 7 Blok 8

SILSILAH POKOK INDUK DURA

Fig. 2

Silsilah Dura Marihat



SILSILAH DURA DOLOK SINUMBAH

Fig. 3

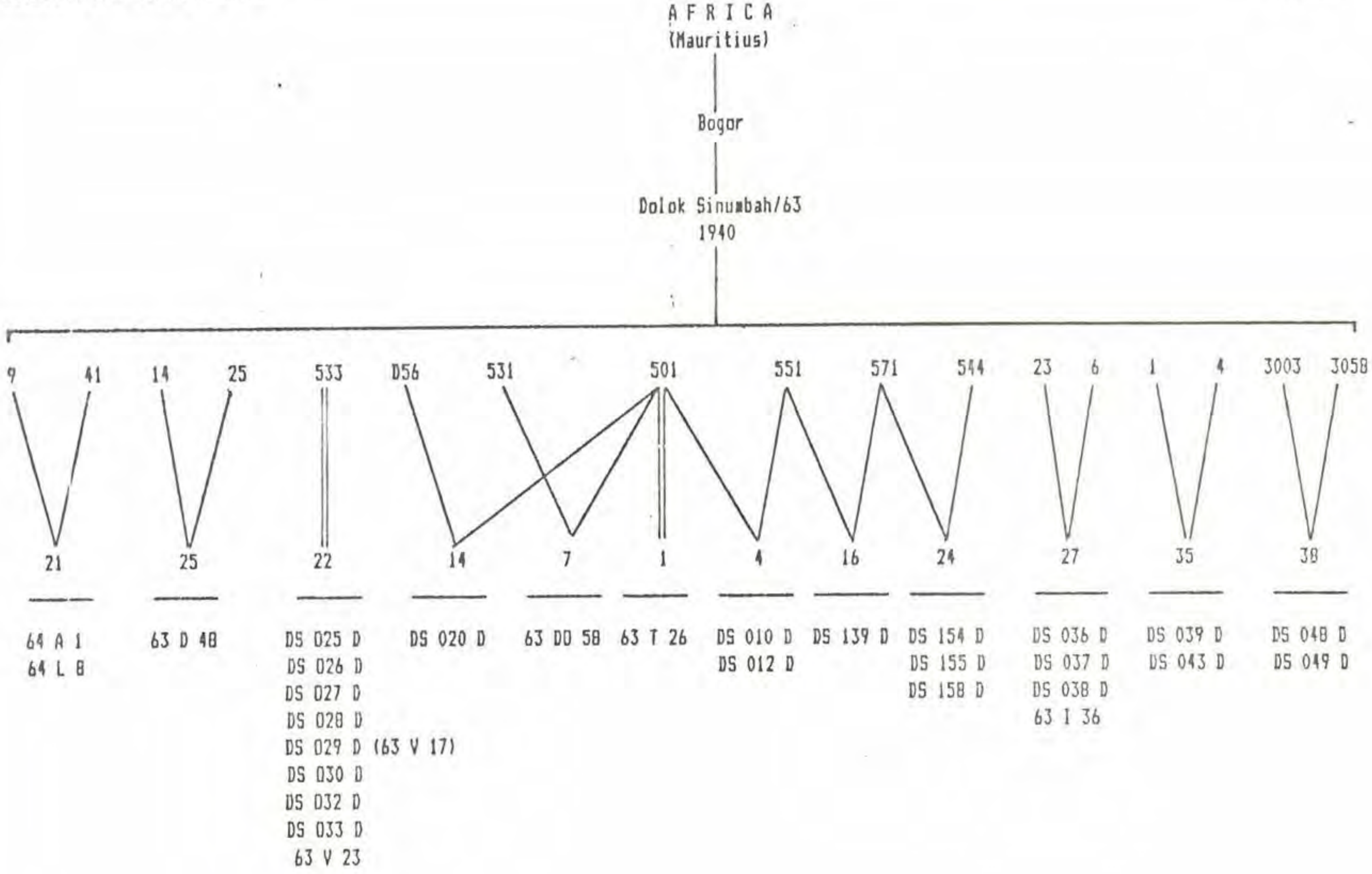
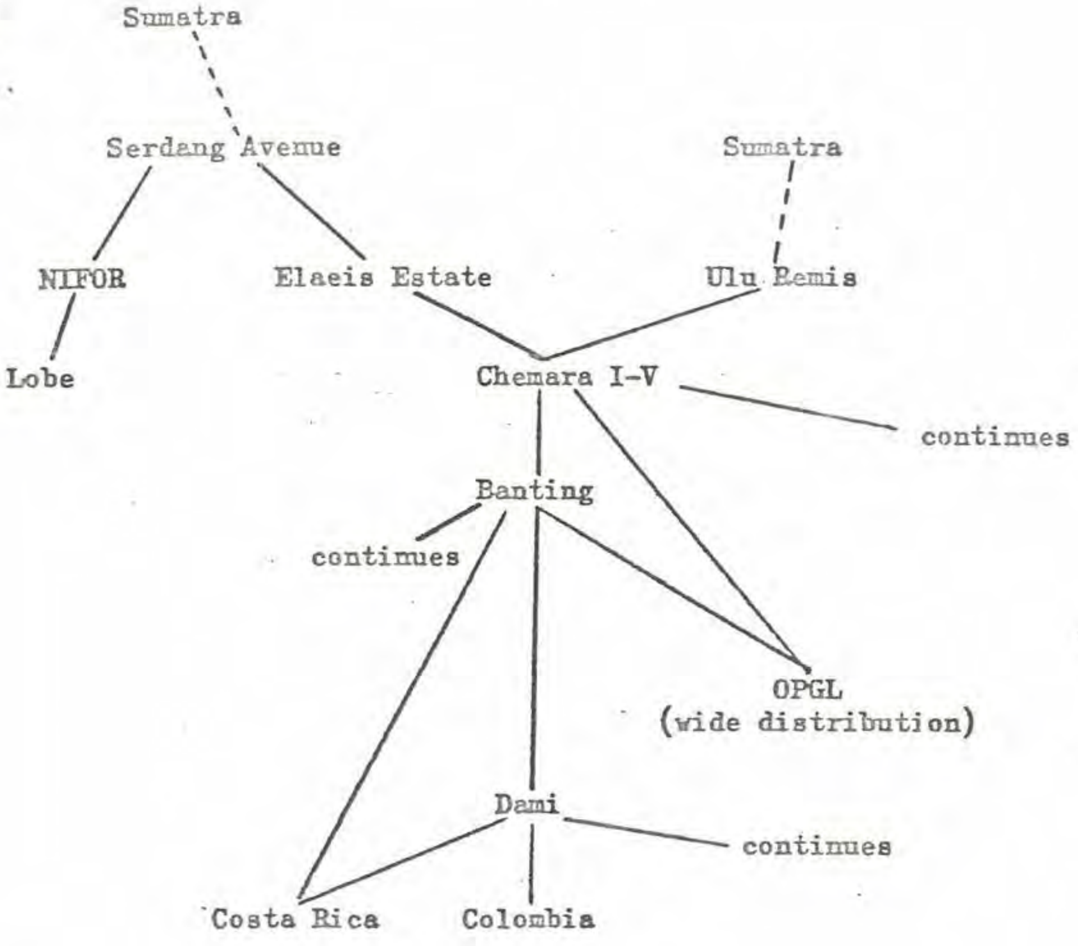


FIG. 4

Deli dura populations of Malaysia

I

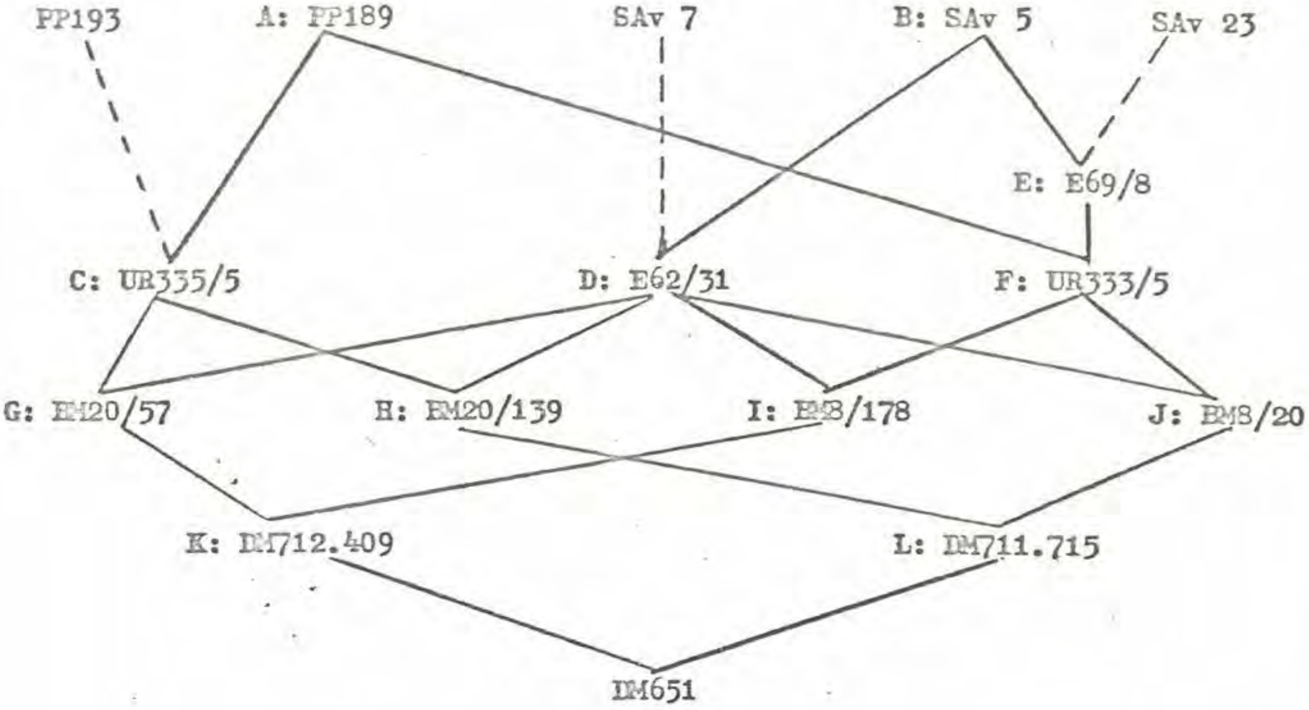


II Sumatra - Elmina - Serdang - E268. E211 etc
wide distribution
E206 Dumpy

wide distribution

III Sumatra - Johore Labis - wide distribution.

FIG. 5



Pathway (common ancestor underlined)	No in path (n)	F_A of ancestor (from Hardon 1970)	Contribution to F_X $0.5^n(1+F_A)$
KGCAFJL	7	A 0.305	0.0102
KGCHL	5	C 0.305	0.0408
KGDHL	5	D 0.381	0.0432
KGDJL	5	D 0.381	0.0432
KGDBEFJL	8	B 0.305	0.0051
KIFJL	5	F 0.219	0.0381
KIDJL	5	D 0.381	0.0432
KIDBEFJL	8	B 0.305	0.0051
KIDHL	5	D 0.381	0.0432
KIFACHL	7	A 0.305	0.0102
KIFEBDHL	8	B 0.305	0.0051
KIFEBDJL	8	B 0.305	0.0051
		TOTAL F_X	0.2925

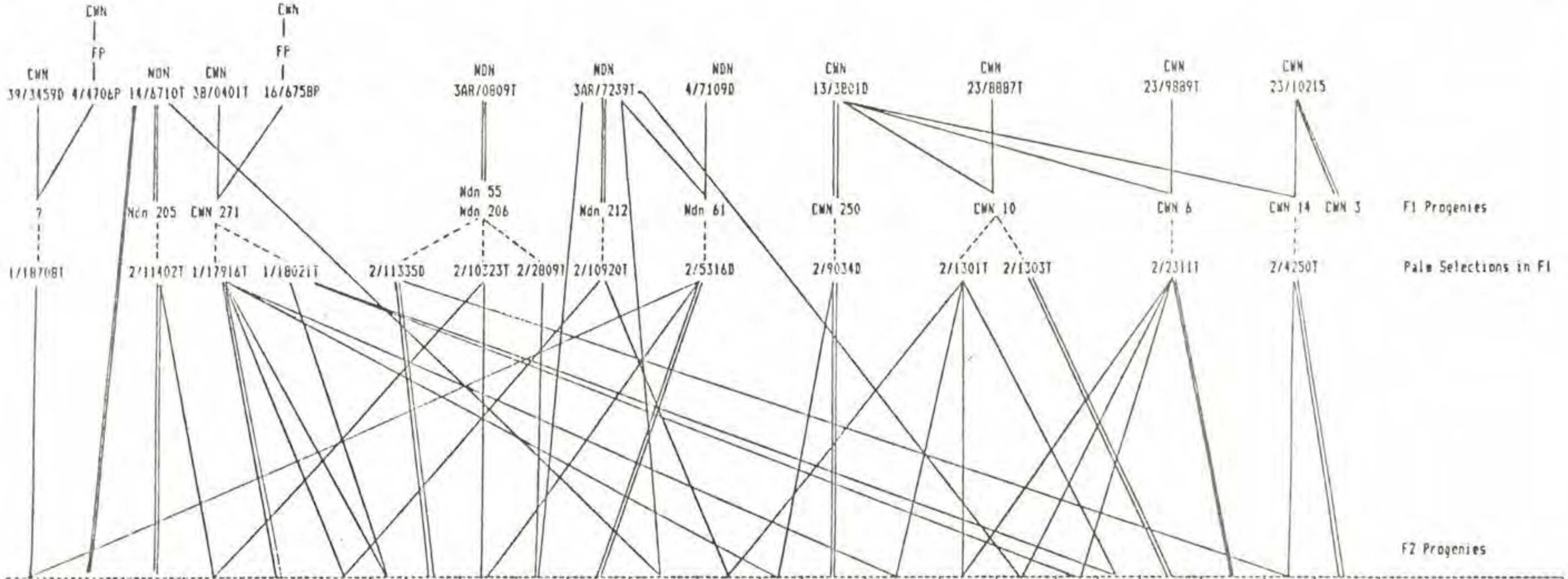
FIG. 5

SAY 23

J: 8/20

PURE EKONA PROGENIES AT LOBE

Fig. 6



397	133	361	381	368	251	335	373	312	200	359	129
TD	TT	TT	TT	TT	TT	TT	DD	DT	TT	DD	TT
24	10	24	19	3	14	18	58	15	17	64	14
24	16	27	31	9	30	26	0	70	23	0	32
8	11	15	9	3	16	12	0	0	17	0	13
	F1 Self	F2 Self		F1 Self		Sib	F1 Self			F1 Self	
120	87	87	91	90	111	90	114	96	113	102	98

256	322	149/374	258/336	344	130	253	257	375	158/376	354	367	Lb
TT	TD	DD	TT	TT	TT	TT	TT	TT	TT	DT	TT	
14	24	34 34	17 12	13	17	14	19	16	16 11	35	15	D
28	23	0 0	25 29	36	28	31	23	29	38 24	24	32	T Segregation
14	0	0 0	14 16	6	12	10	14	13	11* 8	0	12	P
		F2 Self		172 sib				F1 Self	F1 Self		F1 Self	
110	109	72 84	115 121	112	122	99	109	100	148 175	117	131	FFB % trial mean

LAN 243

LAN 250

Sabah
TT 505

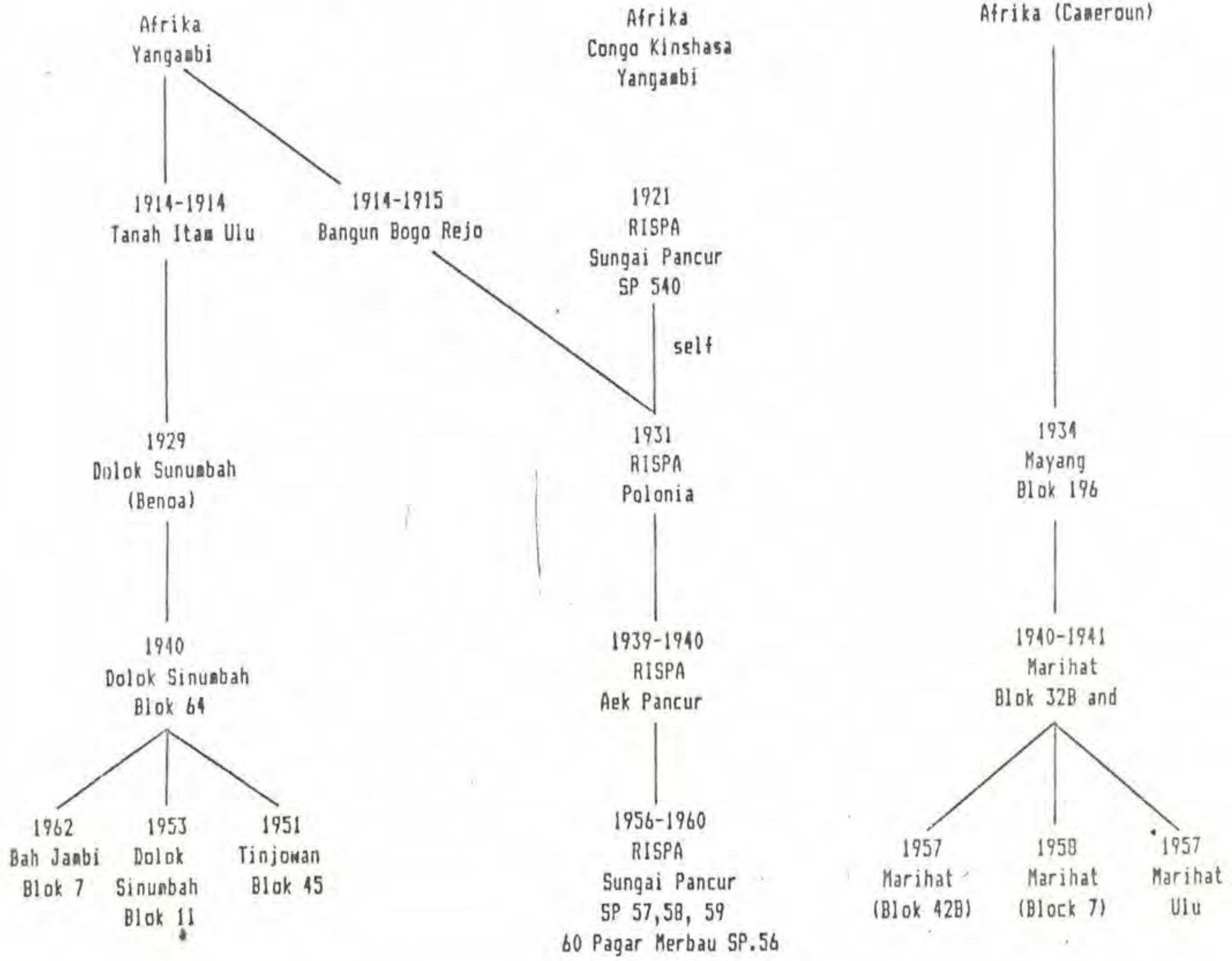
N.B. Bg BGN = 1/17916 x 3AR/7239
Bg B6N = 2/2311 x 2/9034

No 13/3801 => All ex
genes 13/3801

Eric Rosenquist
June 1984

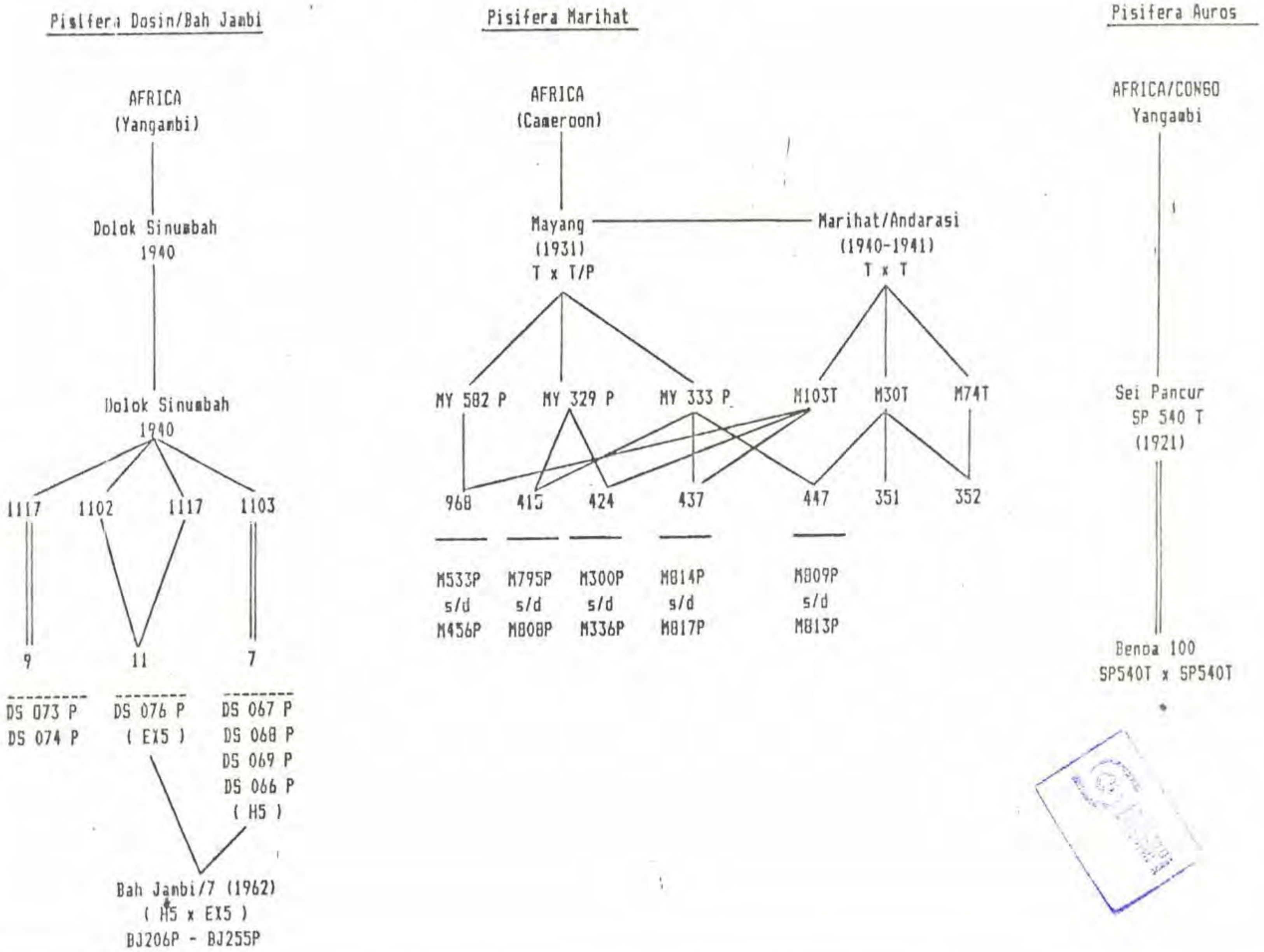
PENYEBARAN TENERA DAN PISIFERA INDONESIA

Fig. 7a



SILSILH POKOK BAPAK PISIFERA

Fig. 7b



ASCENDANCE OF THE BINGA AND YANGAMBI POPULATIONS

Fig.8

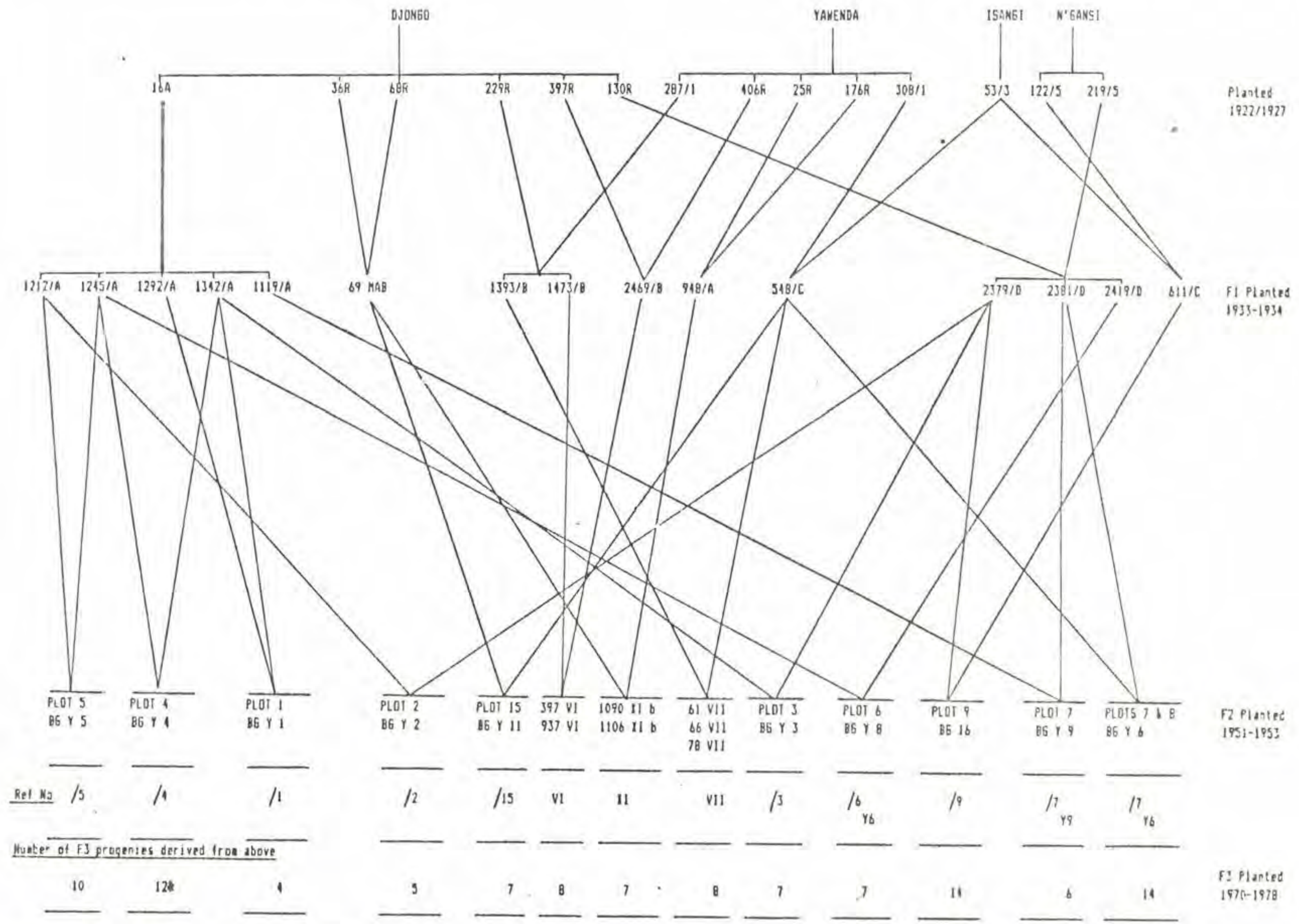


Fig. 9

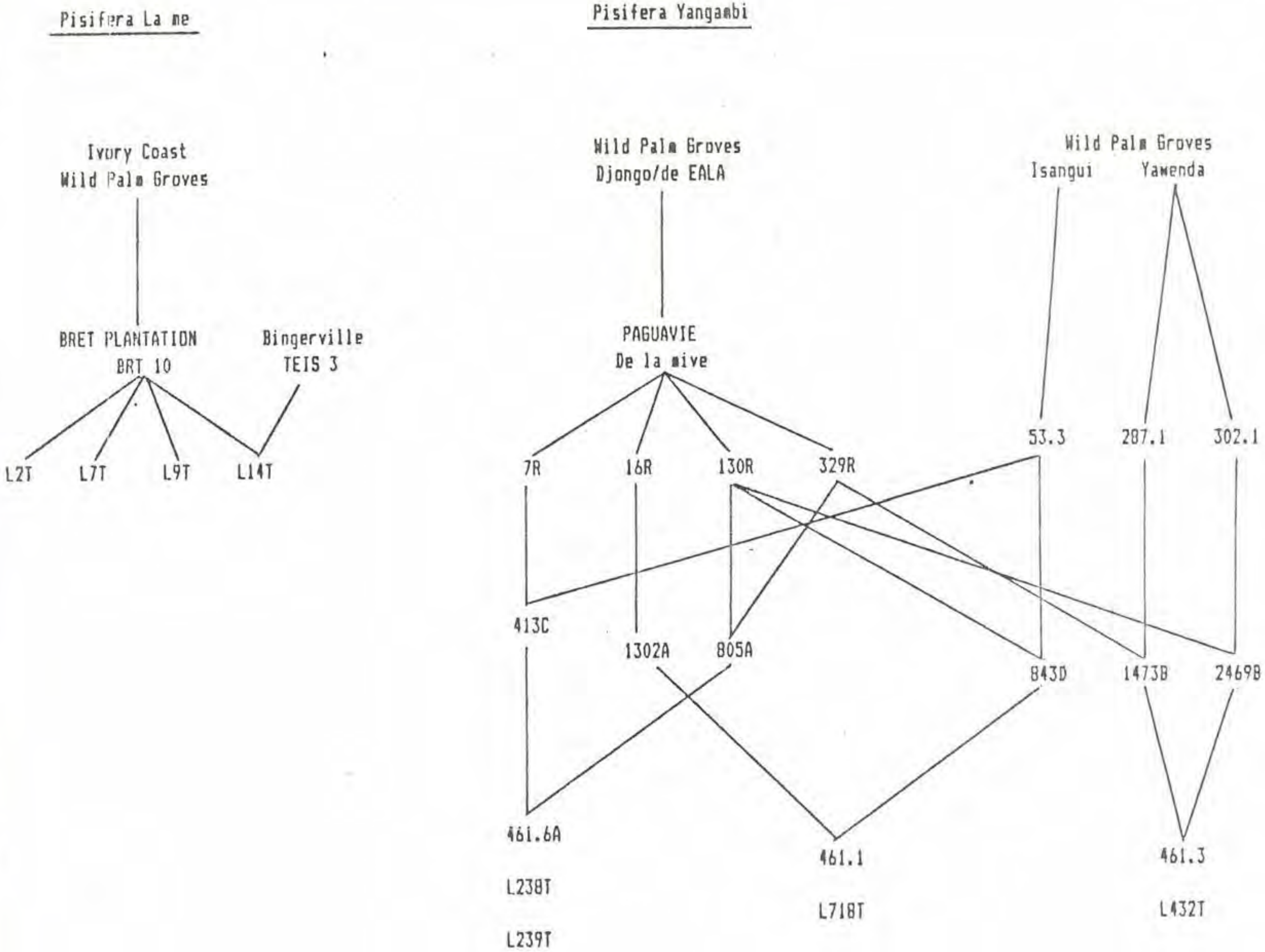
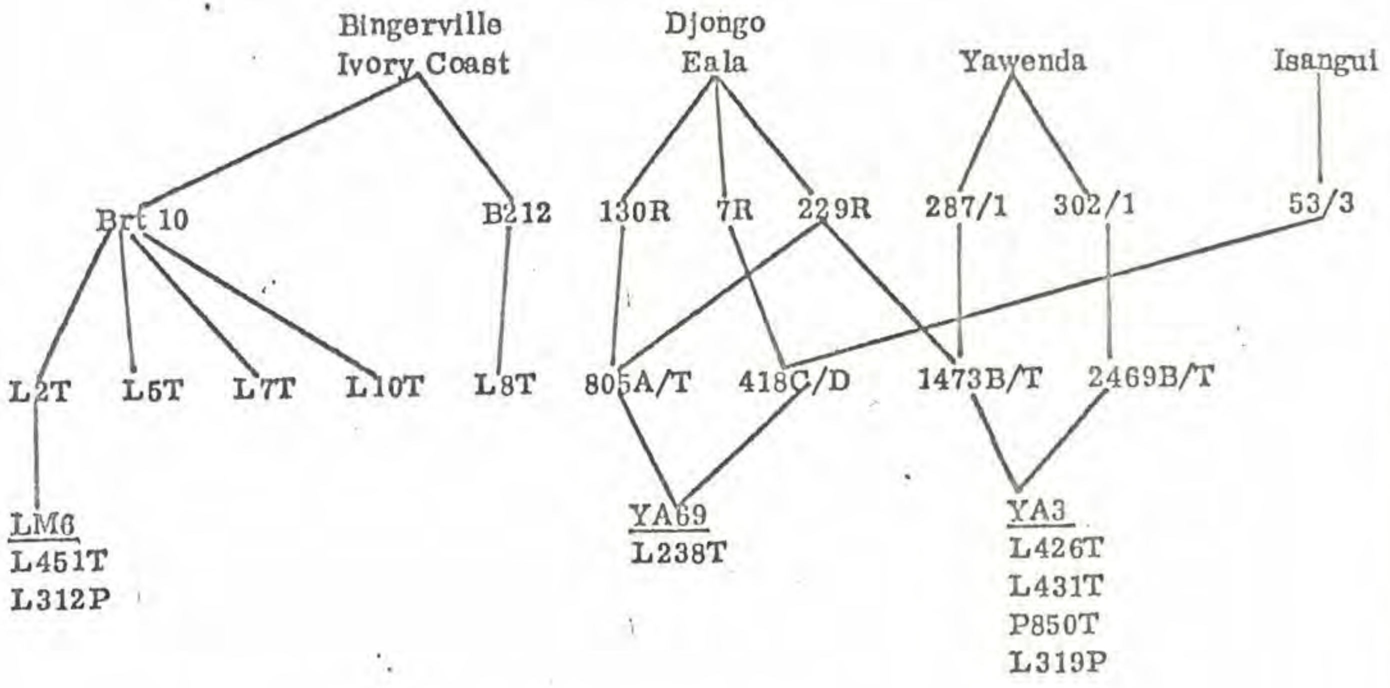

Pisifera La me
Ivory Coast
Wild Palm Groves
BRET PLANTATION
BRT 10
Bingerville
TEIS 3
L2T
L7T
L9T
L14T
Pisifera Yangambi
Wild Palm Groves
Djongo/de EALA
PAGUAVIE
De la mive
7R
16R
130R
329R
Wild Palm Groves
Isangui
Yawenda
53.3
287.1
302.1
413C
1302A
805A
843D
1473B
2469B
461.6A
L238T
L239T
461.1
L718T
461.3
L432T

FIG. 10

THE ANCESTRY OF THE YANGAMBI MATERIAL



Crosses were planted at El Mira in February 1977.

FIG. 11

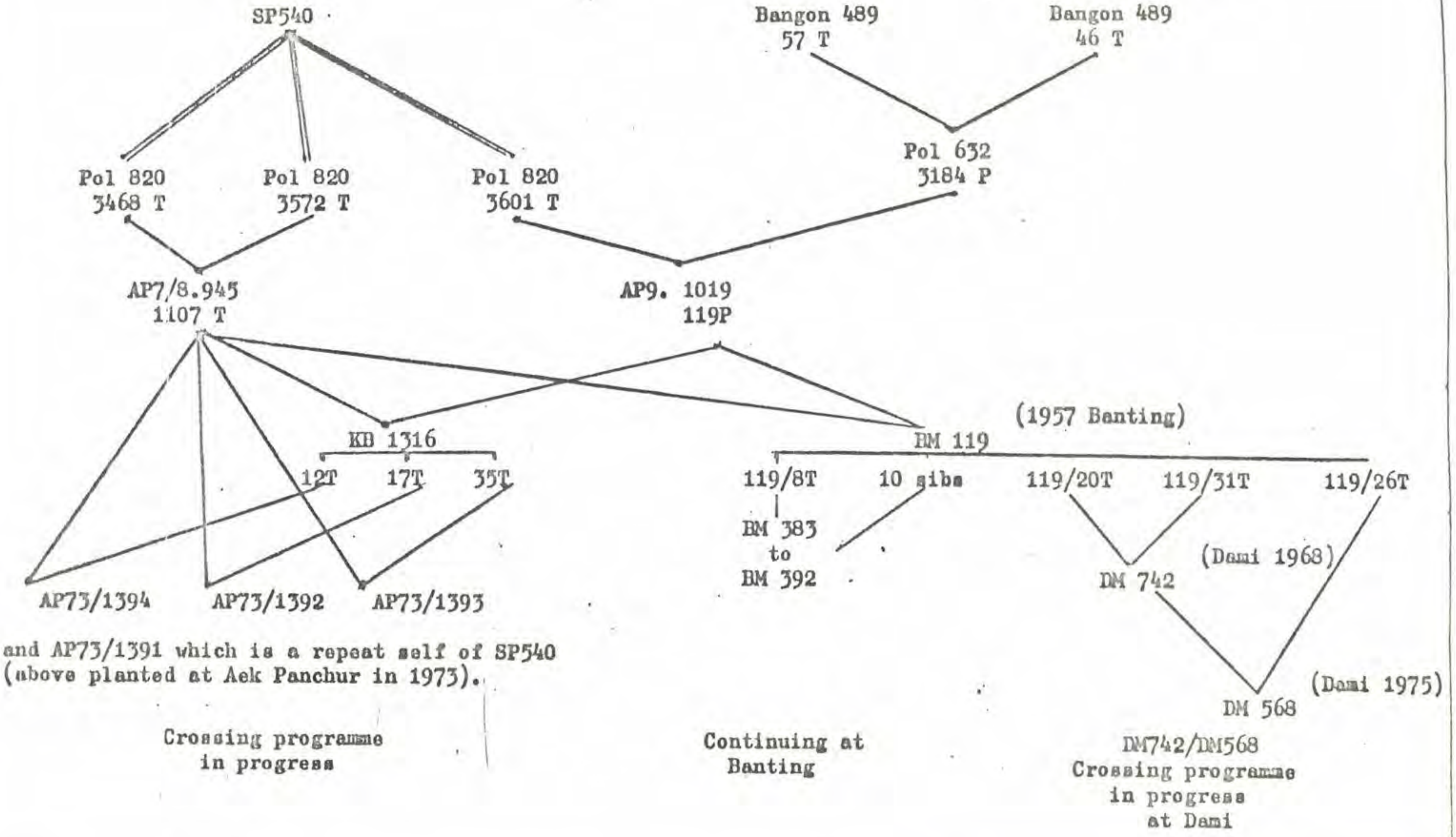
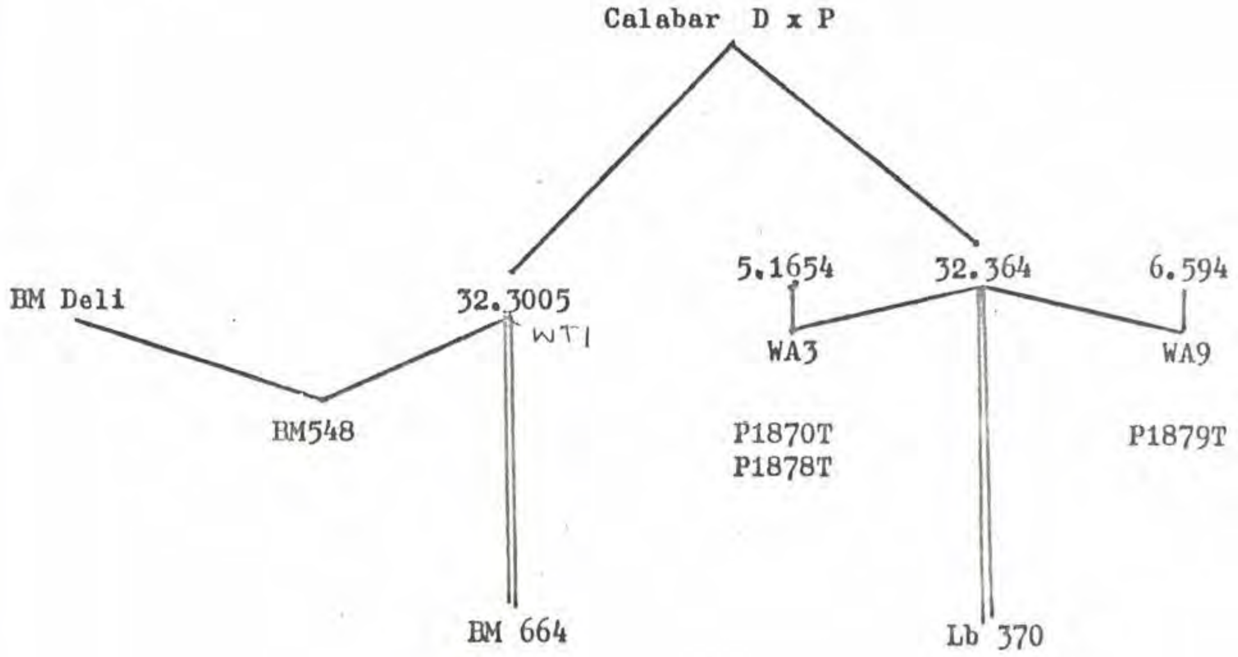

SP540
Bangon 489
57 T
Bangon 489
46 T
Pol 820
3468 T
Pol 820
3572 T
Pol 820
3601 T
Pol 632
3184 P
AP7/8.945
1107 T
AP9. 1019
119P
KB 1316
12T
17T
35T
BM 119
(1957 Banting)
119/8T
10 sibs
119/20T
119/31T
119/26T
BM 383
to
BM 392
DM 742
(Dami 1968)
DM 568
(Dami 1975)
AP73/1394
AP73/1392
AP73/1393
and AP73/1391 which is a repeat self of SP540
(above planted at Aek Panchur in 1973).
Crossing programme
in progress
Continuing at
Banting
DM742/DM568
Crossing programme
in progress
at Dami

FIG. 12


Calabar D x P
BM Deli
32.3005
WT1
5.1654
32.364
6.594
WA3
WA9
BM548
P1870T
P1878T
P1879T
BM 664
Lb 370

SLIDE A

Breeding Populations of Restricted Origin within Deli dura

Indonesia

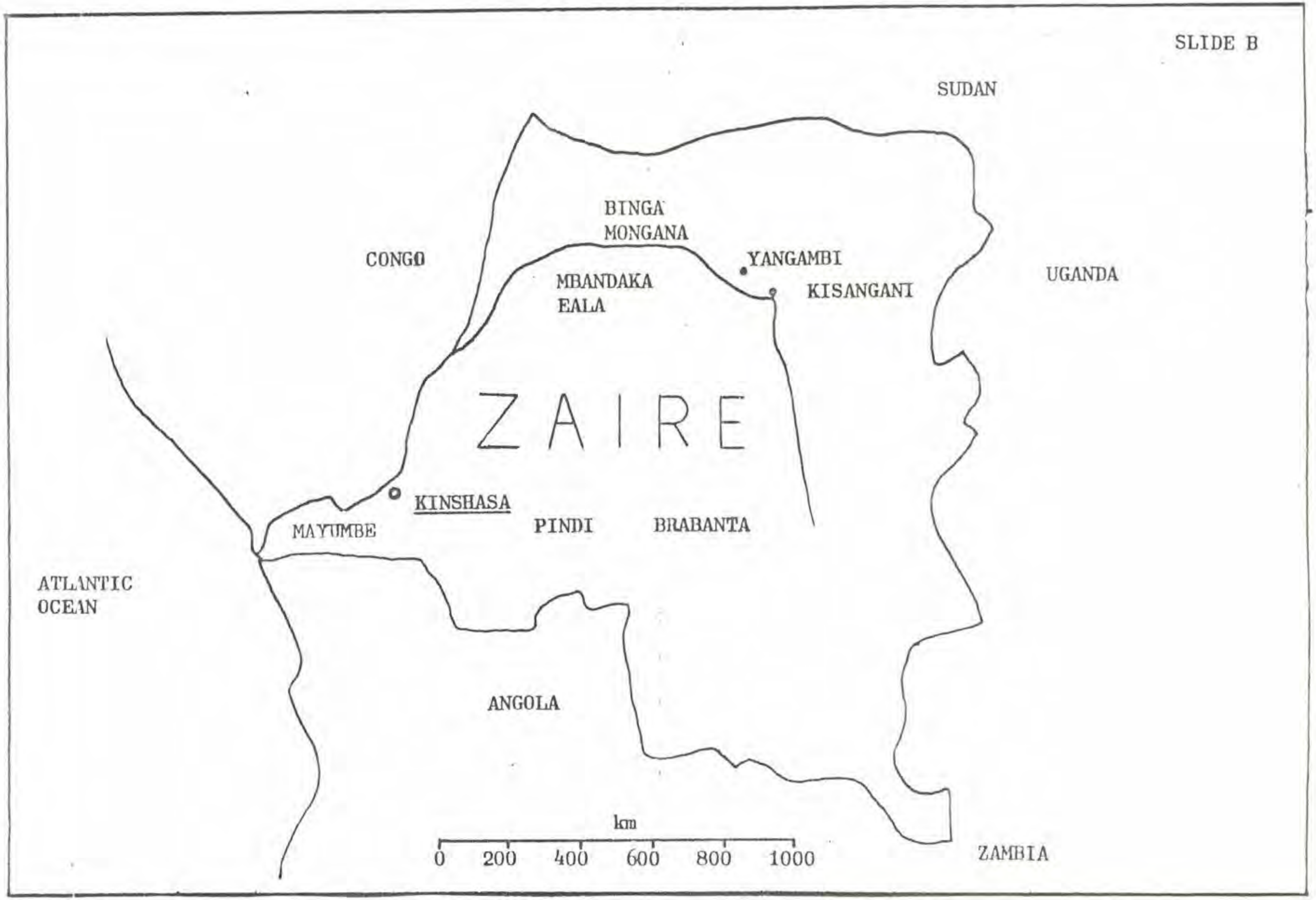
Gunung Bayu	Adlin Lubis 1984
Pabatu blocks 87.88	
Dolok Sinumbah - Tinjowan - RISPA	
Pabatu block 54	
Marihat Baris	
Mopoli/Bangun Bandar	Belgarric 1951
Gunung Melayu	Bah Lias Report 1981

Malaysia

Serdang Avenue (D of A)	Hartley 1967
Elmina (D of A)	Hartley 1967
Ulu Remis-Banting-Dami	Breure et al 1982

Ivory Coast

Dabou - IRHO	Bredas 1969


SLIDE B
SUDAN
BINGA
MONGANA
CONGO
YANGAMBI
MBANDAKA
EALA
KISANGANI
UGANDA
ZAIRE
KINSHASA
MAYUMBE
PINDI
BRABANTA
ATLANTIC
OCEAN
ANGOLA
km
0
200
400
600
800
1000
ZAMBIA

SLIDE C

List and origins of planting material used in IRHO programmes

Origin		Date of introduction	Principal strains or parents of origin	Denomination in the IRHO programmes
Ivory Coast	Bingerville	1924 — 1930	21 *teneras*, Brt 10, B 212	Le Mé
	Yocoboué	1969	19 *tenera*	Yocoboué
Dahomey	Porto-Novo, Banigbé, Kouti, Adja-Ouéré	1924 — 1930	14 *tenera*	Pobé
Yangambi, Zaire (INEAC)	Palmeraie de la Rive, Djongo Yawenda, Isangui, Bamboli	1949 — 1953	7R, 16R, 36R, 37R, 68R, 130R, 229R, 455R . . .	Yangambi
Congo-Brazzaville	Palmeraie de la Rive	1935	Issue of M'Filou } 40 T } P, D	Yangambi
	Bangamba, Mazala, Mikamba Congo, Mamba II, Madoko	1954		Sibiti
Cameroons (Pamol)	Ekona, N'Dian	1969	19 *tenera*	Lobe
Angola	Salazar, Novo Redondo Nhimo, Caxito	1970	TNR 164, TNR 115, TS 754 TS 2274, (14 *tenera*)	Angola
Nigeria (NIFOR)	Njala	1960 — 1963	1.2209, 1.2215, 1.2229. . .	Angola
	Aba, Calabar	,,	108.5, 6.594, 5.1654, 32.364. . .	Nigeria
	Serdang	,,	5.642, 5.2153, 5.368, 5.1295. . .	Deli
Dabou R.C.I. (Socfin)	Sumatra	1927 — 1929	D3D, D8D, D10D, D115D, D118D, D300D. . .	Deli
Johore Labis, Malaysia (Socfin)	Sumatra	1950 — 1954	JL1109, JL1122, JL1133, JL1257, JL1271, JL1273. . .	Deli
Malaysia (Guthrie)	Layang-Layang	1962	UR285, UR289, UR427, UR425, UR447. . . .	Deli
Malaysia	Serdang	1955	E206/1.7, E206/1.9, E206/2.4, E206/3.5. . .	Deli Dumpy

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PHENOTYPIC VARIATION IN NATURAL POPULATIONS OF CAIAUE (Elaeis oleifera (H.B.K.) Cortes) IN THE BRAZILIAN AMAZON

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EMBRAPA / CNPSD
Março / 1985

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Edson Barcelos[1], Márcio de Miranda Santos[1], Maria Elizabeth C. Vasconcellos[2]

1. Introduction

The possibility of employing *Elaeis oleifera* germplasm as a source of genetic variability in breeding programs for oil palm (*Elaeis guineensis* Jacq) is an important strategy for the solution of problems presently hampering cultivation, such as better quality of oil, greater disease resistance and slower trunk growth (HARDON 1969, VALLEJO *et al.* 1975, MEUNIER 1975 and 1976, MEUNIER *et al* 1976).

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X The present work, based on data obtained from natural populations of *E. oleifera* in the Brazilian Amazon and compiled during a joint Empresa Brasileira de Pesquisa Agropecuária-EMBRAPA/ Institut de Recherche pour les Huiles et Oléagineux - IRHO survey,X analyses the characteristics considered most important for intra-and inter-specific genetic breeding programs. In spite of the great environmental heterogenety acting upon the populations and which must have an influence on some of the variables studied, the results revealead aspects of the pattern of variation that exists in this species.

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II. Materials and Methods

The data presented here were obtained during a survey undertaken for the collection of *E.oleifera* seeds that covered the majority of the area of occurrence of this species in the Brazilian Amazon. undertaken by [illegible] and [illegible]

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The area surveyed was divided into 6 regions (Figure 1), with collections in 5 to 13 locations or populations per region and sampling 2 to 25 plants per location. Only plants presenting ripe bunches were sampled and the characteristics linked to habitat, population and to the vegetative and reproductive systems of the plant were registered.

1. Characteristics studied

Measurements were taken according to the methodology employed in studies on oil palm (CORLEY *et al*, sd). Information was collected on a total of 29 characteristics relating to vegetative and reproductive organs of the plant.

Only those characteristics relevant to breeding will be described in this study although some analyses were performed considering all the variables originally involved.

The following variables were studied:

x_1 length of foliar rachis - cm

x_2 weight of bunch - kg

x_3 percentage of normal fruits

x_4 percentage of parthenocarpic fruit

x_5 percentage of mesocarp in normal fruit

x_6 average weight of normal fruit - g

x_7 percentage of oil in dry mesocarp

x_8 percentage of oil unsaturation

2. Statistical Analysis

Considering the number of different plants sampled per population as well as the lack of standardization on the number of populations studied, a hierarchical analysis was applied as a model for variance analysis in order to determine the effect of plants in populations and the effect of populations within regions (KENDALL *et al* 1966, SEARLE 1971, SNEOECOR *et al* 1974, KEMPTHORNE 1979).

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The generalised distance method of mahalanobis was applied employing a total of 29 vegetative, reproductive and oil characteristics in order to synthetize the differences among regions in relation to the total of available characteristics (MAHALANOBIS 1948, RAO 1964, KENALL *et al* 1966, MEUNIER 1969 & RAJANAIDU *et al* 1979).

III. Results and Discussion

The total phenotypic variation for the 8 characteristics studied is shown in Table 1. The coefficient of variation (C.V.) varied between 8,1% and 109,37. The percentage of unsaturation presented the lowest value (8,1%) while the percentage of parthenocarpic fruits on the bunch (x_4) was the largest one. The coefficients of variation found are in general higher than those found for the species in the experimental plantations in Costa Rica (ESCOBAR 1980) and similar to the values found for natural populations of oil palm that occur in the Ivory Coast (MEUNIER 1969) and in Nigéria (RAJANAIDU *et al*. 1979).

The values found for the characteristics studied were consistently superior to those found for the species in natural populations in Honduras, Nicaraguã, Costa Rica, Panamã and Colõmbia (RAJANAIDU *et al* 1983) as well as those found for material of various origins planted in experimental conditions in Costa Rica (ESCOBAR 1980).

This fact shows a more detailed description of the data presented earlier (OOI 1981) where characteristic of bunch and fruit of Brazilian *oleifera* material were compared with that of different origins (Colõmbia, Suriname , Costa Rica, KLM).

The variance analysis (Table 2) indicates the existence of significant differences among regions for all the characteristics studied. Similar differences were fround among the populations, except for the characteristic percentage of oil in dry mesocarp (x7). When the averages are compared among regions (Table 5), it can be observed a striking difference between region 4 and the others for foliar rachis length (x_1) and bunch weight (x_2) being much lower than the average values found for other regions. The other characteristics studied (percentage of normal fruit (x_3), percentage of parthenocarpic fruit (x_4), percentage of mesocarp (x_5),percentage of oil in dry mesocarp (x_7) and percentage of oil unsaturation (x_8) do not presented very significant differences among the various regions (Figure 2 to 9). Figure 1 shows that region 4 (Manaus Caracaraí Highway) is geographically close to Surinam where the *E.oleifera* material studied presents characteristics that are distinct from those of material originating from Costa Rica, Honduras, Panamã, Nicaraguã and Colõmbia. This lead to conclude that there is a strong relationship between the material from region 4 and Surinam.

The variance decomposition (Table 2) shows that the characteristic foliar rachis (x_1) has its greatest source of variation (60%) due to differences among the regions and is mainly influenced by the low average (263,6) presented by region 4 - Manaus Caracaraí, representing material with low vegetative development, and by the high average (472,7) presented by region 6 - Solimões river, indicating material with a great vegetative development. The other characteristics, with the exception of percentage of normal fruit (x_3) and the percentage of parthenocarpic fruit (x_3) for which the main variation is the due to intra population differences (the latter being not significant), present as the main component of variance the differences verified among plants of a same population.

The mahalonobis differences (D^2) computed among the regions, in function of 29 characteristic (vegetative, reproductive, oil content etc), indicate the existence of significant differences among all the regions studied (Table 4). Considering these values as a measurement of divergence between materials occurring in different regions, one can observe that Region 4 - Manaus/ Caracaraí is the most distant region (Figure 9). This information can be employed to guide breeding programs for this species, where region 4, for example, could be crossed with any other region. Regions 1 - Manaus, 2- Madeira river and 3- mid-Amazon river should not be crossed among each other, the same being true for the regions 5 - Negro river and 6 - Solimões river.

Electrophoresis of this material will eventually be performed in order to better define the pattern of genetic variation of this species in the Brazilian Amazon.

IV. Conclusions

Natural populations of *Elaeis oleifera* occurring in the Brazilian Amazon present a phenotypic variation thats permits to be ranked into at least two clearly defined groups: material from the region of Manaus-Caracaraí that is similar to material from Surinam, and material from the other regions , similar to that of other regions of Central and South America.

The characteristics studied presented values (averages, minimums and maximums) superior to those obtained for this species in other countries. For this reason, the germplasm of Brazilian E. *oleifera* has a greater potencial for success in breeding programs.

V. Acknowledgements

We would like to thank those who participated in the EMBRAPA/IRHO prospection for seed collection of *Elaeis oleifera* in the Brazilian Amazon in 1982, namely Drs. Lídio Coradin (CENARGEN-EMBRAPA), Abílio R. Pacheco (CNPSD-EMBRAPA), Emeleocípio B. Andrade (CPATU-EMBRAPA), Soi Chai Ooi (IICA-EMBRAPA), Jacques Meunier, Phillip Amblard and Bertrand Tailliez (IRHO), Antônio R. Carvalho (CEPEC-CEPLAC) and Mr. Glocimar Pereira da Silva (CENARGEN-EMBRAPA).

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TABLE 1 - Phenotypic characteristics observed on plants from natural populations of *Elaeis oleifera* (H.B.K.) Cortés) of the Brazilian Amazon, 1985.

CHARACTERÍSTICA	N*	Mean	Min	Max	σ	C.V. %
x_1 - Foliar rachis length - cm	299	393	188	647	93,78	23,86
x_2 - Bunch weight - kg	205	6,7	0,9	18,0	3,67	54,78
x_3 - Normal fruits (%)	171	59,42	11,2	90,5	15,74	26,50
x_4 - Parthenocarpic fruit (%)	157	9,52	0,0	45,7	10,39	109,37
x_5 - Mesorcarp (%)	176	46,0	14,6	62,3	6,51	14,15
x_6 - Average normal fruit weigth	187	7,87	3,45	14,66	2,30	29,22
x_7 - Oil (%) in dry mesocarp	171	42,84	16,10	57,20	6,52	15,23
x_8 - Unsaturation/oil (%)	171	70,11	59,98	77,66	5,69	8,12

N - number of observations.

TABLE 2 - Variance analysis of phenotypic characteristics observed on plants from natural populations of *Elaeis oleifera* (H.B.K.) Cortés of the Brazilian Amazon, 1985.

CHARACTERISTICS	Mean square			Variance components %		
	Plant	Population	Region	Plant	Population	Region
x_1 - Foliar rachis length - cm	2.340	15.460**	194.560**	20	20	60
x_2 - Bunch weight - kg	9,21	19,42*	28,86*	78,2	18,8	3,6
x_3 - Normal fruits(%)	66,6	634,4**	238,8**	30,8	69,2	-
x_4 - Parthenocarpic fruit (%)	40,0	247,5**	321,2**	41,3	56,5	2,1
x_5 - Mesocarp (%)	25,9	59,9**	164,2**	64,9	22,4	12,7
x_6 - Average normal fruit weigth	2,4	7,3**	19,9**	57,3	28,1	14,6
x_7 - Oil (5) in dry mesocarp	39,7	35,4	366,7**	69,9	-	30,1
x_8 - Unsaturation oil (%)	6,5	21,4**	39,3**	58,0	35,9	7,0

* significant at 5%

** significant at 1%.

TABLE 3 - Comparison between mean values among regions for phenotypic characteristics observed on natural populations of *Elaeis oleifera* (H.B.K.) Cortés of the Brazilian Amazon, 1985.

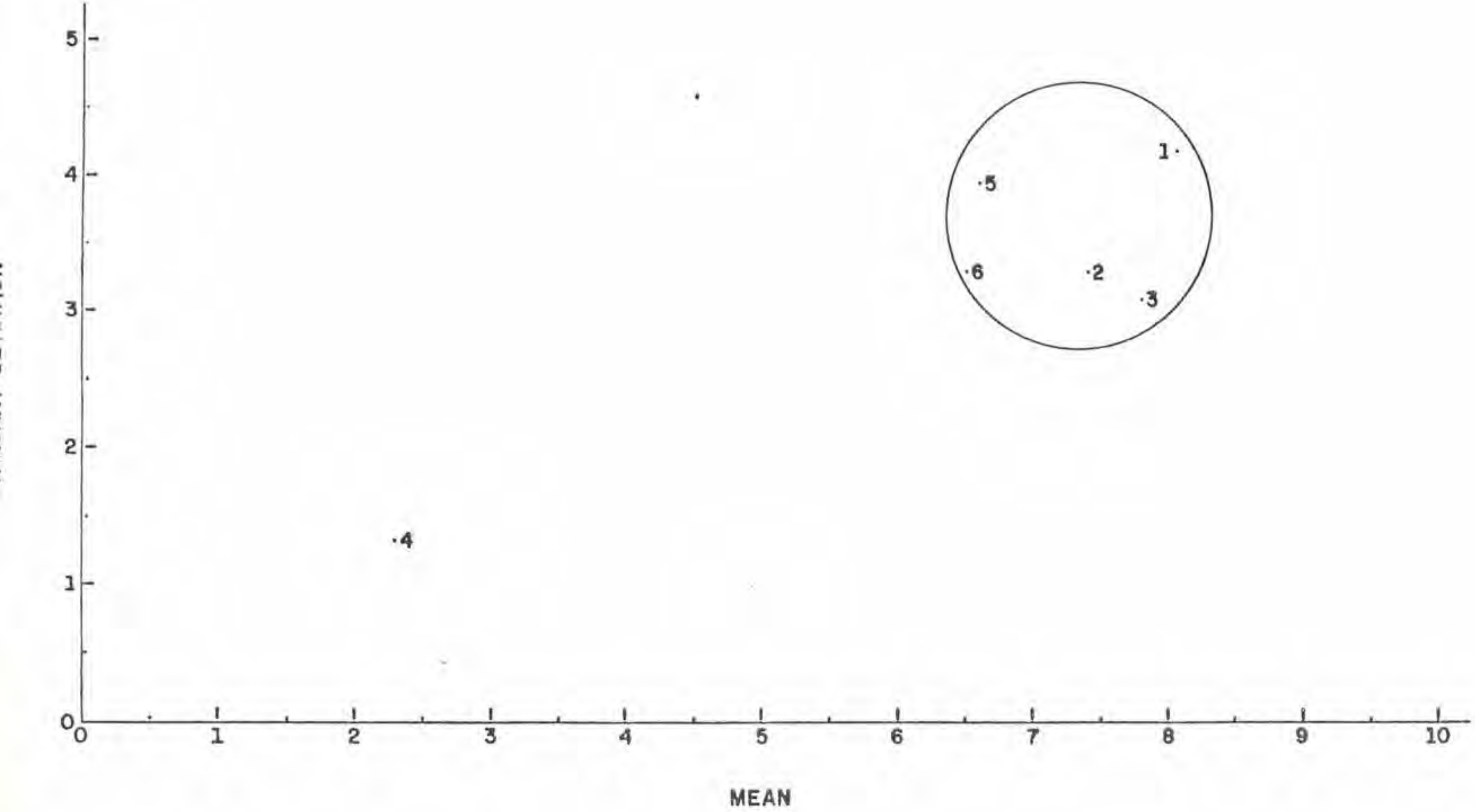
Region	Mean value							
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
1 - Manaus	$406,7_{bc}$	$8,0_{b}$	$59,2_{ab}$	$15,6_{b}$	$44,1_{a}$	$5,8_{a}$	$39,8_{ab}$	$69,9_{abc}$
2 - Madeira river	$399,2_{bc}$	$7,4_{b}$	$55,4_{a}$	$7,1_{a}$	$48,4_{a}$	$8,4_{b}$	$44,4_{c}$	$71,7_{cd}$
3 - Mid-Amazon river	$421,9_{c}$	$7,8_{b}$	$67,0_{b}$	$10,8_{ab}$	$44,4_{a}$	$7,8_{b}$	$44,6_{c}$	$68,5_{a}$
4 - Manaus - Caracaraí	$263,6_{a}$	$2,3_{a}$	$61,8_{ab}$	$7,1_{a}$	$46,9_{a}$	$7,2_{ab}$	$42,2_{bc}$	$73,5_{d}$
5 - Negro river	$354,1_{b}$	$6,6_{b}$	$58,8_{ab}$	$8,6_{ab}$	$46,6_{a}$	$7,3_{ab}$	$46,2_{c}$	$69,4_{ab}$
6 - Solimões river	$472,7_{d}$	$6,5_{b}$	$55,2_{a}$	$8,1_{ab}$	$45,5_{a}$	$2,55_{b}$	$36,3_{a}$	$80,8_{bcd}$

Obs: The mean values followed by identical letters do not differ significantly.

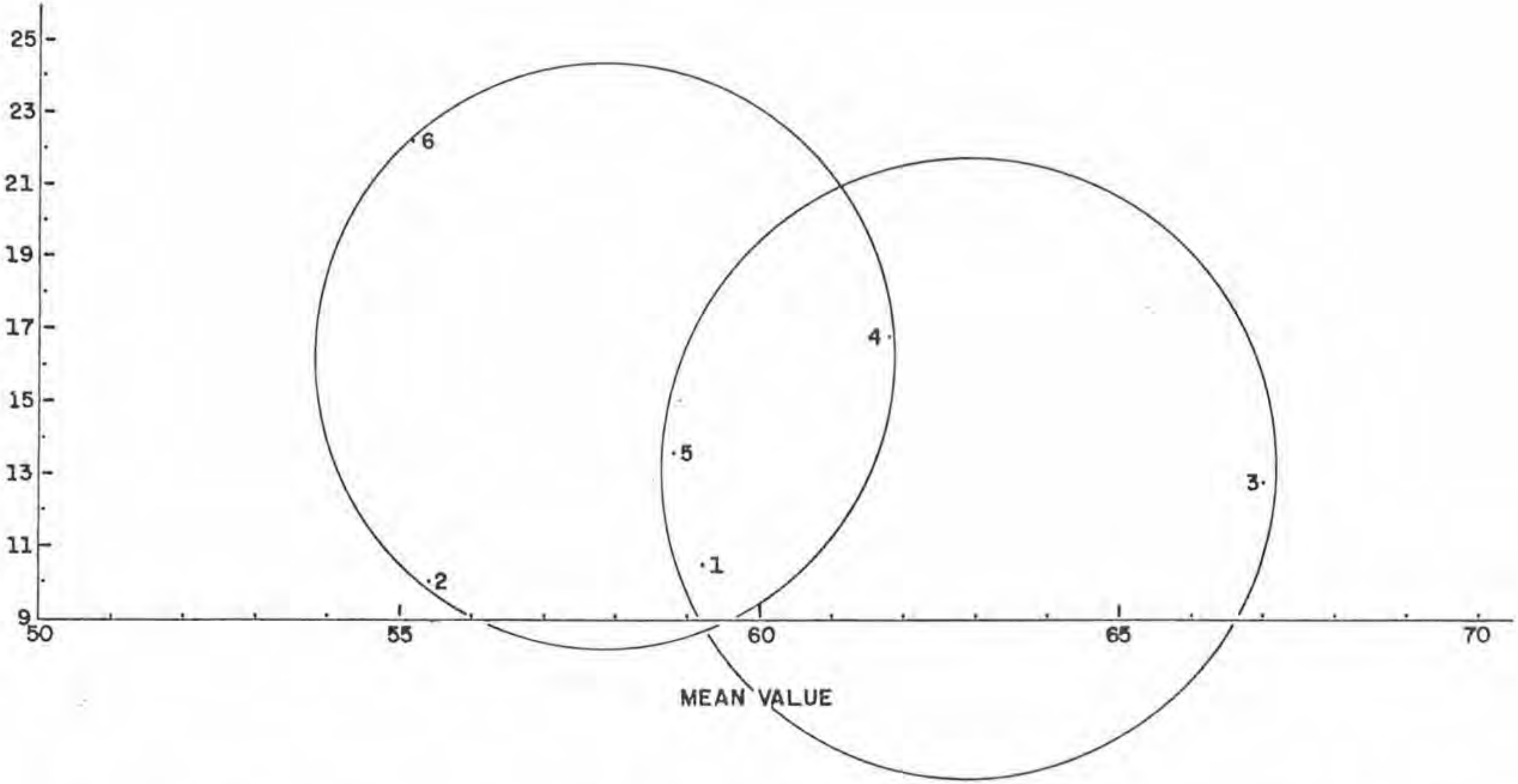
TABLE 4 - Significance study of Mahalanobis distances among regions

Regions	Regions 2	 3	 4	 5	 6
1 - Manaus	3,45**	3,04**	7,72**	4,03**	4,71**
2 - Madeira river		3,55**	8,56**	4,32**	5,13**
3 - Mid- Amazon river			8,48**	3,82**	5,20**
4 - Manaus - Caracaraí				8,01**	7,31**
5 - Negro river					4,62**
6 - Solimões river					-

**significant at 1%



IG. 3- BUNCH CHARACTERISTICS AMONG REGIONS (NUMBERS 1 TO 6) BUNCH WEIGTH (Kg)



4- BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) FRUIT TO BUNCH (%)

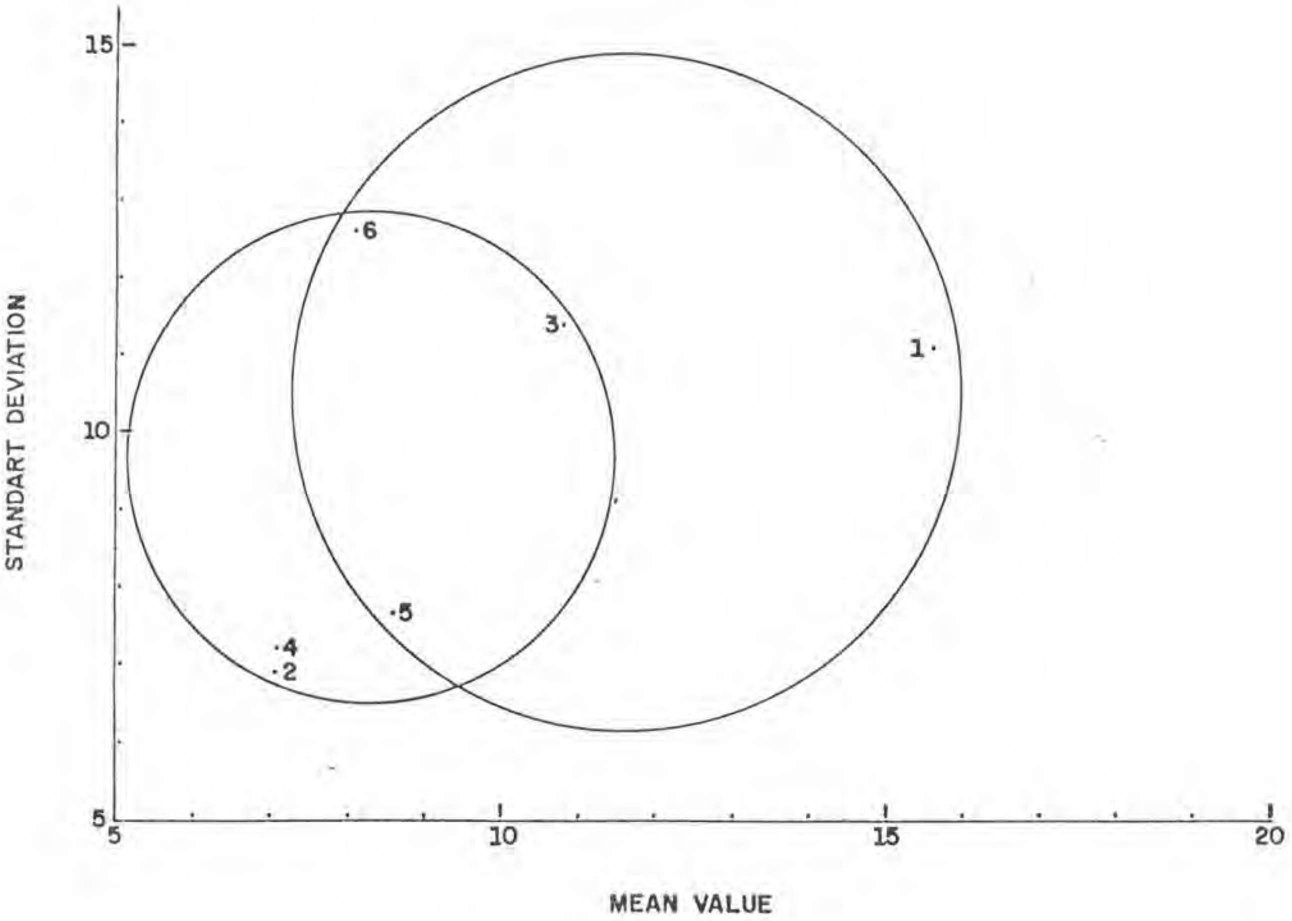
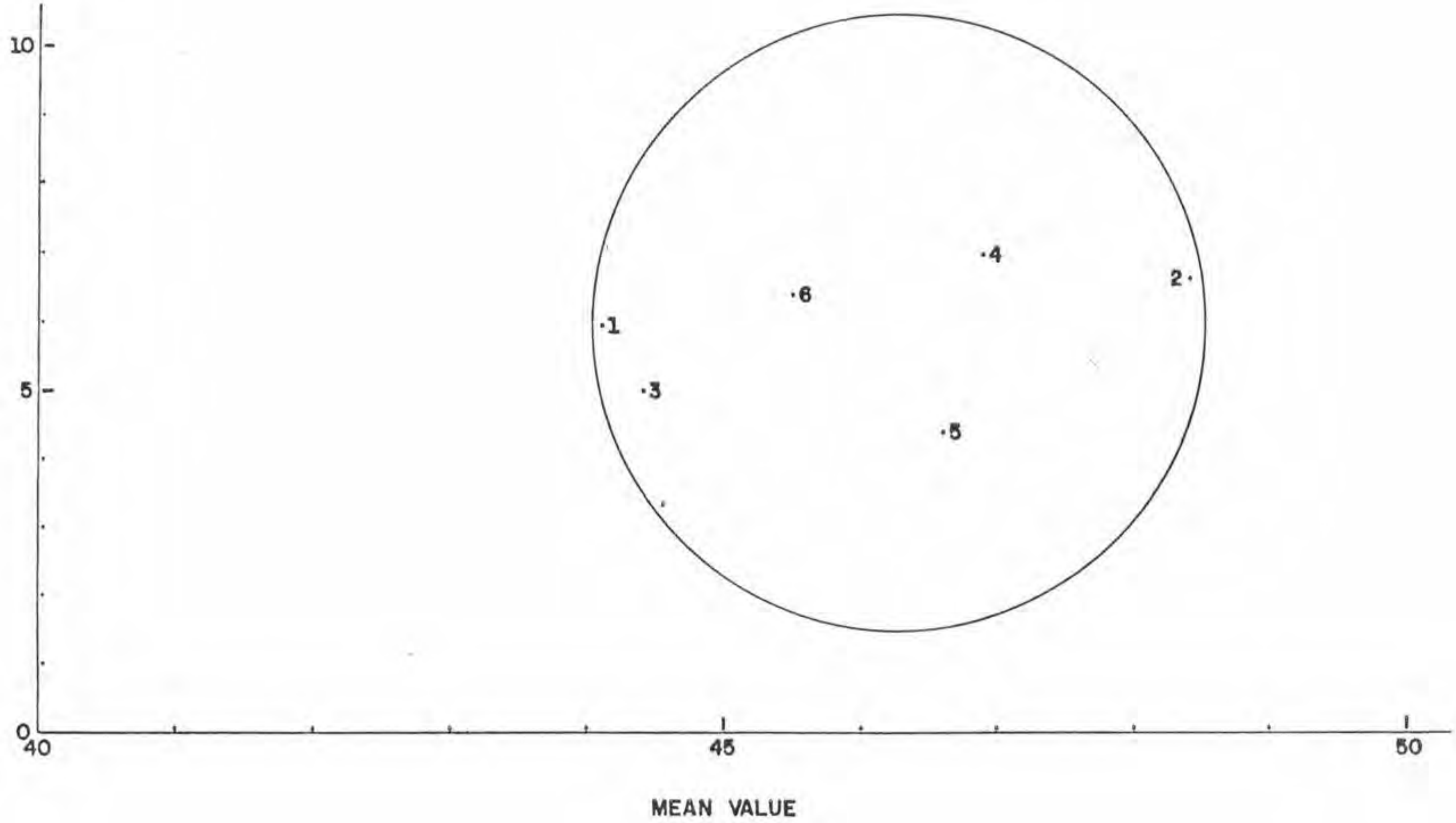


FIG. 5- BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) PARTHENOCARPIC FRUIT TO BUNCH (%)



. 6 - FRUIT QUALITY CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) MESOCAPP/ FRUIT PERCENTAGE

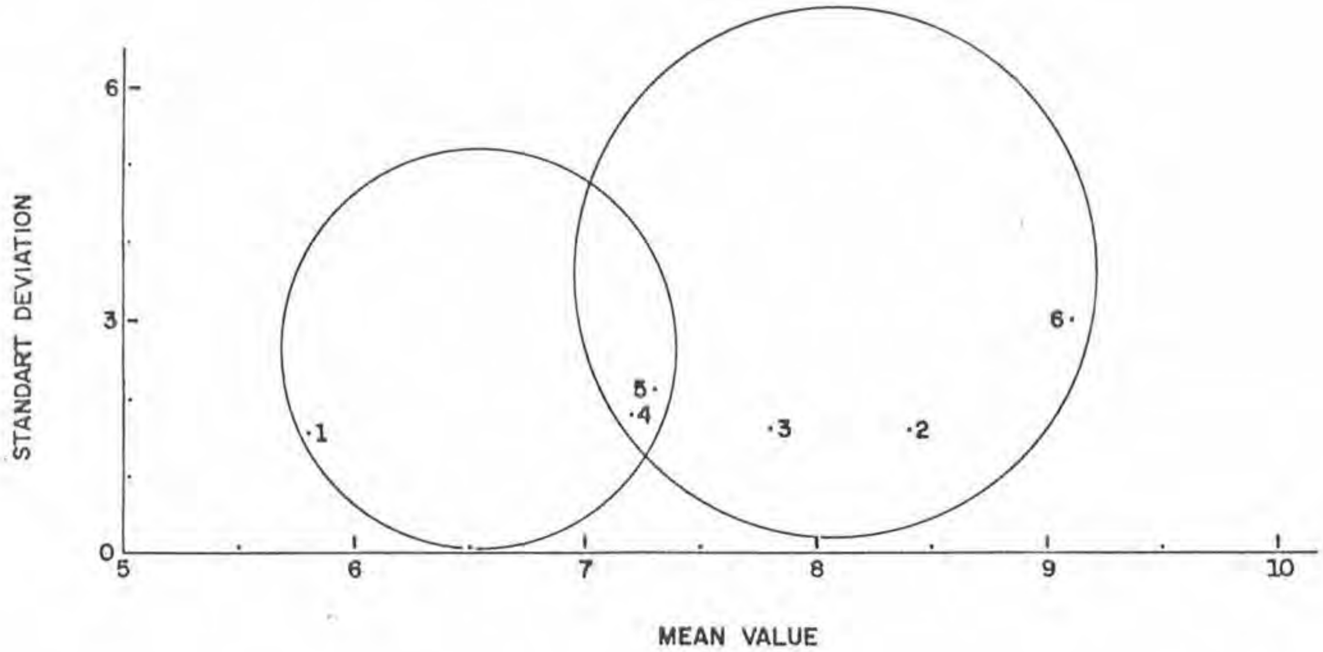


FIG. 7 - BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6)
MEAN NORMAL FRUIT WEIGHT (g)

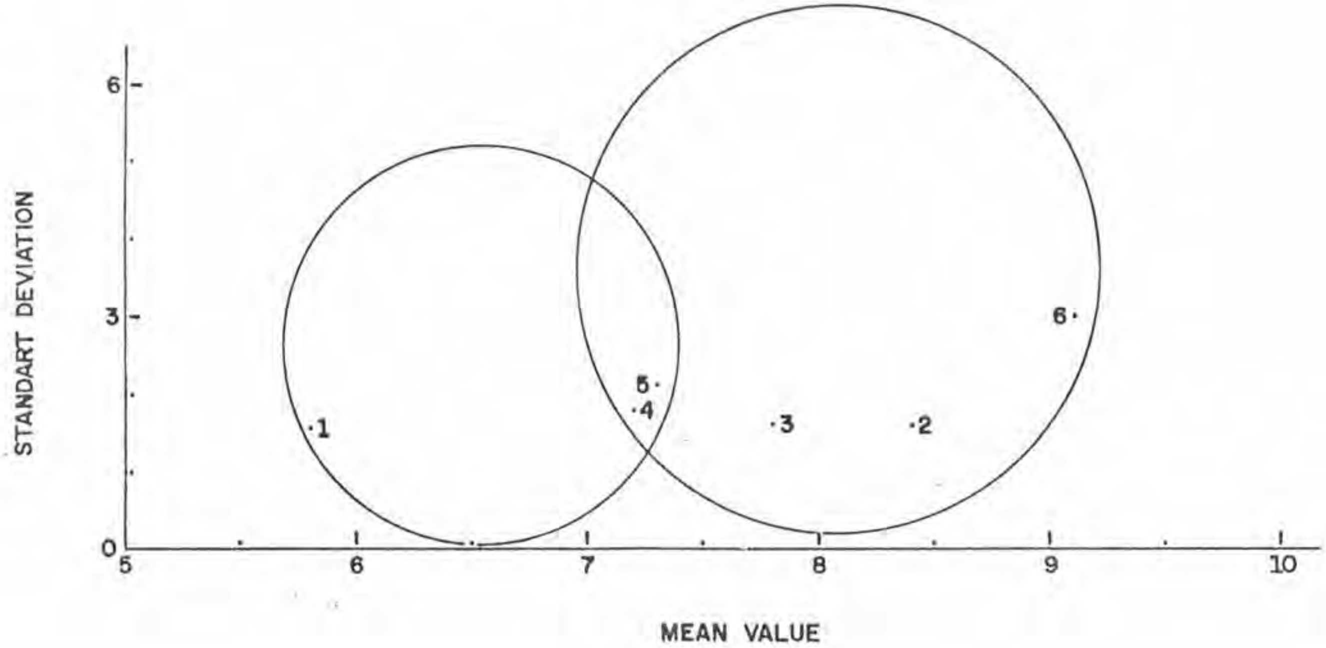


FIG. 7 - BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) MEAN NORMAL FRUIT WEIGHT (g)

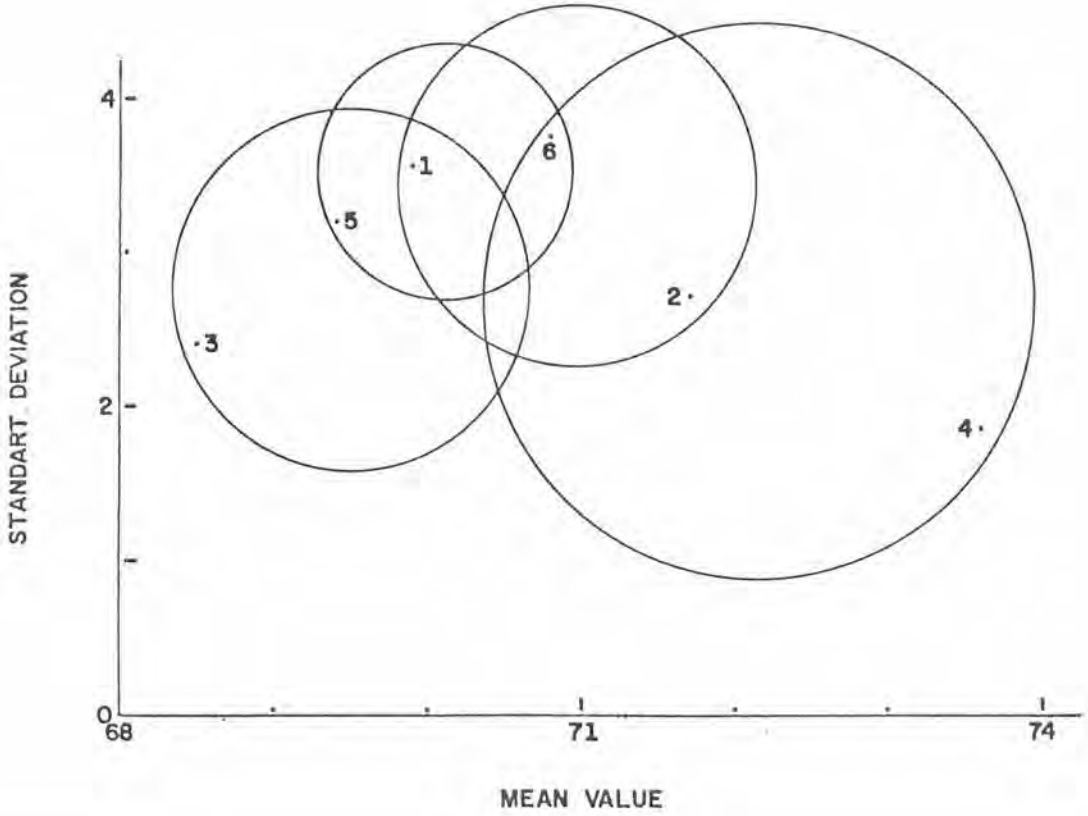


FIG. 9- OIL ANALYSIS CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) OIL INSATURATION PERCENTAGE

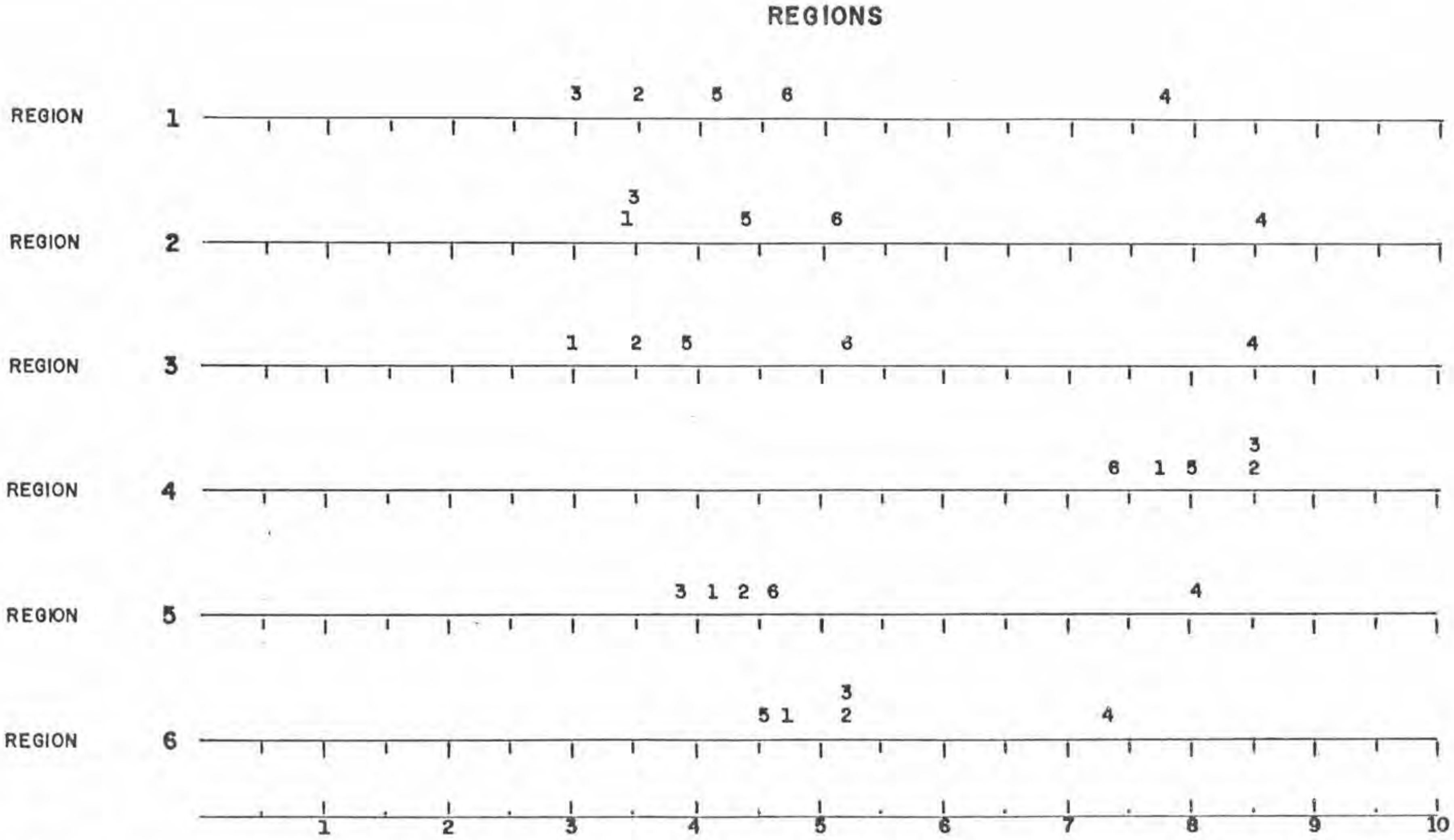


FIG. 10 - MAHALANOBIS'S DISTANCES AMONG REGIONS

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Sicle 3n4

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The values found for the characteristics studied were consistently superior to those found for the species in natural populations in Honduras, Nicaraguá, Costa Rica, Panamá and Colômbia (RAJANAIDU *et al* 1983) as well as those found for material of various origins planted in experimental conditions in Costa Rica (ESCOBAR 1980).

This fact shows a more detailed description of the data presented earlier (OOI 1981) where characteristic of bunch and fruit of Brazilian *oleifera* material were compared with that of different origins (Colômbia, Suriname , Costa Rica, KLM).

The variance analysis (Table 2) indicates the existence of significant differences among regions for all the characteristics studied. Similar differences were fround among the populations, except for the characteristic percentage of oil in dry mesocarp (x7). When the averages are compared among regions (Table 5), it can be observed a striking difference between region 4 and the others for foliar rachis length (x_1) and bunch weight (x_2) being much lower than the average values found for other regions. The other characteristics studied (percentage of normal fruit (x_3), percentage of parthenocarpic fruit (x_4), percentage of mesocarp (x_5),percentage of oil in dry mesocarp (x_7) and percentage of oil unsaturation (x_8) do not presented very significant differences among the various regions (Figure 2 to 9). Figure 1 shows that region 4 (Manaus Caracaraí Highway) is geographically close to Surinam where the *E.oleifera* material studied presents characteristics that are distinct from those of material originating from Costa Rica, Honduras, Panamá, Nicaraguá and Colômbia. This lead to conclude that there is a strong relationship between the material from region 4 and Surinam.

The variance decomposition (Table 2) shows that the characteristic foliar rachis (x_1) has its greatest source of variation (60%) due to differences among the regions and is mainly influenced by the low average (263,6) presented by region 4 - Manaus Caracaraí, representing material with low vegetative development, and by the high average (472,7) presented by region 6 - Solimões river, indicating material with a great vegetative development. The other characteristics, with the exception of percentage of normal fruit (x_3) and the percentage of parthenocarpic fruit (x_3) for which the main variation is the due to intra population differences (the latter being not significant), present as the main component of variance the differences verified among plants of a same population.

The mahalonobis differences (D^2) computed among the regions, in function of 29 characteristic (vegetative, reproductive, oil content etc), indicate the existence of significant differences among all the regions studied (Table 4). Considering these values as a measurement of divergence between materials occurring in different regions, one can observe that Region 4 - Manaus/ Caracaraĩ is the most distant region (Figure 9). This information can be employed to guide breeding programs for this species, where region 4, for example, could be crossed with any other region. Regions 1 - Manaus, 2- Madeira river and 3- mid-Amazon river should not be crossed among each other, the same being true for the regions 5 - Negro river and 6 - Solimões river.

Electrophoresis of this material will eventually be performed in order to better define the pattern of genetic variation of this species in the Brazilian Amazon.

IV. Conclusions

Natural populations of *Elaeis oleifera* occurring in the Brazilian Amazon present a phenotypic variation thats permits to be ranked into at least two clearly defined groups: material from the region of Manaus-Caracaraĩ that is similar to material from Surinam, and material from the other regions , similar to that of other regions of Central and South America.

The characteristics studied presented values (averages, minimums and maximums) superior to those obtained for this species in other countries. For this reason, the germplasm of Brazilian E. *oleifera* has a greater potencial for success in breeding programs.

V. Acknowledgements

We would like to thank those who participated in the EMBRAPA/IRHO prospection for seed collection of *Elaeis oleifera* in the Brazilian Amazon in 1982, namely Drs. Lídio Coradin (CENARGEN-EMBRAPA), Abílio R. Pacheco (CNPSD-EMBRAPA), Emeleocípio B. Andrade (CPATU-EMBRAPA), Soi Chai Ooi (IICA-EMBRAPA), Jacques Meunier, Phillip Amblard and Bertrand Tailliez (IRHO), Antônio R. Carvalho (CEPEC-CEPLAC) and Mr. Glocimar Pereira da Silva (CENARGEN-EMBRAPA).

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TABLE 1 - Phenotypic characteristics observed on plants from natural populations of *Elaeis oleifera* (H.B.K.) Cortés) of the Brazilian Amazon, 1985.

CHARACTERÍSTICA	N*	Mean	Min	Max	σ	C.V. %
x_1 - Foliar rachis length - cm	299	393	188	647	93,78	23,86
x_2 - Bunch weight - kg	205	6,7	0,9	18,0	3,67	54,78
x_3 - Normal fruits (%)	171	59,42	11,2	90,5	15,74	26,50
x_4 - Parthenocarpic fruit (%)	157	9,52	0,0	45,7	10,39	109,37
x_5 - Mesorcarp (%)	176	46,0	14,6	62,3	6,51	14,15
x_6 - Average normal fruit weigth	187	7,87	3,45	14,66	2,30	29,22
x_7 - Oil (%) in dry mesocarp	171	42,84	16,10	57,20	6,52	15,23
x_8 - Unsaturation/oil (%)	171	70,11	59,98	77,66	5,69	8,12

N - number of observations.

TABLE 2 - Variance analysis of phenotypic characteristics observed on plants from natural populations of *Elaeis oleifera* (H.B.K.) Cortés of the Brazilian Amazon, 1985.

CHARACTERÍSTICS	Mean square			Variance components %		
	Plant	Population	Region	Plant	Population	Region
x_1 - Foliar rachis length - cm	2.340	15.460**	194.560**	20	20	60
x_2 - Bunch weight - kg	9,21	19,42*	28,86*	78,2	18,8	3,6
x_3 - Normal fruits(%)	66,6	634,4**	238,8**	30,8	69,2	-
x_4 - Parthenocarpic fruit (%)	40,0	247,5**	321,2**	41,3	56,5	2,1
x_5 - Mesocarp (%)	25,9	59,9**	164,2**	64,9	22,4	12,7
x_6 - Average normal fruit weigth	2,4	7,3**	19,9**	57,3	28,1	14,6
x_7 - Oil (5) in dry mesocarp	39,7	35,4	366,7**	69,9	-	30,1
x_8 - Unsaturation oil (%)	6,5	21,4**	39,3**	58,0	35,9	7,0

* significant at 5%

** significant at 1%.

TABLE 3 - Comparison between mean values among regions for phenotypic characteristics observed on natural populations of *Elaeis oleifera* (H.B.K.) Cortés of the Brazilian Amazon, 1985.

Region	Mean value							
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8
1 - Manaus	$406,7_{bc}$	$8,0_{b}$	$59,2_{ab}$	$15,6_{b}$	$44,1_{a}$	$5,8_{a}$	$39,8_{ab}$	$69,9_{abc}$
2 - Madeira river	$399,2_{bc}$	$7,4_{b}$	$55,4_{a}$	$7,1_{a}$	$48,4_{a}$	$8,4_{b}$	$44,4_{c}$	$71,7_{cd}$
3 - Mid-Amazon river	$421,9_{c}$	$7,8_{b}$	$67,0_{b}$	$10,8_{ab}$	$44,4_{a}$	$7,8_{b}$	$44,6_{c}$	$68,5_{a}$
4 - Manaus - Caracaraí	$263,6_{a}$	$2,3_{a}$	$61,8_{ab}$	$7,1_{a}$	$46,9_{a}$	$7,2_{ab}$	$42,2_{bc}$	$73,5_{d}$
5 - Negro river	$354,1_{b}$	$6,6_{b}$	$58,8_{ab}$	$8,6_{ab}$	$46,6_{a}$	$7,3_{ab}$	$46,2_{c}$	$69,4_{ab}$
6 - Solimões river	$472,7_{d}$	$6,5_{b}$	$55,2_{a}$	$8,1_{ab}$	$45,5_{a}$	$2,55_{b}$	$36,3_{a}$	$80,8_{bcd}$

Obs: The mean values followed by identical letters do not differ significantly.

TABLE 4 - Significance study of Mahalanobis distances among regions

Regions	Regions 2	3	4	5	6
1 - Manaus	3,45**	3,04**	7,72**	4,03**	4,71**
2 - Madeira river		3,55**	8,56**	4,32**	5,13**
3 - Mid- Amazon river			8,48**	3,82**	5,20**
4 - Manaus - Caracaraí				8,01**	7,31**
5 - Negro river					4,62**
6 - Solimões river					-

**significant at 1%

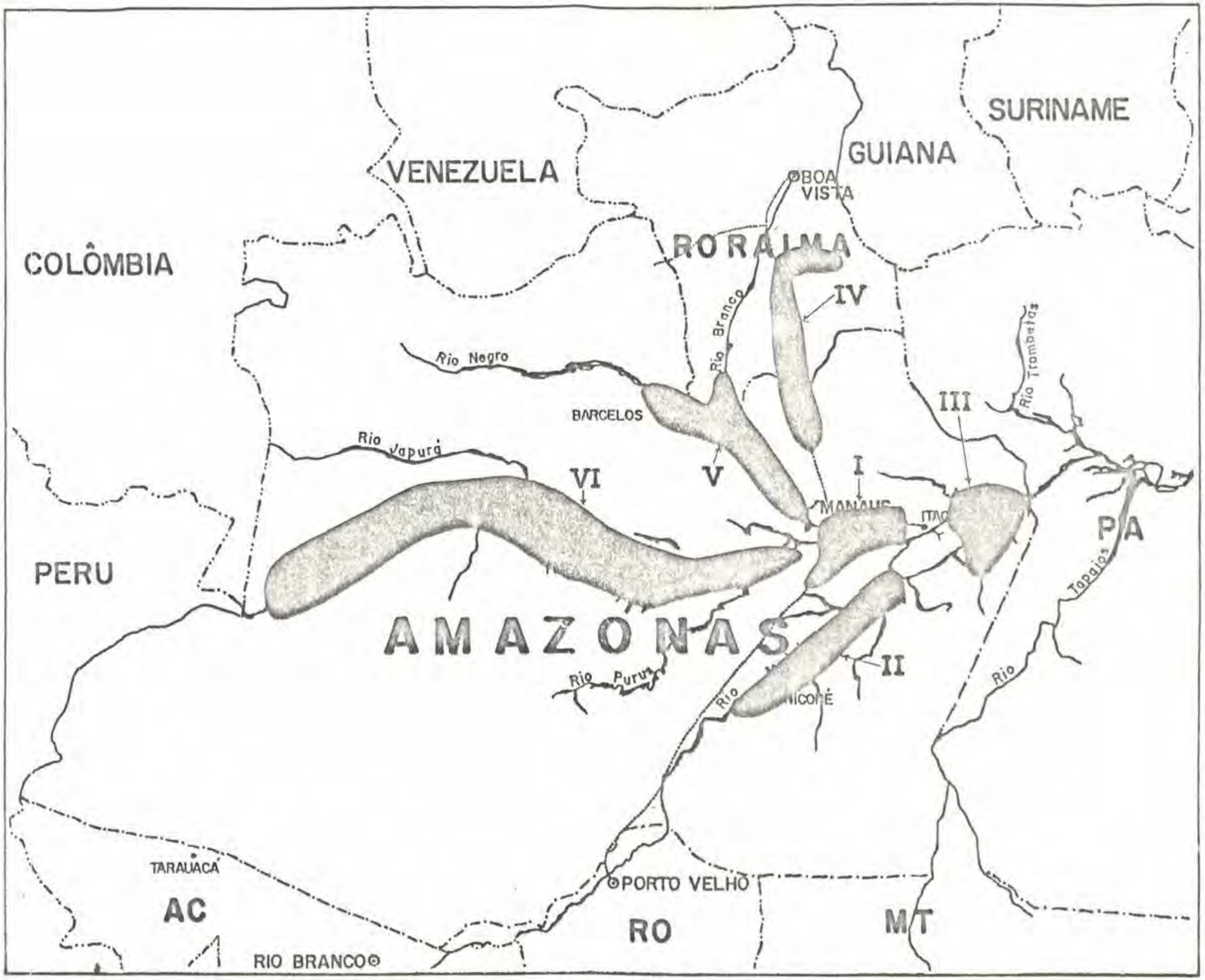

FIG. 1- REGIONS OF THE AMAZON BASIN WHERE *Elaeis oleifera* WAS COLLECTED AND STUDIED.

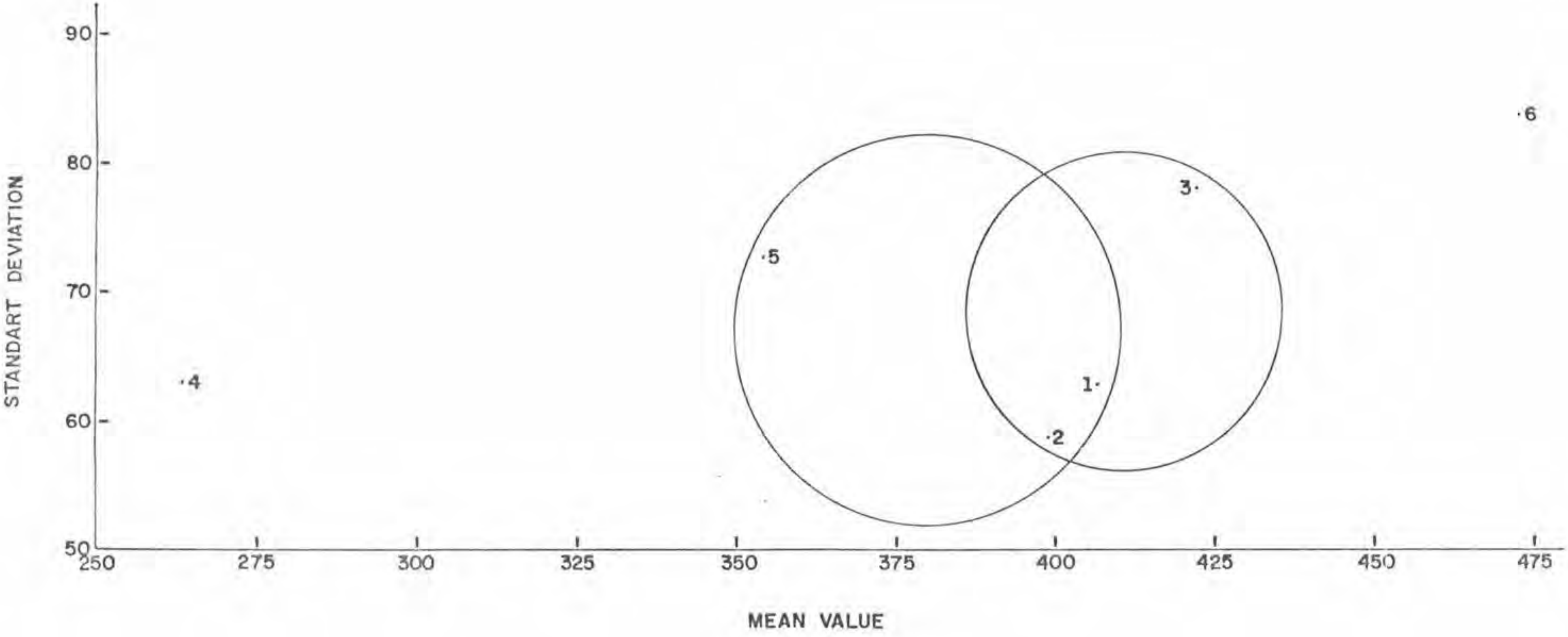

FIG. 02 - VEGETATIVE CHARACTERISTICS AMONG REGIONS (NUMBERS 1 TO 6) FOLIAR RACHIS LENGTH (cm)

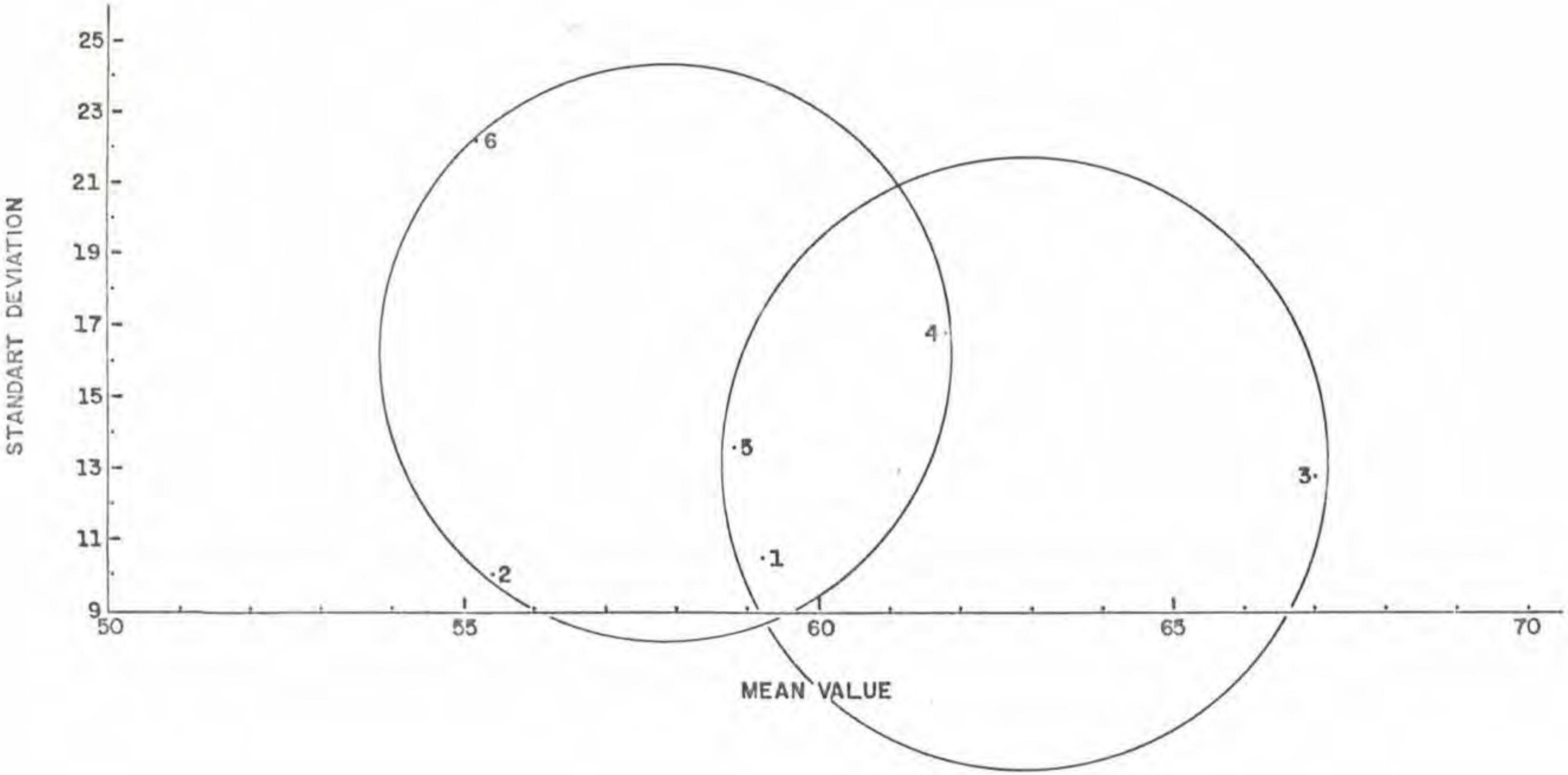

FIG. 4 - BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) FRUIT TO BUNCH (%)

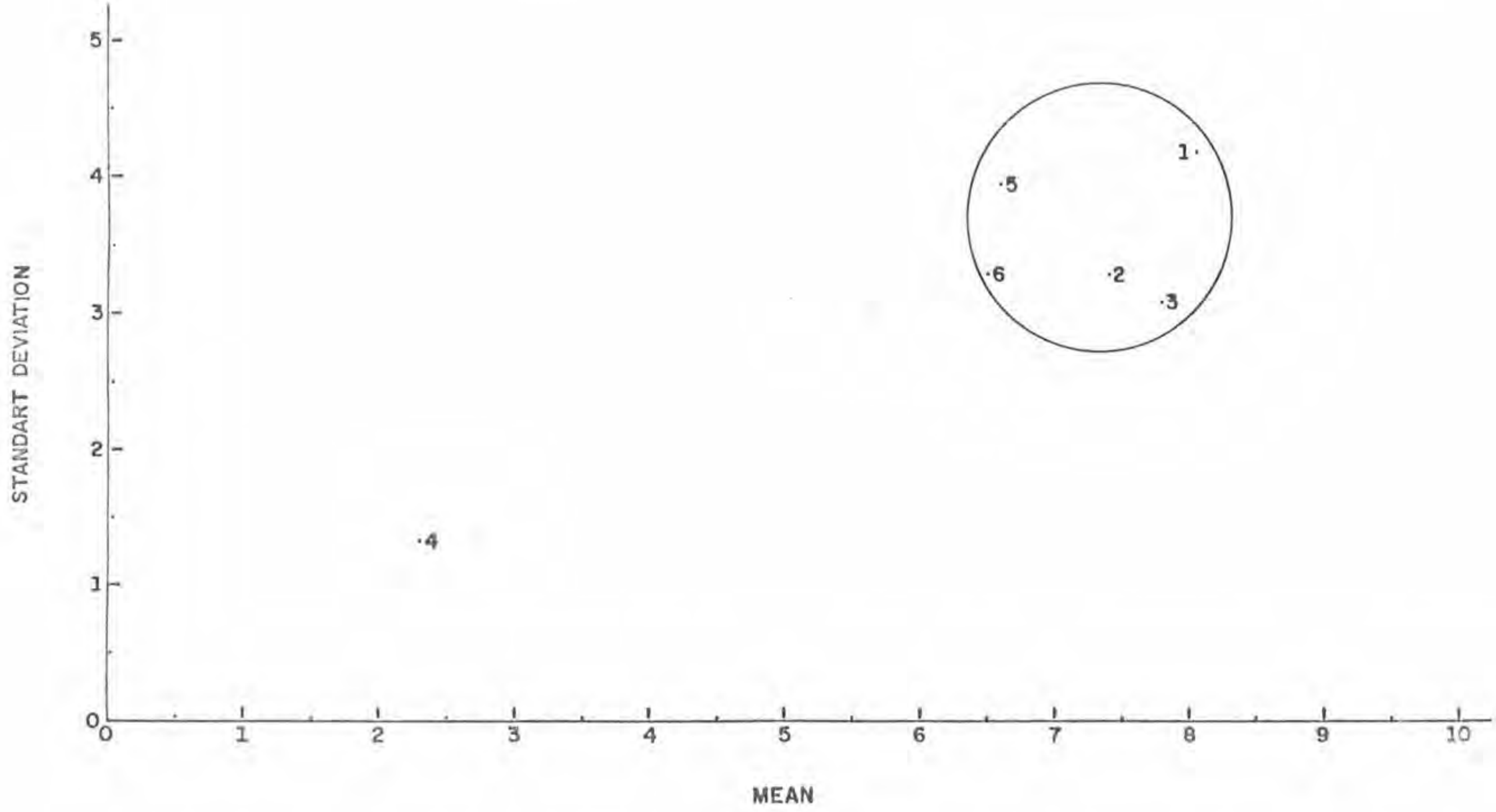

FIG. 3- BUNCH CHARACTERISTICS AMONG REGIONS (NUMBERS 1 TO 6) BUNCH WEIGTH (Kg)

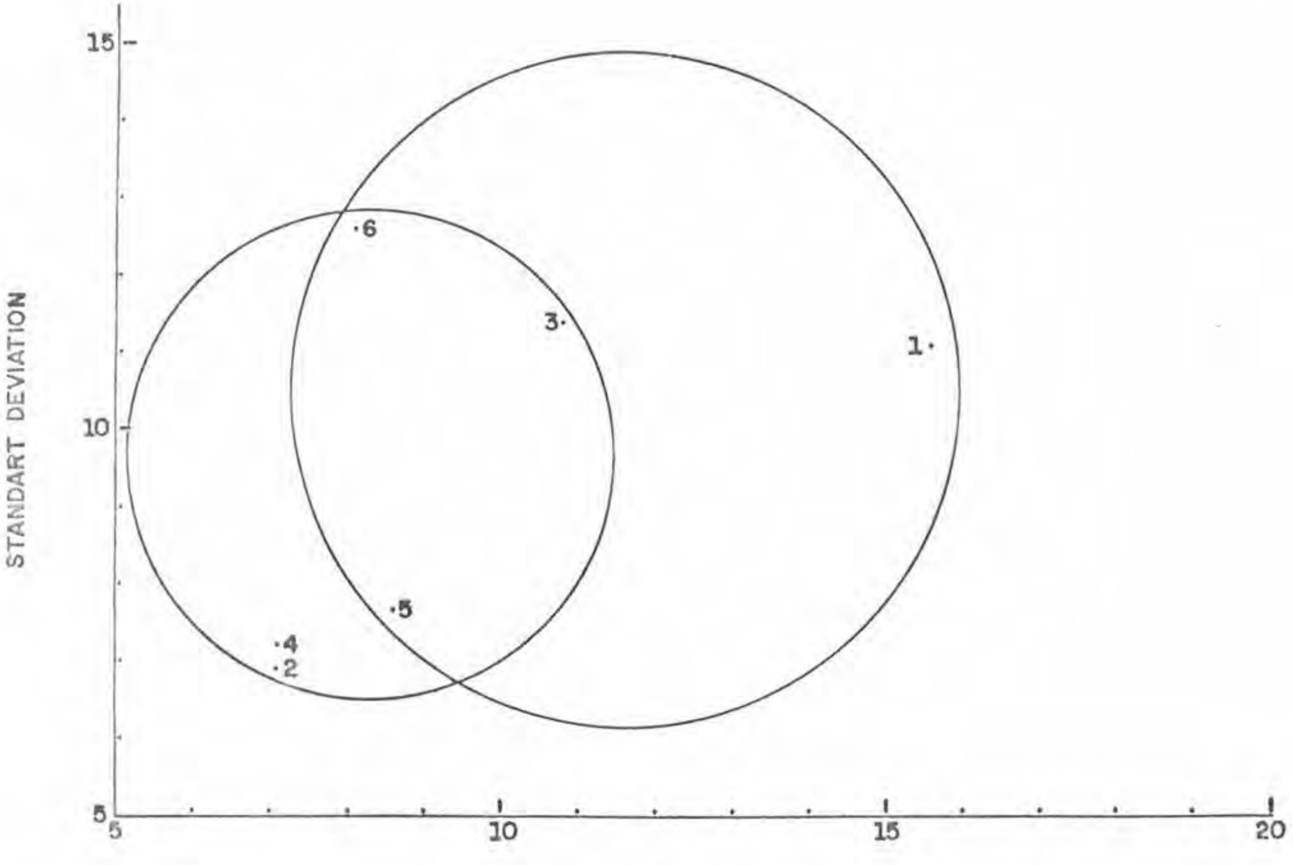

FIG. 5 - BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) PARTHENOCARPIC FRUIT TO BUNCH (%)

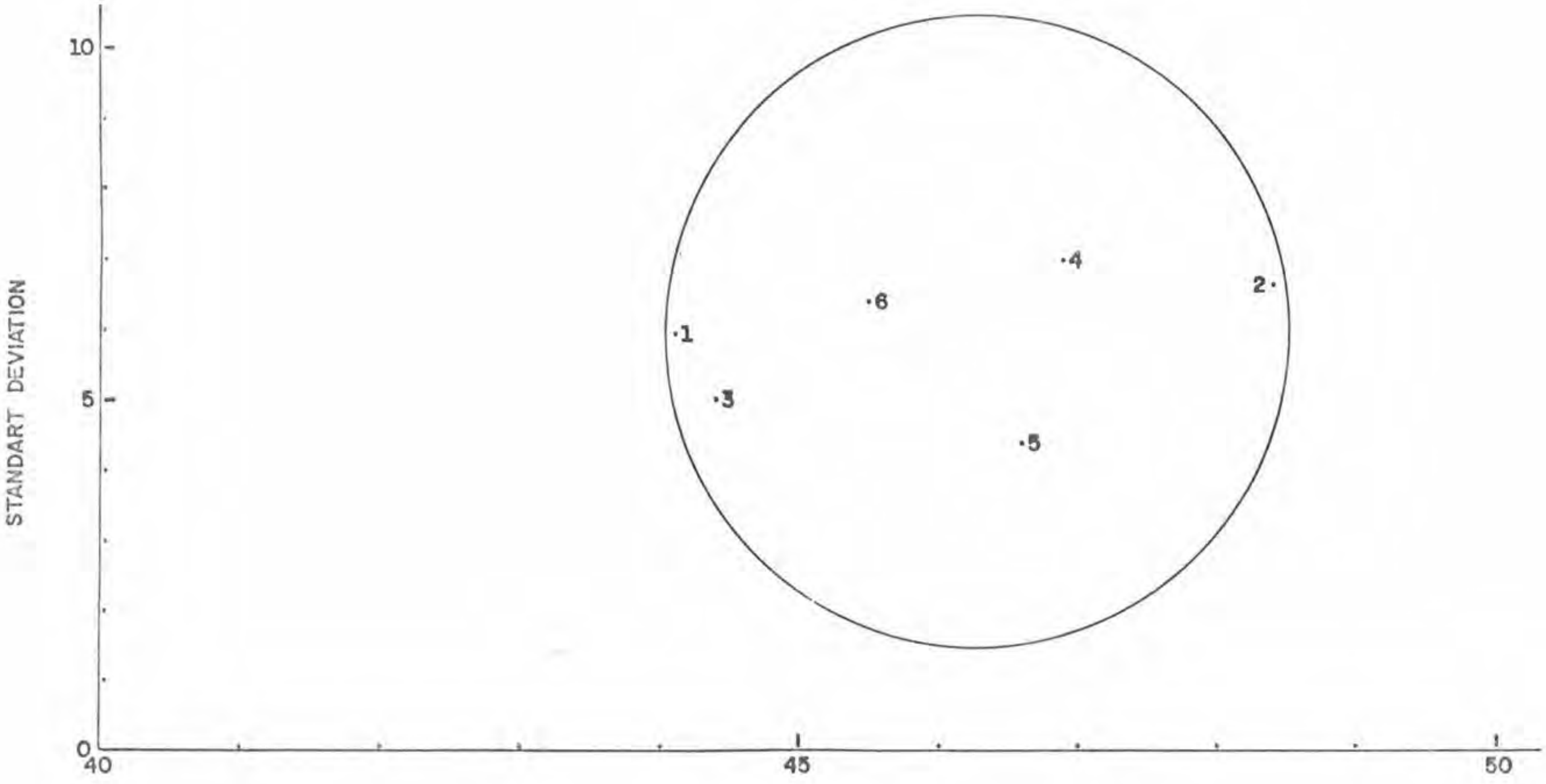

FIG. 6 - FRUIT QUALITY CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) MESOCAPP/ FRUIT PERCENTAGE

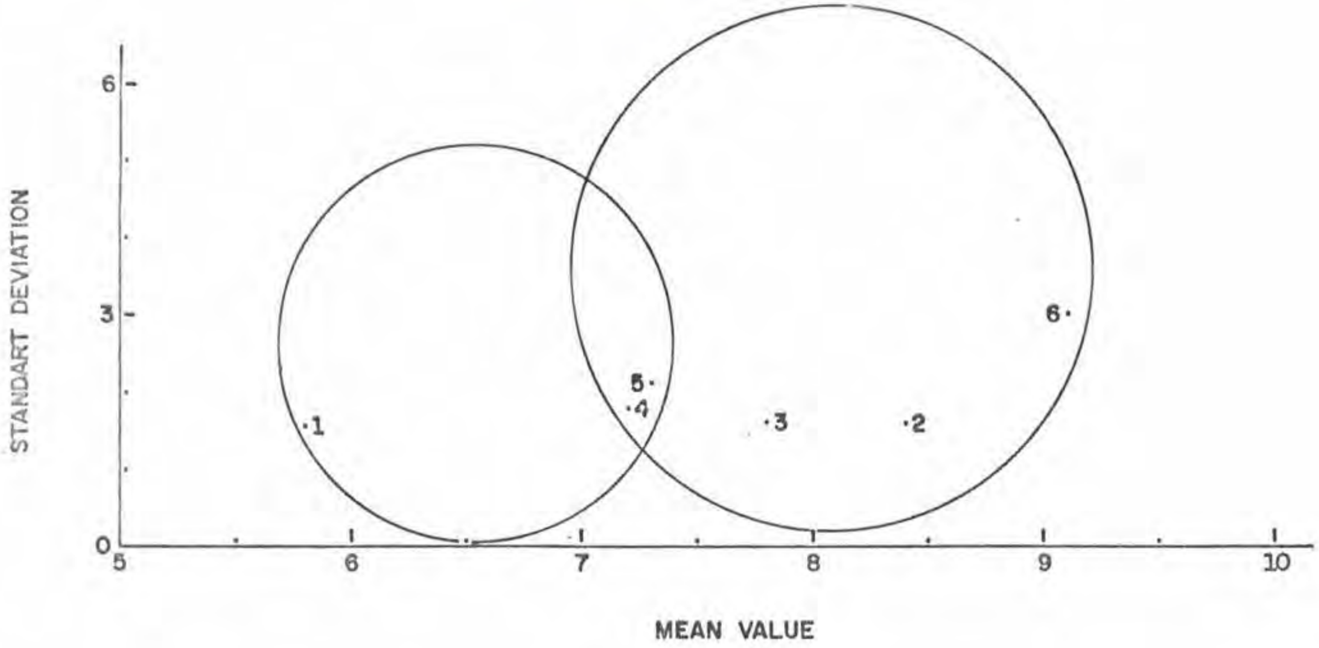

FIG. 7 - BUNCH COMPOSITION CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6)
MEAN NORMAL FRUIT WEIGHT (g)

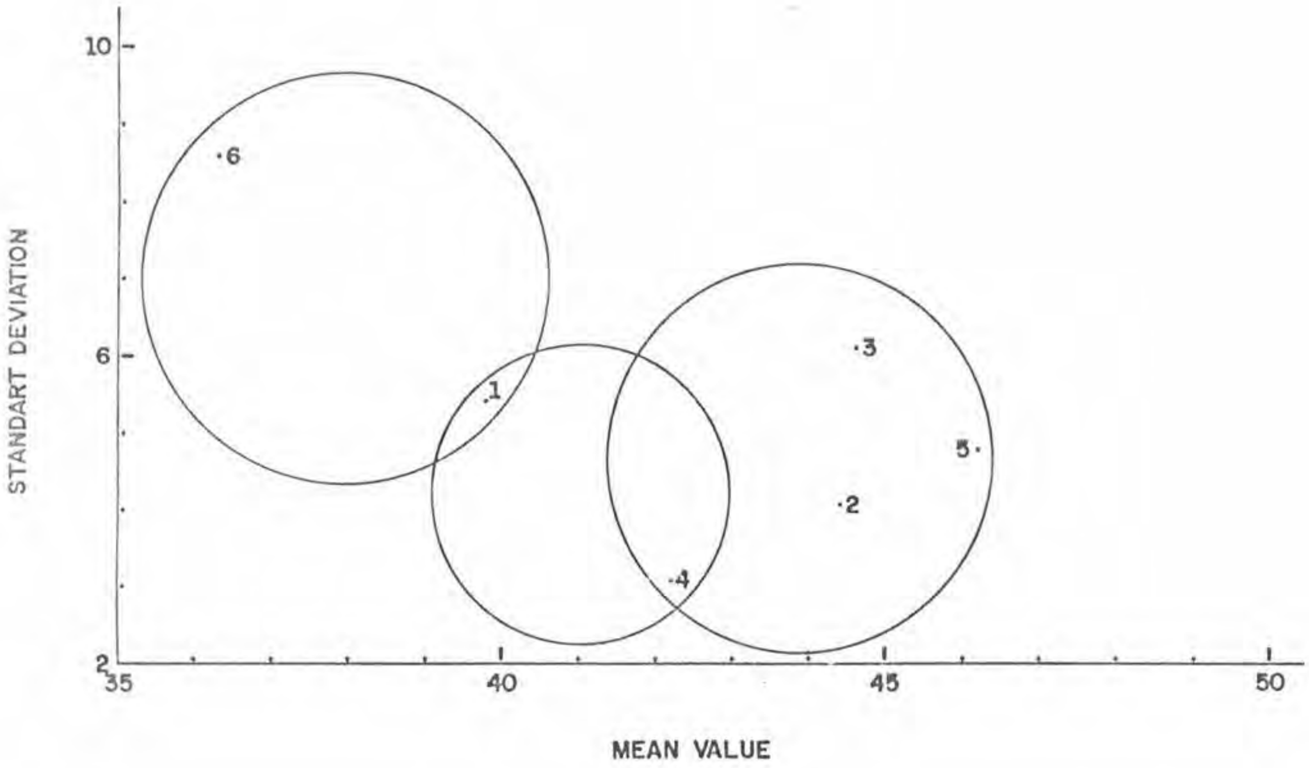

FIG. 8- OIL ANALYSIS CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) OIL/ DRY PULP PERCENTAGE

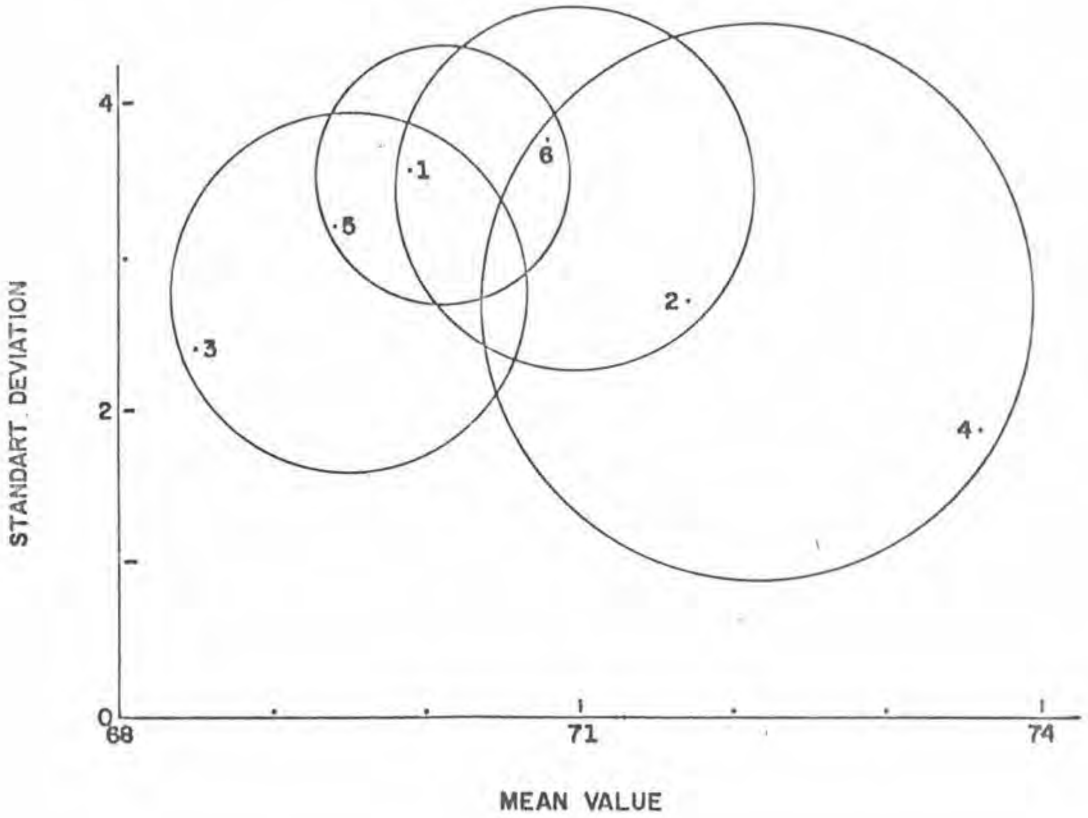

FIG. 9- OIL ANALYSIS CHARACTERISTICS AMONG REGIONS (NUMBER 1 TO 6) OIL INSATURATION PERCENTAGE

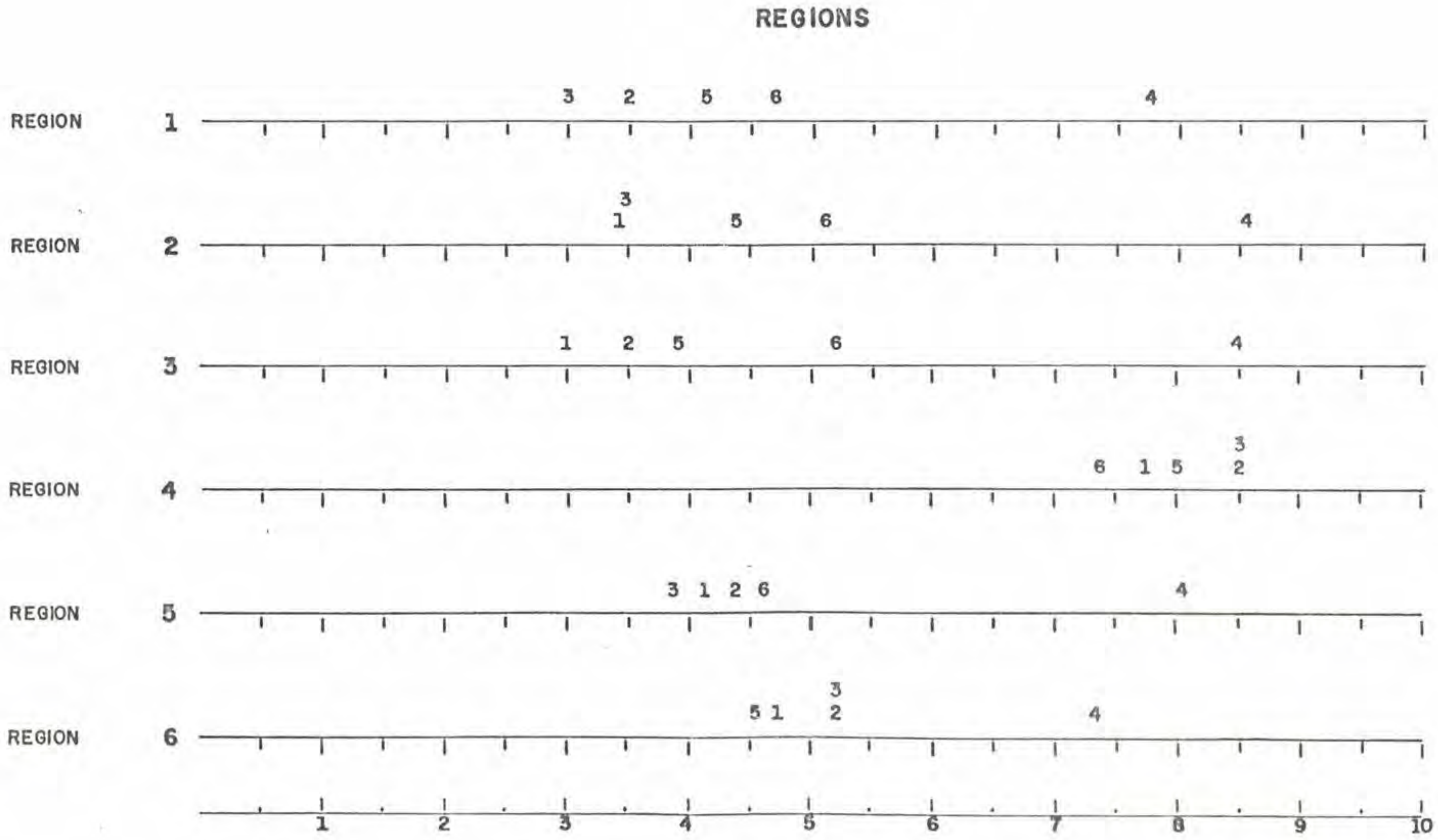

FIG. 10 - MAHALANOBIS'S DISTANCES AMONG REGIONS

INTERNATIONAL
WORKSHOP ON
OIL PALM GERMPLASM
AND UTILIZATION

PLANT GENETIC RESOURCES - AN OVERVIEW OF THE INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES

IBPGR PROGRAMME

By

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INTRODUCTION

The International Board for Plant Genetic Resources - familiarly known as the IBPGR - was established in 1974 by the Consultative Group on International Agricultural Research (CGIAR). The basic mandate of the IBPGR is to help to organize a global network of plant genetic resources centers whose activities will serve to safeguard, and to keep readily available for exchange and use the genetic diversity of the major crop species and of other plants of economic importance.

When the IBPGR was created it was faced with a daunting task and had to find its own way in the previously untrodden frontiers of plant genetic resources conservation. There were very few properly organized national and international programmes and the priorities were only defined in broadest terms and action plans were lacking.

The IBPGR in close association with the United Nations Food and Agriculture Organization (FAO) initiated its activities first by developing a list of priorities among crops and geographical regions (IBPGR, 1976) and second by translating such priorities into action programmes by fielding collecting missions for major staple food crops - especially in the case of emergency situations, for example, sorghum and millet collection in drought hit Sahelian zone of West Africa from 1975 onwards. The priorities include cereals, food legumes, root and tubers, oilseed crops, vegetables fibre crops, sugar and beverages. The Board's strategy has been and will continue to be, the assessment and continued revision of priorities for action. For instance sorghum and pearl millet rated the highest global priority in the 1970's but this was lowered to a second priority in 1980's inview of the practical work already undertaken or accomplished by the Board and other institutions like ICRISAT. At the same time in early 1980's some major fruit crops were added (IBPGR 1981) to the list of priority crops and by 1982 forage grasses and legumes were added.

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OIL PALM GENETIC RESOURCES

Although, oil palm was accorded second priority, relatively a very high priority for action, the IBPGR involvement in collection and conservation of Elaeis species was minimal. In accordance with the Board's mandate the majority of its funds have been and will in the future continue to be allocated for work on major food crops. However, the IBPGR has not neglected oil palm completely. In 1982 the Board has provided a grant to Palm Oil Research Institute of Malaysia (PORIM) to collect oil palm germplasm in Central America and also closely collaborated with PORIM during 1984 in its collecting efforts in Africa. The IBPGR convened a Working Group on the Genetic Resources of Oil Palm (Elaeis species) during September 19-21, 1984. The Working Group reviewed the existing collections. Based upon the information on existing collections the Group identified the geographical areas for future collecting. They are: Angola, central and eastern parts of Zaire, Congo and Gabon, parts of Cameroon, Ivory Coast and Bahia region of Brazil for Elaeis guineensis, and Venezuela, Brazil, The Guyanas and Suriname for E. oleifera. As one might expect the collection in Malaysia housed by PORIM was considered to be most comprehensive in the world and since the Government of Malaysia has offered that this collection is fully and freely available, the Group suggested that PORIM collection to be designated as a "Universal Collection" and collections in Brazil and Ivory Coast to serve as duplicate repositories. The Board at its recent meeting in February 1985 agreed to the above recommendations of the Working Group and the IBPGR Secretariat in the near future will contact the relevant authorities in this regard.

IBPGR ACTIVITIES AND ACCOMPLISHMENTS DURING FIRST DECADE (1874-1984)

When the IBPGR was established in 1974 there was little awareness by the general public and governments of the imperative need for an international programme for plant germplasm conservation.

By the time the IBPGR completed its first decade, the level of general awareness had been raised markedly. The IBPGR was instrumental in focussing awareness on the need for crop germplasm conservation and has in fact precipitated a great deal of action world-wide to collect, conserve and make freely available for all users, significant parts of the genepools of numerous crops. This has been matched by the establishment of storage facilities to hold base and active collections of germplasm. The conservation movement has not only recently played a part in raising the understanding of general public for conservation of crop genetic diversity but also the governments are becoming aware of their responsibilities in this field and in 1982 FAO Conference requested that an International Undertaking and a Commission on Plant Genetic Resources should be formed. The first meeting of the FAO Commission on Plant Genetic Resources was held, 11-15 March 1985 in Rome.

The IBPGR had a remarkable catalytic effect on international action over the past ten years and to have provided help-both technical and financial - to hundreds of centers world-wide. The developments have come about largely through IBPGR support to various national, regional and international programmes and also with the good will of scientists and their institutions, around the world comprising about 100 countries and 580 institutes, particularly the International Agricultural Research Institutions of the CGIAR.

One of the most striking results of the Board's activities has been the mobilization of best scientific advise so that the collections, conservation and documentation of the samples can be targeted to emergency situations and to fill important gaps in existing collections. This has resulted in larger collections being available to plant breeders than ever existed before in the history of plant breeding. The IBPGR is greatful to the voluntary cooperation of the scientists.

Collection: Over past 10 years the IBPGR has organized and/or associated with 582 collecting missions in more then 90 countries and gathered over 121,000 new seed samples.

The missions in most cases left complete sets of duplicates in the country of origin. Although most missions were for seed crops, action after 1980 was initiated on clonally propagated crops, especially root and tuber and plantation crops. In the coming years the collecting work will be upgraded and make it more scientific. The principle emphasis would be on eco-geographical surveys and much greater attention will be given to wild relatives inorder to make existing collections more fully representative of the genepools.

Conservation: In 1978 there were only six genebanks in the world with suitable facilities and equipment to store germplasm for long-term security. The Board over the years encouraging and assisting countries in setting up genebanks. It has provided basic equipment to national genebanks in several countries. During 1983 the IBPGR provided funds to Malaysia to set up a medium-term storage facility at MARDI. The Board during the past decade has designated 46 centers in 31 countries as base collections and they cover 30 seed crops. Of the 46 centers 25 are located in 18 developing countries. The network of base collections is in place but it needs fine tuning. There are many samples that need to be duplicated for safety within the network; there are many of these genebanks which require their standards looking at and help being given to upgrade their practical work. The Board through its support to research work on seed physiology has developed both conceptual and technical standards for seed conservation. Based on these the IBPGR seed storage committee finalized standards for the international register of genebanks, which will be used for monitoring the base collection network.

In the coming years the Board will give priority to developing a second tier of genebanks - active collections, which will have medium-term storage facilities and will be responsible for day-to-day work on multiplication, characterization and evaluation, documentation and exchange of materials and information.

The Board started intensive work on clonal crops since 1980 and has been supporting invitro research work for conservation, especially cyopreservation on cassava, cocoa, banana, Citrus, coconut, colocasia (taro) and sweet patato. Significant results are beginning to stem from that work, but it is too early to expect any major results for implementation as some of these projects have started about year ago. The Board is also establishing a database on disease indexing and biochemical characterization of invitro cultures and also support work to develop novel collection techniques for clonally propagated crops and also for cacoa and coconut.

Information and documentation: The Board's strategy has been to encourage and assist curators holding significant collection to organize a data management system for easy retrieval of information. The IBPGR provided technical assistance to many genebanks in developing countries to establish computerized systems. The Board has published internationally agreed descriptor lists for about 50 crops and inaddition published directories of crop germplasm directories for most crops, summurizing what is held where.

The Board's recent emphasis has been to encourage the establishment of crop specific data bases. The Board has also found that crop databases need to be linked to centers where there is an active genebank and where evaluation work is in progress. The IBPGR has also involved in characterization and evaluation of crop germplasm and has provided funds to several national and international institution and this work will be increased in the future inview of the great need for the data. However, the Board recognizes that these activities require rather large finding.

Training: Lack of trained manpower has been one of the most serious drawbanks to building up and improving work on plant genetic resources, particularly to the developing countries. To bridge the gap, the IBPGR, since its inception, has been supporting training courses, upto M.Sc. level at the University of Birmingham, UK, where a specialized course on Genetic Resources Conservation and Utilization is offered to scientists from the third world countries. About 200 students, of which 68% are from 45 developing countries participated. In addition over 1,000 scientists/technicians were given specilized training for short periods in various fields of genetic resources work. Recently, an intern scheme at the pre- and post-doctoral level, has been instituted by the IBPGR. In a few years this scheme will have a major impact on the world network.

During January-February 1985 the IBPGR programme was reviewed by a panel of experts appointed by the Technical Advisory Committee of the CGIAR. Dr. Hardon was one of the improtant members of that review panel. It was gratifying to note that the panel at the outset stated that the IBPGR has achieved what CGIAR could have achieved in ten years.

The review panel's report was discussed by the IBPGR at its recent meeting in February 1985. The Board consurred with the views expressed by the panel. The Board noted with satisfaction that the panel believed that the IBPGR should not only continue its work but that it should take significant new directions - inorder to respond most effectively to changing needs of genetic resources conservation and utilization.

A major recommendation of the report states that the IBPGR should concentrate more of its attention to developing the now slender research base, which provides the scientific principles for conservation and utilization of germplasm. The panel considered that the Board should be more active in providing contract research but in addition is firmly of the view that it should develope its own in-house research capability. Currently this matter is being discussed by the TAC. The panel also recommended that change of emphasis in Board's activities, should include greater attention to the evaluation and utilization of germplasm now in store. The Board was in full agreement with the panels recommendation, realising very well the financial and other implication.

INTERNATIONAL
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AND UTILIZATION

EMBRAPA

LONG TERM CONSERVATION OF OIL PALM (ELAEIS GUINEENSIS)

BY

J.J. HARDON

Long Term Conservation of Oil Palm
(Elaeis Guineensis) J.J. Hardon

Introduction

Where long term conservation of a crop is considered, it has to be established why it is necessary, what should be preserved and how it should be done.

Hence the first question that needs to be answered is, whether loss of genetic diversity is a serious problem in the species. To be able to answer this question requires information on:

i. The geographic range of distribution
ii. Eco. systems and population structure
iii. Intra. specific variation and its distribution

The geographic range of distribution is generally given as the tropical rainforest belt from Angola to Cape Verde. Zeven (1967) states that the natural habitats for oil palm are those areas which are too wet for a rainforest vegetation, i.e. sources and banks of rivers, wet valleys, swamps etc. The present wide distribution of oil palm is the tropical rainforest belt of West Africa is ascribed to human conterferance.

Primanary Population

Assumming that Zeven's (1967) definition of the matural habitat of the oil palm is correct, there seems to be little information published on primary populations. Considering the mature of the habitat, it may be assumed that oil palm occur small clumps of various dimension. Evidence suggests that insect pollination is important but that wind pollination occurs as well.

In fact, wind pollination may be an adaptive trait increasing the likelihood of isolated palms or very small clumps to be pollinated by more distant populations. Distribution of seeds takes place mainly by birds, rodents and by water. However it would seem likely that a majority seeds will remain within the source population which suggests same degree genotypic assortative mating. These largely speculative views indicate that effective breeding populations may be small, a situation similar to the one reported by Ashton (1969) for tropical hardwood species. Again, assuming that priminary populations can be identified, from secondary populations by their habitat, they would seem to be of considerable interest.

Generally, in primary population prevailing environmental conditions of habitats or niches are mirrored in the genetic characteristics of the population.

Hence, between population genetic differentiation may be a major item of variance.

Since so libble is known about presumed primary population it would seem difficult to decide whether or not genetic conservation activities are required.

At this point distinction should be made between "gene pool conservation" and "nature conservation". Frankel (1970) has pointed out that nature conservation deals with identifyable habitats and communities while gene pool conservation is conservation at the level of species and populations. The need for nature conservation to safe natural ecosystems and biomas is not in question. However to decide on whether or not specific action is needed to safequard priminary populations of the oil palm requires activities that are referred to as eco-geographic surveys including information or inter and intra population variation.

Secondary Populations

The result reported by Rajanaidu (this workshop) largely concern probably secondary populations established through some form of human interference. The distribution of the oil palm in the forest zone does not seem to be even, ranging from isolated palms, to small clumps and dense and extensive groves, becoming rarer as one travels north to the drier parts and into the Sudan Zone. The systematic sampling of populations carried out in Nigeria and more recently in the Cameroons and Zaire are an essential first steps in the understanding of these populations. The results indicate high variation within palms and much less between sites. It suggests that natural selection and adaptation to specific environments has not yet lead to any extensive population differentiation. Hardon (1974) suggested that whatever population differentiation was observed may be largely due to genetic drift and small source populations rather than selective process. The alternative of continuous variation in a relatively uniform and stable environment as is sometimes ascribed to the rainforest of the humid tropics would not apply, as material was also collected from the drier northern ragions with no apparent increase in genotypic differentiation.

These results are convincing support to the notion that the wide spread distribution of oil palm in the rainforest zone is indeed of recent origin. Considering the nature of the variation and the extensive occurence of oil palms thoughout its area of distribution it would seem unlikely that as a gene pool, this material is in danger of erosion in the forseable future.

Methods of Conservation

In sufficient information on priminary populations and their native habitats preclude decisions on the need for genetic conservation. As for secondary populations, the conclusions is that genetic erosion may not as yet be a serious threat.

In spite of this, it would seem necessary to start thinking about the most appropriate methods of conservation, as such activities require long term strategies and planning.

Factors affecting mode of conservation at the species level are:

- The geographic range of distribution
- Intra-specific variation and its structure
- Effective population sizes

The two major alternatives:

- In situ conservation which is the maintenance of self-perpectuating populations in natural eco-systems.

- Ex situ conservation which is the maintenance of genetic resources outside the natural ecosystem, generally on the basis of sampling and under some form or management.

In Situ Conservation

In the world conservation strategy prepared by the International Union for conservation of nature and Natural Resources (IUCN, UNEP, WIUF 198) the main objectives of in situ conservation are given as:

- to maintain essential ecological processes and life support systems

- to preserve genetic diversity

- to ensure the sustainable utilization of species and ecosystems.

However, scientific principles on which the conservation of ecosystems and biomes are basid, are not neccessarily identical to those that should govern in situ conservation of crop genetic resources. A major consideration is that genetic resources of oil palm cut across a wide range of identifyable ecosystems distributed over large geographic areas. It is assumed that primary populations can be identified as specific population inhabiting suitable natural ecosystenous. Conservation of some of these ecosystems is undoubtedly valuable. However it is unlikely that a major or representative part of the gene pool can be maintained in this manner suggesting the need for additional ex situ conservation.

The same, though perhaps to a lesses extent may apply to secondary populations.

Apart from the difficulty of adequately representing the total genetic variation in restribted conservation areas, there are a number of important legal and management constraints. Experience shows that long term tenure and the legal enforcement of protection of mature resorves is often tenuous to say the least. Considering the serious economic problems of a large number of countries in West and Central Africa add to the insecurity of in situ conservation.

Ex Situ Conservation

Ex situ conservation of genetic resources is most common for economic plants. Guldager (1975) recognises the following four objectives for ex situ conservation with consequences for the methodology applied:

-1. Static conservation aimed at the maintenance of genotypes

-2. Static conservation aimed at the maintenance of gene frequencies on genes (gene pools)

-3. Evolutionaty conservation where within collections gene frequencies are affected by natural selective processes.

-4. Selective conservation in which gene frequencies are deliberately modified to satisfy better the requirement of breeding programmes.

An extreme example of this is the collection carried out by INEAC in the nineteen fifties selecting approximately 1 in 24000 palms observed, often in commercial plantings from INEAC seed. A better example is the palms selected in Yocoboue in the Ivory Coast by the IRHO (Meunier, this workshop).

Alternative 2 - Static conservation of genepools on gene frequencies - best describes the recent PORIM collection in West Africa. The original objective was to provide Malaysia with a wider range of oil palm material for breeding. However the method of collection, based on essentially random sampling of natural/ semi-natural populations is more similar to sampling genetic variation for conservation.

If, as the author believes, genetic erosion of the gene pool of oil palm is not at present a serious problem, it would seem justified to aim collection at material useful to breeding programmes.

Collecting and Conservation Strategies

Considering the narrow genetic base of most breeding programmes, the need for introducing new unrelated materials would seem convining.

Selective conservation requires extensive information on individual palms or populations before collection. This will probably require systematic surveying of populations over a period of time. Clearly that can only be done by institutions in the country of origin of such population as for instance has been done by the IRHO in the Ivory Coast. It is still arguable how effective detailed recording of grove palms is compared with a single check of highly heritables characteristics and the planting of open pollinated seeds from such selected palms.

The ideal situation would be if a number of institutions over the area of distribution of the oil palm would carry out such surveys. Seeds from selected palms could be planted in ex situ living collections and serve as a gene pool for breeding programmes. It would seem justified to have such an activity financed by the oil palm industry at large. A network of such ex situ conservation collections could serve as a nucleus for for further more extensive conservation action if genetic erosion becomes a problem.

Clearly Malaysia would enonously benefit by such a scheme and therefor should be prepared to share the financial burden.

However, preceeding an organised selective conservation programme, much more information is required on distribution of oil palm populations, identification of major areas of variation, primary populations and their genetic differentiation, populations grown in more extreme environments, amongst others at the periphery of geographic distribution etc. Time would seem to have come to embark on more systematic research in these areas. Again, the major oil palm producers should be prepared to finance such activities. Essentially it requires field botanists to carry out eco-geographical surveys. Considering the employment situation of graduates is for instance Europe, it would not be difficult be find well trained researchers for such work.

The cost involved would be minimal since eco-geographical surveys require few facilities and staff.

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