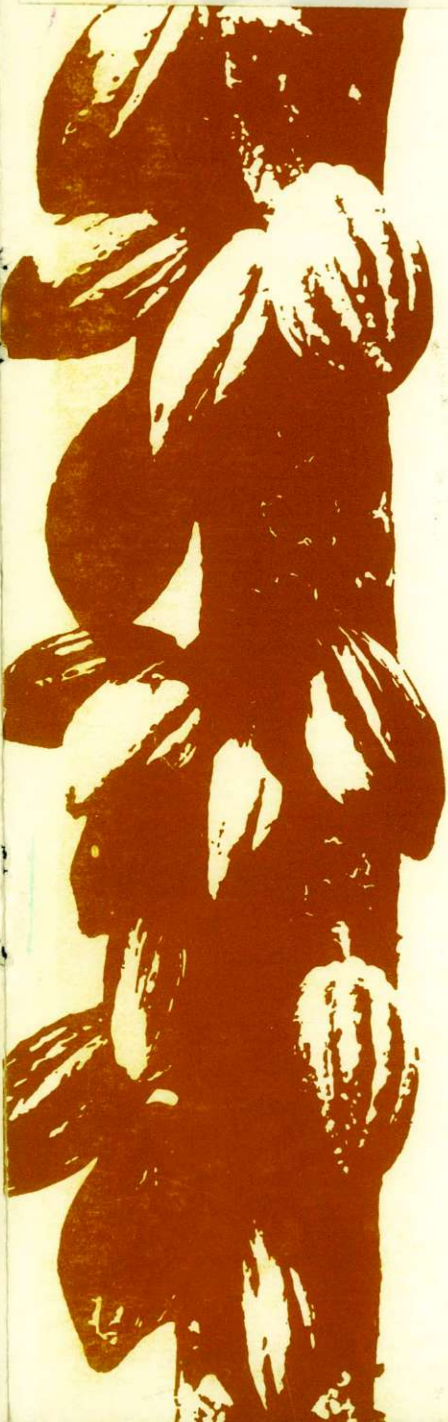

LONDON COCOA TRADE AMAZON PROJECT

FINAL REPORT

PHASE TWO

SPECIAL ISSUE OF

COCOA GROWERS' BULLETIN

Number 39 December 1987

LONDON COCOA TRADE AMAZON PROJECT

(PROJECT FUNDED BY LONDON COCOA TERMINAL MARKET ASSOCIATION ON BEHALF OF THE LONDON COCOA TRADE)

FINAL REPORT PHASE 2

J. B. ALLEN
Plant Collector, c/o Director-General, INIAP, Apartado 2600, Quito
(Present address: Sunnybank, Caberston Avenue, Walkerburn, Peebleshire, EH43 6BA, Scotland)

Report Edited by R. A. Lass and Sue Sanderson

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1. INTRODUCTION

1.1 BACKGROUND

It is generally acknowledged that the most effective way of increasing cocoa yields is to introduce new planting material; it is similarly accepted that progress in cocoa breeding depends on the introduction of germplasm from wild populations of cocoa. Wild cocoa (Theobroma cacao) is widely distributed in the tropical rain forest areas of South and Central America, and over the past 50 years a number of expeditions to collect wild cocoa germplasm have been organised, of which the London Cocoa Trade Amazon Project (LCTAP), described in this report, is the most recent and most systematic and thus ambitious.

The general aim of the London Cocoa Trade Amazon Project was to make available to breeders wild cocoa from the Amazon Region of Ecuador. The project was planned and financed in 2 stages, collectively known as LCTAP. Phase One, covering the period May 1979 - March 1983, has already been published (Allen and Lass, 1983). The present report describes the activities and presents the results of Phase Two, during the period April 1983 - October 1985, with some additional data collected up to June 1986.

FUNDING

The London Cocoa Terminal Market Association (LCTMA) now called London Cocoa Terminal Market (LCTM), having already provided generous funding for Phase One of LCTAP, agreed to provide the additional financial support which was needed to conduct the second phase of the project. The member firms of LCTM have continued to take a keen interest in the progress of the project, which is seen as a fundamental contribution to the long-term stability of the world cocoa industry. Their support for the project continues to be recognised not only in the name of the project, but also in the identification of collected material with the prefix LCT-EEN (LCT standing for London Cocoa Trade, see Section 2.7).

Support in Ecuador was provided by INIAP, the national agricultural research institute. The project was based at the INIAP Napo-Payamino Experimental Station at San Carlos (between Lago Agrio and Coca, Napo Province). One member of the station's scientific staff, Agr José Baquero, worked full time on the project as a technical assistant throughout both Phase One and Phase Two. In March 1984, INIAP appointed a new graduate to work part time on the project, Ing Roger Mera. It was intended that Ing Mera would take responsibility for other research programmes at San Carlos as well as LCTAP. This arrangement proved impracticable, and a second graduate, Ing Juvenal Cabrera, was appointed in 1985 to work full time with the cocoa genebank at San Carlos. After a 3 month training period at the INIAP Pichilingue Station, Ing Cabrera started work at San Carlos in August 1985.

The project continued to operate as a component of the INIAP Cocoa Programme, based at Pichilingue. Close contact was maintained with Ing Jaime Vera (head of the Cocoa Programme), Ing Eduardo

Mogrovejo (cocoa breeder) and Dra Carmen Suarez (Director of Pichilingue, and later Technical Sub-Director for the Coastal Region), and also with the members of the British Overseas Development Administration cocoa research team at Pichilingue.

1.2 PHASE ONE

The specific objectives of LCTAP Phase One were:

a. to make a systematic collection of wild cocoa from the Amazon Region of Ecuador, bringing into cultivation as much as possible of the genetic variation present in wild cocoa populations in this region;

b. to establish a field genebank - that is, a permanent germplasm collection - of this wild cocoa at San Carlos in Ecuador;

c. to initiate the distribution of the collections to breeders, by the transfer of material to quarantine.

The final report on LCTAP Phase One (Allen and Lass, 1983) began by reviewing published information on genetic variation in wild cocoa populations, and on collecting expeditions, with particular emphasis on the Upper Amazon region.

The proposal for further collecting in this region was based on three factors: the high level of variability of wild cocoa in the region; the proven value of Pound's Upper Amazon collections for breeding programmes; increasing development, with new roads, oilfields and settlements, which make collecting easier but also imply the imminent destruction of the wild cocoa populations of the region.

The Phase One report continued with a general description of the Amazon Region of Ecuador, including information on climate, soils, vegetation, agriculture and settlement patterns. Most of this information remains applicable to Phase Two; some additional climatic data are included in Appendix 2 of the present report. Collecting and propagation methods were described in detail in the Phase One report; the present report summarises this methodology, and also outlines the results of some experiments on techniques.

The Phase One report included detailed accounts of 16 collecting trips. The accompanying maps, located each collection precisely, and provided some information on the soils, vegetation and settlement of the areas where collections were made. The report also included descriptions of the characteristics of the collections, and observations of witches' broom and other diseases. By the end of Phase One, 364 collections of T. cacao had been made, of which 245 had been established in the field gene bank at San Carlos, including 115 collections of budwood and 130 collections of seed. The report explained that these collections were intended to be a random sampling of the wild cocoa populations in the region, as there was no reliable basis for selection in the field. The accounts of the collecting trips show how this theoretical collecting strategy translates into practice in the field.

A preliminary analysis of the characteristics of wild cocoa populations from different parts of the Amazon Region of Ecuador demonstrated the overall uniformity of much of the collected material. Wild cocoa from this region typically has a pale green flush, with little or no anthocyanin pigment, wrinkled green (ripening to yellow) pods and a high frequency of white seeds.

By the end of Phase One (March 1983), about 85 collections (35% of those in San Carlos were represented in quarantine in Kew.

1.3 OBJECTIVES OF PHASE TWO

The principal specific objectives of LCTAP Phase Two were:

a. to complete the transfer of the collections to quarantine;

b. to extend the systematic description of the morphological characteristics of the collections, using the descriptor list recommended by IBPGR;

c. to initiate the preliminary evaluation of the agronomic characteristics of the collections, including vigour and disease resistance;

d. to extend the programme of collecting trips, to cover areas not visited during Phase One, including areas which had recently become accessible because of new road construction or other developments;

e. to develop contacts with scientists and institutions with interests in cocoa germplasm collecting in Colombia, Peru and Bolivia.

As with Phase One, these main objectives implied some further activities. These were, first, the continued maintenance of the cocoa genebank at San Carlos, and, second, the training of INIAP staff.

2. METHODS

2.1 COLLECTING

Collecting and propagation methods have not changed from those used in Phase One (Allen and Lass, 1983, Section 3.1). These methods may be summarised as follows:

a. material was collected in the course of short trips, lasting from two days up to 2 weeks (except for the expedition to the Rio Caquetá in Colombia, described in Section 3.2);

b. pods were collected wherever possible, and budwood was collected if no pods were available;

c. seeds were stored in unopened pods, or in damp charcoal; budwood was stored in damp newspaper, after sealing the ends of the budsticks with wax;

Figure 1 Plan of San Carlos genebank

Notes:

1. Updated to 31.7.86 (but excludes new Blocks 9 and 10).
2. All collections are LCT–EEN unless otherwise identified.
3. Other collection prefixes:
   EBC = Expedición Botánica Caquetá
   NAPO = NAPO (Chalmers)
   AGU = AGUARICO (Chalmers)
4. Collection grouped
   (tree position in row in brackets):
   [A]= 25 (2), 26 (3–6), 27(7–10)
   [B]= 28 (1), 29 (2–4)
   [C]= 2 (1), 32 (3), 38 (5)
   [D]= 103 (1), 146 (2), 137 (3)
   [E]= 90, 120, 121, 124, 126
   [F]= 145 (1), 158 (2)
   [G]= NAPO 24 (1), AGUARICO 31 (2)

```
                     BLOCK 3A   BLOCK 3B             BLOCK 5            BLOCK 7A    BLOCK 7B
                         (CLONES)                 (SEEDLINGS) 1               (CLONES)
                     12345      54321              1234567890             12345       54321
    BLOCK 1          *****      *****              **********             *****       *****
 (SEEDLINGS) 1       *****      *****              **********             *****       *****
    1234567890   30  ooooo      ooooo  373     348 oooooooooo        374  o----       ooooo  2
    _*********   31  ooooo      ooooo  371     347 oo-ooooooo        376  oo---       ooooo  NAP024
    **********   33  ooooo      -oooo  370     346 oooooooooo        378  oo---       ooooo  AGU31
 1  oooooooooo   36  ooooo      ooooo  369     345 ooooooo-o-        379  o----       -oooo  32
 4  oooooooooo   37  ooooo      -oooo  368     344 oooooooooo        382  oo---       ooo-o  38
 5  oooooooooo   46  ooooo      ooooo  367     343 ooo-oooooo     EBC114  o----       -oooo  97
 6  oooooooooo   49  ooooo      --ooo  366     342 ooooo-o-oo             -----       ooooo  103
 8  oo-ooooooo   52  ooooo      ooooo  364     341 oooooooooo     EBC118  o----       ooooo  120
10  oooooooooo   57  ooooo      --ooo  362     340 oooooooooo     EBC122  o----       ooooo  126
11  oooooooooo   60  ooooo      -oooo  142     339 oooooo-ooo     EBC135  -oooo       ooooo  128
14  ooo-ooooo-   63  -oooo      --ooo  141     338 oooooooooo     EBC138  oo---       ooooo  137
15  oooooooo--   65  ooooo      ooooo  133     337 oo-ooooooo     EBC141  o----       --ooo  145
18  oooooooo--   68  ooooo      ooooo  333     336 ooooooooo-     EBC145  o----       ooooo  158
19  oooooooo--   73  ooooo      ooooo  327     335 oooooooooo             -----       ooooo  391
20  oooooooo-o   74  ooooo      --ooo  124     334 oooooo----          oooooooooo  EBC148
21  oooooooooo   80  ooooo      --ooo  297     332 oooooooooo          -------ooo  EBC147
22  oooooooooo   81  ooooo      ooooo  280     331 -ooo------          ---------o  EBC142
23  oooooooooo   91  ooooo      -oooo  121         ----------          oooooooooo  EBC138
24  oooooo-o-o  [C]  o-o-o      ooooo  193     329 o---oo-o--          ---------o  EBC135
[A] -oo-oooooo   47  o----      ooooo  94      328 oooo-ooooo          --------oo  EBC126
[B] oooo------  [D]  ooo--      ooooo  312     313 ooooooooo-          oooooooooo  EBC125
44  o-o-o-oooo  107  ooooo      ooooo  278     302 oooooooooo          --------oo  EBC123
48  ooooooooo-  108  ooooo      ooooo  195     300 oooooooooo          ----oooooo  EBC121
58  oooooooooo  122  ooooo      -oooo  189     326 oooooo--oo          --oooooooo  EBC101
59  oooooooooo  123  ooooo      --ooo  166     325 ooooo-o-oo          -----ooooo  EBC100

    BLOCK 2         BLOCK 4A   BLOCK 4B             BLOCK 6             BLOCK 8
  (SEEDLINGS)           (CLONES)                  (SEEDLINGS)         (SEEDLINGS)
61  o---oooooo  125  ooooo      -oooo  300     324 oooooooooo          -----ooooo  EBC91
62  oooooooooo  130  ooo--      ooooo  281     323 oooooooooo          oooooooooo  EBC86
64  oo--oo----  144  ooo--      oo-oo  269     321 ooooooooo           o-oooooooo  EBC85
65  ooooo-oooo  150  oo---      ooooo  267     320 oooooooooo          ------oooo  EBC84
66  oo-ooooooo  151  ooooo      ooooo  264     306 ooooooooo-          ------oooo  EBC79
67  oooooooooo  152  ooooo      -oooo  259     296 oooooooooo          -----ooooo  EBC78
68  oooooooooo  153  -oooo      ooooo  258     295 ooo-oooooo          oooooooooo  EBC77
69  -ooo------  154  -o-oo      ooooo  257     288 oooooooooo          -ooooooooo  EBC76
70  ooooooo-oo  155  ooooo      ooooo  255     134 ooooo-----          o-oooooooo  EBC58
71  ooooooo-oo  156  ooooo      ooooo  254     271 oo-ooo----          oooooooooo  393
72  oooooooooo  157  ooooo      -oooo  253     248 -ooooooooo          ----------
74  oo-ooooo--  [E]  ooooo      -oooo  251     246 oooooooooo          --------oo  EBC48
76  oooo-oo---  [F]  oo---      ooooo  250     244 ooo--ooooo          ------oooo  EBC30
77  ooooooo--o NAP027 -oooo     ooooo  249     243 -o--------          -ooooooooo  EBC29
82  oooooooooo NAP029 oooo-     ooooo  241     242 -oooooo-oo          oooooooooo  EBC10
79  oooooooooo NAP051 ooooo     ooooo  238     241 ooo-------          oooooooooo  EBC9
78  oo-oooo-oo  [6]  oo---      -----          212 oooooooooo          ooo-oooooo  EBC6
83  oooooooooo  282  ooooo      ooooo  283     215 ooooo-----          oooooooooo  EBC5
84  ooo-oooooo  146  o-ooo      ooooo  237     214 -oooo-----          o-o---oooo  372
85  oooooooooo  148  o-ooo      -oooo  236     205 o---oooo-o          ooooo---oo  361
86  oooooooooo  149  ooo--      ooooo  234     203 ooo-------          ooooo-oooo  360
87  oooooooooo  162  ooo-o      ooooo  232     202 ooooo-oooo          ooo-ooo--o  359
88  oooooooooo  163  ooooo      ooooo  231     201 o-o-oo-ooo          ooooooo-oo  358
89  oooooooooo  164  ooooo      ooooo  228     199 oooooooooo          oooooo-ooo  357
90  oooooooooo  165  ooo--      ---oo  227     196 o-oooooo--          ooo-oooooo  356
92  oooooooooo  166  ooo--      ooooo  223     182 oooooooooo          ooooooo-o-  354
93  oooooooooo  169  ooooo      ooooo  222     162 oooooooo-o          ---------o  355
101 oooooooooo  172  ooooo      ooooo  221     136 oooooooooo          ----ooooo-  353
109 oooooooooo  175  oooo-      oooo-  220     132 oooooooooo          o-oooooooo  352
113 ooo-------  178  oooo-      ooooo  219     160 o-oooooooo          oo--oooooo  351
115 oooooooo-o  179  ooooo      ooooo  218     159 --ooooooo-          -o---ooooo  350
127 oooooooooo  181  ooooo      ooooo  217     145 o-oooooooo          ooo-oooooo  349
128 -o--------  185  ooooo      o-ooo  216     142 ooo--oo---          **********
130 oooooooooo  187  ooo--      -----          131 o--o-oo-oo          **********
    **********       *****      *****              **********          ******____
    **********       *****      *****              **********          ******____
    1234567891       12345      54321              1234567891          1987654321
             0                                              0          0
```

d. all the collected material (except from the Rio Caqueta) was taken to San Carlos for propagation;

e. seed was sown in plastic bags in the nursery, with germination rates approaching 100 per cent;

f. budwood was used either for patch budding of individual buds, or for side-grafting of entire budsticks (Soderholm and Shaw, 1965). The latter technique was preferable.

Because of the importance of budwood for transferring material to quarantine, some experiments were made to test the effects on budding success rates of anti-fungal treatments, different packing methods and varying periods of storage. The results of these experiments are presented in Section 5.2.

2.2 FIELD GENEBANK

The field genebank occupies about 4 ha of land at the San Carlos site of the INIAP Napo-Payamino Experimental Station. San Carlos is located between Lago Agrio and Coca in Napo Province (0°20'S, 76°50'W) at 265m altitude. Climatic data for San Carlos are included in Appendix 2. The site was originally covered by mature forest, apparently undisturbed although the number of pottery fragments in the soil suggest that the forest was cleared at some time in the past, possibly several hundred years ago.

Part of the genebank site is shaded by trees remaining from the original forest, while the rest is shaded by planted Inga edulis (guabo) at 9m by 8m spacing. The shade level is now moderate (20-40% of full sun) and fairly uniform throughout the site. Given the high rainfall throughout the year, and high average cloud cover, additional shade was not provided for newly planted trees.

The plan of the genebank is indicated in Figure 1. Seedlings and budded plants were placed in separate blocks. For each collection of seed, a maximum of 10 seedlings were retained and planted in a single row. Where less than 10 seedlings were available, the gaps were left unplanted, and no attempt was made to fill these gaps by further propagation unless it appeared that there was a risk of losing all the seedlings through damage or disease. Budwood collections were planted as a row of up to 5 plants, and extra budded plants were propagated to fill gaps in these rows wherever possible. All trees were spaced at 4m (between rows) by 3m (within rows).

The collections were planted out in groups once or twice a year since January 1981. Routine maintenance involved:

a. weed control: every 3-4 months, the entire area of the genebank and nursery was roughly cleared by machete. Planted areas (where weed growth was not suppressed by the closure of the canopy of the cocoa) were then treated with a mixture of paraquat (1 kg/ha) and diuron (1 kg/ha). Unplanted areas were treated with 2,4-D (2 kg/ha). (Note: these treatment rates are approximate);

b. chupon removal: every 1-2 months;

c. sanitary pruning: starting in May 1985, and planned to be repeated at yearly intervals, all trees were pruned to reduce the density of the canopy, remove epiphytes and low branches, and generally improve access for harvesting and data collection;

d. formation pruning: apart from the reduction of canopy density and the removal of low branches (see above), this has been kept to a minimum, to avoid obscuring variability in growth habit. However, for practical reasons, the height increase of the trees has been restricted by removing chupons above the first jorquette (except where the first jorquette occurred below about 1m, in which case a second jorquette would be allowed to form);

e. disease and pest control: no disease control has been undertaken, as the observation of natural infection forms part of the evaluation of the collection. As part of the assessment of witches' broom disease, all brooms were counted and removed in July 1984, but this very laborious procedure will not be repeated. Insect pests in general have not presented serious problems. Ants inhabiting the trees (including Ectatomma tuberculatum (Olivier), Crematogaster sp, and Paratrechina sp; see Wright, 1984) impede harvesting and data collection, and have occasionally been controlled by spraying with malathion or dimethoate. Leaf-cutting ants (Atta sp) cause limited damage to individual trees, and some large nests have been destroyed with diesel fuel oil. Damage to young plants in the nursery by defoliating insects sometimes reached unacceptable levels, and was controlled by spraying with malathion or dimethoate. Some very young seedlings were killed or damaged by rabbits, which bit off the tops of the plants but did not eat them. Rabbit damage was apparently minimised by regular cutting of the vegetation immediately round the nursery.

The results of a soil analysis for the San Carlos genebank site are given in Table 1, with some typical values of cocoa-growing soils for comparison. These results show that the soil at San Carlos is somewhat more acidic, and has a lower exchangeable calcium content, than most cocoa-growing soils. Nitrogen, magnesium and potassium levels are below average, but phosphorus and organic matter are high.

Table 1: Soil analysis data for San Carlos Genebank site, compared with typical cocoa-growing soils

	pH	Org. Mat	Tot. N	Tot. P	Exchangeable Bases Ca	Mg	K	Ca /Mg	(Ca+Mg) /K
		(%)	(%)	(ug/g)	(meq/	100g)		(Ratios)	
S.Carlos (0-10 cm)	4.2	9.4	0.30	702	5.19	1.60	0.48	3.24	14.1
Typical Average	7.1	5.6	0.57	540	20.99	4.33	0.51	5.49	63.2
Cocoa Soil Max.	7.7	15.4	1.60	550	36.80	10.20	0.89	13.09	110.3
Cocoa Soil Min.	6.0	1.7	0.14	530	7.50	1.66	0.09	3.60	10.4

NOTES:

i) the results for San Carlos are based on duplicate analyses of 5 samples taken from the genebank site and the adjacent forest. The analysis was done by A Gray, Department of Forestry and Natural Resources, Edinburgh University;

ii) comparative data for typical cocoa growing soils were taken from Wood (1975), Table 4.1. They include soils from Ghana, Nigeria, Ivory Coast, Trinidad, Sabah and Western Samoa, sampled at depths between 0-4 cm and 0-20 cm. The total phosphorus figures are from only two samples.

2.3 DESPATCH TO QUARANTINE

During LCTAP Phase Two, shipments of germplasm have been sent to four quarantine centres:

a. Barbados: Cocoa Research Unit Quarantine Station, Ministry of Agriculture, Graeme Hall, Barbados;

b. Kew: Royal Botanic Gardens, Kew, UK;

c. Miami: USDA Subtropical Horticulture Research Station, Miami, Florida;

d. Montpellier: IRCC, CIRAD, Montpellier, France.

Shipments to Kew ended in March 1984, with KEW-23. The Kew quarantine unit closed at the end of 1984 and all LCTAP material held there was sent to Trinidad. The Barbados quarantine facility, run by the Cocoa Research Unit in Trinidad, opened in April 1985, and a major effort was made to transfer the LCTAP material to Barbados between May and October 1985. Two trial shipments to Montpellier were made in October 1984 and September 1985.

Shipments to quarantine included budded plants and seedlings raised in the San Carlos nursery as well as budwood and seed. Packing methods have tended to vary in the light of experience; the procedures which have proven most satisfactory may be summarised as follows.

For plants:

a. the plants are first pruned to a total height, including the roots, of about 50 cm. All the leaves are then cut off at mid-petiole;

b. the roots are gently shaken free of soil, and then washed;

For plants and budwood:

c. the material is then immersed for about 30 seconds in a fungicide, either ferbam (1:4 paste with water), or difolatan (captafol) (0.3% suspension). The choice of fungicide was determined by the quarantine centre receiving the material. Material sent to Barbados was also treated by dusting with 5% furadan granules, as a combined insecticide and nematocide treatment;

d. the material is packed in damp newspaper, 5-8 plants or up to a dozen budsticks being bundled together in three large sheets of slightly damp newspaper. Several of these bundles are then placed inside a large plastic bag, which is secured with adhesive tape but not tightly sealed. These bags are then placed in 60 litre plastic drums with tight-fitting lids. Up to some 80 plants can be fitted into one of these drums when the plants are packed in newspaper. Expanded polystyrene granules were used to provide some degree of insulation and protection from shocks. Maximum-minimum thermometers were placed inside some packages to check on temperature fluctuations in transit.

On arrival, budwood has been budded by various patch-budding and side-grafting techniques, depending on the quarantine centre. Budding success rates continued to be rather low (see Section 5), but this caused less concern than in the past as most material was sent in the form of complete plants. On arrival at a quarantine centre, these plants need only be replanted in soil in plastic bags.

2.4 DESCRIPTION OF MATERIAL

The description of a germplasm collection serves three principal functions. First, it provides information for the permanent identification of material held within or distributed from a genebank. Although the total elimination of identification errors in distributed clones poses many difficulties (Engels, 1986), there is no doubt that the publication of full descriptions of distributed germplasm, using standard descriptor lists, will avoid much confusion when this material reaches breeders' working collections. Secondly, it provides a basis for the analysis of patterns of variation within and between populations. Such an analysis is necessary both for evaluating alternative collecting strategies (see Section 8), and also for breeders who wish to work with genotypes representative of specified populations. Thirdly, information on characters of agronomic importance provides a direct basis for the selection of superior genotypes for use in breeding programmes.

The complete descriptor list used in this project is given in Appendix 4. The coding of the descriptors, and the methodology of recording, follows closely the recommendations of Engels (1981), with one important exception; pod and bean data were recorded from a sample of 1-5 pods per collection, rather than the recommended sample of 10-20 pods. Many of these data were obtained on collecting trips, at the time of collection when few wild trees yielded more than two or three healthy pods. For collections made as budwood, it was necessary to wait until pods were produced at San Carlos, but time did not permit measurements to be made on large samples of pods. Nonetheless, many descriptors showed little variation within a collection, so that the data (presented in Appendix 5) do adequately describe the characteristics of the collected genotypes. This is particularly true of qualitative descriptors such as pod surface texture and pod apex form, and of ratios between measurements, such as the ratio of pod diameter to pod length.

Particular care has to be exercised in the interpretation of the bean colour descriptors. For pods collected in the wild, these data reflect the gene frequencies of the wild populations. These are of much more interest than the bean colour variation which occurs as a result of cross-pollination within the genebank. However, it can be deduced that a clone which produces only white beans in the genebank is homozygous for the recessive non-pigmented bean allele.

2.5 EVALUATION OF MATERIAL

The purpose of evaluation is to provide information on the performance of individual genotypes. The conventional practice in cocoa breeding programmes has been to set up replicated trials in which a fairly small number of genotypes are planted under experimental conditions and their performance assessed over a period of up to 20 years (for example, Lockwood, 1976). The difficulty with this approach is that cocoa collecting expeditions tend to generate very large numbers of genotypes, and a complete evaluation of this material, with proper experimental design involving replicated plots at several sites, requires very substantial resources. This has resulted in long delays in the evaluation of important collections of cocoa germplasm. For example, the main populations held in the International Cocoa Genebank, Trinidad (ICG,T) add up to about 1,760 genotypes (Kennedy, 1985); a series of 7 major progeny trials started between 1965 and 1968 used as parents only 36 of these genotypes (University of the West Indies, 1983). Collecting programmes in Brazil, Colombia and Ecuador (including LCTAP) over the past 40 years have resulted in the incorporation of perhaps 4000-5000 genotypes into field genebanks, and only a small fraction of this germplasm has yet been used in breeding programmes.

Ever since the LCTAP collections were first planted in the field genebank, it was intended that certain basic data would be recorded on the performance of this material in cultivation. The extension of

LCTAP through Phase Two made it possible to extend and systematize this data recording. For breeders wishing to use this material in a breeding programme, these data are intended to provide information on the following points:

- the range of variation among the collections in characters such as vegetative growth, early yield and growth habit;
- the range of variation in susceptibility to witches' broom disease and other diseases occurring in the region;
- the existence of exceptional genotypes within the genebank, in terms of any of these characters.

The main basis for the evaluation of the LCTAP collections is the routine recording of the following data:

a. Every three months (starting October 1981):

1. stem diameter or girth: measured at 15 cm above soil level.

   Originally, diameters were measured with a caliper; from April 1984, girths were measured using a fibreglass tape. For trees up to about 3 years old, the trunk is almost circular in cross-section, and errors resulting from the calculation of girths from diameters are probably trivial;

2. height of jorquette, if present: recorded for trees up to about 2 years old;

3. witches' broom disease: presence or absence of brooms;

4. other diseases or unusual insect damage: noted when seen;

b. Every month (starting October 1981):

5. flowers: presence or absence

c. Every 3-4 weeks (starting October 1983):

6. healthy pods: the number of ripe, uninfected pods;

7. diseased pods (*Moniliophthora*): the number of full-size pods showing unambiguous symptoms of infection with *Moniliophthora roreri*;

8. diseased pods (other diseases): the number of full size pods showing infections other than *Moniliophthora*. It was assumed that most of these pods were actually infected with *Crinipellis*, as the fairly long interval between harvests would have allowed *Moniliophthora* to sporulate. Immature diseased pods were removed and not recorded.

9. yield: fresh weight of beans from the healthy pods.

These data are analysed and discussed in Section 5. Flowering and genetic compatibility are considered in the sections dealing with description of the LCTAP genotypes (Section 2.4 and Section 6).

2.6 COMPUTING

Extensive use was made of a microcomputer for data handling and word processing, including tasks such as the analysis of yield and pod infection data, and the preparations of lists of material held in quarantine. The computer used was an Osborne 1, belonging to John Allen. Wordstar was used for word processing, and dBase II for data handling; some short programs in Pascal and C were written for special purposes, such as graph-plotting.

While the use of a computer was undoubtedly helpful, there were serious reliability problems probably caused by conditions at San Carlos. Several electronic failures were due either to voltage spikes from the generator, although whenever possible the computer was run from a car battery, or to overheating. The humid conditions led to fungal growth on the surface of the floppy disks; the fungal mycelium rubbed off on the disk drive heads, which needed frequent cleaning. Some disks became unreadable because of fungal growth, although it was sometimes possible to clean such disks by rubbing the surface with a cotton handkerchief.

2.7 NUMBERING SYSTEM

All material is identified by one of the prefixes LCT-EEN (London Cocoa Trade - Estación Experimental Napo) or EBC (Expedición Botánica Caquetá). The latter prefix refers to material collected in Colombia in May-June 1984 (see Section 3.2). Trees propagated from budwood are assumed to be genetically identical, constituting a single clone which carries the original collection number (for example, LCT-EEN-46). For collections of seed, each seedling is assumed to be genetically distinct, and is identified by a suffix in the series s1, s2, s3 ....s10. For example, the ten seedlings of the collection LCT-EEN-324 held in the San Carlos genebank are identified as LCT-EEN-324/s1, 324/s2, 324/s3, etc.

Seeds and seedlings have also been sent direct to quarantine, and these are identified as follows:

a. Kew: (now in Trinidad): suffix s101, s102, s103 .....
b. Miami: suffix s201, s202, s203 ......
c. Barbados: suffix s301, s302, s303 .....

3. NARRATIVE REPORTS OF COLLECTING TRIPS

This section of the report describes the collecting trips, in chronological order. The initials after each heading indicate who participated in each trip JBA - John B Allen; JB - Agr Jose Baquero; JC - Ing Juvenal Cabrera; RM - Ing Roger Mera. The numbers in square brackets in the text are the collection numbers; the prefix is understood to be LCT-EEN unless otherwise stated (for example, 373 refers to the collection LCT-EEN 373]. Individual trees are not normally described in the text, as detailed tree descriptor data are presented in Appendix 5. The areas explored and the locations of individual collections are shown in Figures 2.1 - 2.5. Most distances and times are approximate.

3.1 SAN JOSE DE PAYAMINO: 21-27 FEBRUARY 1984 (JBA)

At the invitation of Ms Dominique Irvine (Department of Anthropology, Stanford University), who had been doing fieldwork there, I was able to visit the Indian comuna of San José de Payamino. San José is located on the upper Rio Payamino, about 20 km north of Loreto where we collected in 1980, but at a slightly lower altitude (300m). It is only about 4 hours up river from Coca, but the river is shallow with many rapids and most boatmen in Coca are reluctant to make the journey. I travelled to San José on 21 February in a canoe belonging to Sr Genaro Garcia, son of the former school-teacher in San José.

The terrain around San José includes both steep-sided ridges and low, rounded hills; soils in these areas are characterised by a high gravel content. There are also flat areas of alluvial deposit along the Rio Payamino and the Rio Tutapishcu. Based on similarities with Loreto and Villano, the area appeared suitable for wild cocoa, which we had found to be common in the forest around Loreto. However, in 5 days of systematic searching of the forest around San José, I found only 5 wild-type trees, and 4 of these appeared to have been planted. Budwood was collected from only 4 trees [376-379], as 2 of the apparently planted trees were growing side by side and I assumed that they were closely related.

Several other species of Theobroma were noted in the area. In the forest, T.subincanum was common, with many seedlings; as this species was not yet represented in the San Carlos collection, I collected some seedlings [375]. Theobroma bicolor was commonly planted both near houses and also in chacras. Near one house I also found a planted tree of T.glaucum in full flower, with large inflorescences of dark red flowers covering the two trunks from near ground level up to a height of around 4m. Somewhat confusingly, the Quichua name 'challua cacao' was used for this tree as well as for wild T.cacao. Theobroma bicolor was known as 'patasi'.

My stay in San José was longer than planned as no canoe was available for the return journey until 27 February, when I travelled back to Coca in the company of a deputation of comuna officials. The canoe was very overloaded and the passengers had to disembark to allow safe passage through the rapids. I returned to San Carlos the same day and the collections were budded on 28 February.

3.2 RIO CAQUETA, COLOMBIA: MAY-JUNE 1984

3.2.1 BACKGROUND

This expedition was organised by the Corporación de Araracuara, a semi-autonomous regional development agency which operates in the National Territories of Colombia. This term covers several of the remoter regions of Colombia, which are directly administered by a government department, DAINCO (Departamento Administrativo de Intendencias y Comisarias). The expedition formed part of a series of projects in the field of natural resources, known as the Second Botanical Expedition (the first Botanical Expedition was that of José Celestino Mutis in the 18th century). The Second Botanical Expedition resulted from a personal initiative by President Belisario Betancur; it is financed by the Colombian government and administered directly by the Presidential Office. The importance attached to these projects may be gauged from the assignment of a budget of about $US 50,000 to the three week cocoa collecting expedition on the Rio Caqueta; participants were invited from all the Amazon Pact countries, with all expenses, including air fares, paid by Colombia.

The stated objective of the expedition was to collect wild cocoa germplasm, in a remote area from which material is not at present available. Collected material would be immediately distributed amongst participating institutions. A further, implicit, objective was to enable scientists from different countries, actively involved in cocoa germplasm collecting, to work together in the field, to compare collecting methods and to discuss strategies for the evaluation and use of collected germplasm.

3.2.2 PARTICIPANTS

COLOMBIA

Dr Francisco Correa G., Director, Corporación de Araracuara
Dr Francisco Ocampo R., Head of Cocoa Programme, ICA (Instituto Colombiano Agropecuario)
Dr Luís Lopez J., Head of Genetic Resources Unit, ICA
Dr Roberto Jaramillo, botanist, Universidad Nacional, Bogotá
Dr Javier Rodriguez, anthropologist, Second Botanical Expedition
Constanza la Rotta, botanist, Corporación de Araracuara
Pablo Palacios, botanist, Corporación de Araracuara
Ing Marco Antonio Figueroa, Corporación de Araracuara
Miguel Arango, journalist, DAINCO
Luis Angel Trujillo, captain of boat 'Santa Catarina'
Xavier Restrepo, expedition administrator
Maria-Dolores Sanchez, economist, Corporación de Araracuara (expedition organizer in Bogotá)

BOLIVIA

Ing Wagner Terrazas, Director, Museo Nacional de Historia Natural
Ing Orlando Unzueta, Ministerio de Asuntos Campesinos y Agropecuarias

BRAZIL

Ing Paulo Machado, CEPLAC/DEPEA, Belém
Ing Cayo Marcius Vasconcelos, CEPLAC/DEPEA, Belém

ECUADOR

John Allen, INIAP/LCTAP
Ing Roger Mera, INIAP

3.2.3 THE EXPEDITION

The expedition assembled in Bogotá during 17-20 May. One day (18 May) was spent visiting the ICA research station at Tibaitata, just outside Bogotá, where the ICA Genetic Resources Unit is based, under the direction of Dr Luís Lopez. The facilities of this Unit, which has received regular financial support from IBPGR (International Board for Plant Genetic Resources) are impressive, including a new $100m^3$ cold room for long-term seed storage. The cocoa germplasm collection is at the ICA tropical research station at Palmira, near Cali.

On 21 May we flew to Araracuara, at the junction of the Caquetá and Yari rivers, in a Summer Institute of Linguistics DC-3. The Corporación de Araracuara has a base here, with an airstrip, living quarters and workshops as well as a herbarium, and a programme of agricultural projects (partly supported by the government of the Netherlands). Here, the detailed plans for the expedition were explained. The general intention was to collect down the Rio Caquetá to the frontier with Brazil, just beyond La Pedrera. Our base for the trip would be the river boat 'Santa Catarina', normally used as a floating shop for Indian communities in the area; the boat would be under the command of Luis Angel Trujillo, the corregidor (main official) for the Miriti region. Sr Trujillo's technical expertise (apart from the boat, he was also responsible for radio communications with Araracuara and Bogotá) and local knowledge turned out to be indispensable element in the success of the expedition. A reconnaisance trip had noted the locations of a number of wild cocoa populations, thus reducing the amount of time which would have to be spent searching this large area. The possibility was raised of a side-trip to the Rio Apaporis. One may remark at this point that the Rio Apaporis and the La Pedrera area were visited by the Anglo-Colombian cocoa collecting expedition in 1952.

ARARACUARA TO QUEBERADA DEL SOL

After setting off downstream from Araracuara on 22 May, collecting started on 23 May. All collections, including a few non-Theobroma collections, were assigned the prefix EBC (for Expedicion Botanica Caqueta). The locations of the Theobroma collections are listed in Appendix 3; to save space, this information will not generally be repeated here.

Four days (23-26 May) were spent collecting between Araracuara and the 'Quebrada del Sol' (river of the sun) [EBC 1-56]. It quickly became obvious that there were extensive populations of apparently wild cocoa on the narrow strip of dry ground along the banks of the main river, and along the margins of the frequent large islands. These trees were of a distinctive type, quite different from the typical wild cocoa found in Ecuador. They had, typically, one or two tall, relatively slender, and sometimes slightly twisted trunks, with numerous well-developed flower cushions on the trunks. In one or two cases, the appearance of these trees reminded me of the occasional references made in conversation with other collectors to wild cocoa with a liana-like habit. The few pods that were found were yellow, small, fairly smooth-surfaced, and thin-walled. The seeds were small and light to medium purple in colour. On the whole expedition only one collected tree was recorded as infected with witches' broom disease, but in many cases a definite check on witches' broom infection was not possible. The height of the trees and the lack of chupons created problems when collecting pods and budwood; fortunately our local guides, notably Eli Andoque, fortified by continuously chewing coca leaves, were expert tree-climbers.

No cocoa was found in the seasonally-flooded depressions which extend considerable distances beyond the strips of raised ground along the main river, nor was it found along any of the tributaries of the Caquetá, some of them substantial rivers in their own right (the Caquetá itself is more than 2km wide in parts). This distribution might be explained by the presence of more fertile soils along the main river, which carries and deposits sediments from the edge of the Andean cordillera; most of the tributaries are clear-water streams arising within the Amazon plain. Soil samples were collected by the expedition but unfortunately the analyses are not available. Some previous collectors (notably the Anglo-Colombian expedition) interpreted the location of these wild cocoa populations as evidence that they were not truly of wild origin. While there is no doubt that many of these sites have been cultivated at some time in the past, our local informants were in no doubt that the cocoa which we collected had originated within the area even if some of the trees had been planted.

While visiting Indian houses, one was struck by the extensive cultivation around these houses of T.bicolor. This species, which is known only in cultivation, appears to be an important food crop in the Caquetá area. At Punta Sebastian we found a variant pod type [EBC 13], with a shallower reticulation than normal, and a thinner pod wall. Otherwise, the trees of this species resembled those found in Ecuador. We also found the wild species T.obovatum, unfortunately without fresh pods.

To avoid the biting insects prevalent along the main river, wherever possible the 'Santa Catarina' was taken up a side-stream for the night. Two nights (26-27 May) were spent moored about an hour's journey up the 'Quebrada del Sol'. At this point, the 'Quebrada del Sol', otherwise a typical slow-moving jungle river, falls some 20 metres over rocks into a large pool, fringed with beaches of white sand, creating a welcome variation on the landscape of river and forest which repeats itself unchanged for hundreds of kilometres down the Caquetá. The headwaters of this and other tributaries of the Caquetá have hardly been explored, and several groups of Indians living on these rivers have no contact with the outside world; they probably migrated from the Caquetá to these inaccessible areas in order to escape from commercial rubber collectors in the early part of this century.

Near the mouth of the 'Quebrada del Sol' we found T.microcarpum and T.glaucum; both species occurred repeatedly downstream to La Pedrera, while T.obovatum was not found again until La Pedrera (where it appeared to have been planted).

QUEBRADA DEL SOL TO PUERTO MIRITI

From 27 May to 2 June, we continued to collect downstream to Puerto Mirití [EBC 57-111]. On this section of the Caquetá we encountered a distinct population of cocoa, which tended to replace that described previously as we approached the frontier with Brazil. This population differs from that described above in its large yellow pods with very hard, thick shells, containing large, pale purple, seeds. This type of cocoa was planted in several places, as well as being found in forest, and there may be some doubt as to its wild status, particularly as there is much trade on the Caquetá from Brazil up as far as La Pedrera (river traffic upstream from La Pedrera is limited by major rapids at Puerto Cordoba). This type of cocoa was collected at La Pedrera by the Anglo-Colombian expedition; one of their collections (SPEC 41) is known for its exceptionally hard pod wall (G. Lockwood, personal communication).

On this section of the Caquetá, we also found T.grandiflorum (always planted, and presumably introduced from Brazil) and T.subincanum, a wild species.

Daily life on the expedition continued to be memorable. The 'Santa Catarina' was somewhat crowded, particularly after the late arrival of the Bolivian participants. The idea was that everybody would sleep in hammocks, which were slung in the central part of the boat each night. Certain expedition members more immune to jungle life decided to sleep off the boat wherever possible; I spent two nights sleeping in Indian houses and 2 nights in the forest with my hammock slung between 2 trees. Our basic diet of rice and tinned food was regularly supplemented by hunting and fishing: we ate catfish and pirana, as well as turtle, tapir and agouti.

Apart from the 'Santa Catarina', the Corporación de Araracuara provided 2 fast launches with outboard motors for reaching collection sites. Our normal practice was to split into two groups, led by Dr Ocampo and Dr Lopez, which worked independently and exchanged notes at the end of each day.

Owing to the length of the expedition, the Corporación had arranged several flights from Araracuara to take budwood to Palmira and San José de Guaviare (another Corporación base). Every 3 or 4 days, one of the launches took budwood up to Araracuara, returning with supplies for the expedition. With the help of good radio links, these complex transport and supply operations worked surprisingly smoothly.

EXCURSION TO THE RIO APAPORIS

On 3 June, a party of 4 expedition members, including myself with boatman and cook, set off for a brief exploration on the Rio Apaporis. We travelled for 6 hours up the Rio Mirití-Parana and spent the night in the maloca (a large communal house) of the Macuna Indian community. We were told there was no wild cocoa along the Mirití-Parana, and the flooded forest along its banks, dominated by dense stands of palms (Astrocaryum and Euterpe species) did appear an unlikely habitat for cocoa. The next morning, after waking early (3.40 a.m.), we walked 8 km, on a good path, through to the Apaporis. A locally hired guide carried the outboard motor, and we set off upstream on the Apaporis, using first an old canoe belonging to our guide, and later a new, large canoe which had apparently drifted down from a village upstream and had not yet been returned to its rightful owners.

Our guide located a number of wild cocoa trees on the south bank of the Apaporis, unfortunately without pods, so it is impossible yet to say whether they resemble either of the Caquetá populations [EBC 113-118]. Three trees were also collected at an Indian community (Centro Providencia) on the track between the two rivers [EBC 112, 119; LCT-EEN 382]. It is interesting to note that the Anglo-Colombian expedition followed the same route, including the portage between the 2 rivers (but in the opposite direction) almost 32 years ago; they reported finding no wild cocoa on the Apaporis (our guide indicated that it was uncommon).

Our day on the Apaporis was marked by several untoward events. First, as our guide was manoeuvring the canoe into the bank through dense flooded vegetation, we disturbed a large nest of wasps at about head height, resulting in general panic and several stings for each member of the party. An hour or so later, Dr Ocampo narrowly escaped grabbing hold of a thin green snake while looking for a handhold on a steep bank; our guide killed the snake and told us that it was the lethally poisonous 'pudridora', which causes its victim's body tissue to disintegrate from within. Finally, while returning, one canoe towing the other, the back fell off the old canoe; fortunately, we had already unanimously resolved to remain in the new 'borrowed' canoe. Late in the afternoon, in pouring rain, we walked back along the path to the Mirití-Parana and after another night in the maloca we returned to the 'Santa Catarina', on 5 June.

PUERTO MIRITI TO VILA BETTENCUR

The rest of the expedition continued to collect from Puerto Miriti, past La Pedrera, down to the Brazilian frontier post at Vila Bettencur, and the Apaporis party joined them for the final day of collecting (6 June) [EBC 120-148]. Pods collected in this area were predominantly of the hard-walled type described previously. The 'Santa Catarina' remained at Puerto Cordoba, above the rapids known as the 'Chorro de Cordoba', where the Caquetá narrows to about 200m and falls several metres over rocks. These rapids are somewhat dangerous, and so while the launches passed them, expedition members were advised to disembark and walk down past the rapids.

3.2.4 RETURN TO BOGOTA AND SAN CARLOS

One more day (7 June) was spent at Puerto Cordoba, packing up, and compiling lists of collection localities and characteristics. The next day, most of the expedition flew back to Bogotá in DAINCO's own Cessna Chieftain aircraft which just accommodated 9 passengers and a considerable quantity of baggage, including all the pod collections. The rest of the expedition, including the 3 botanists

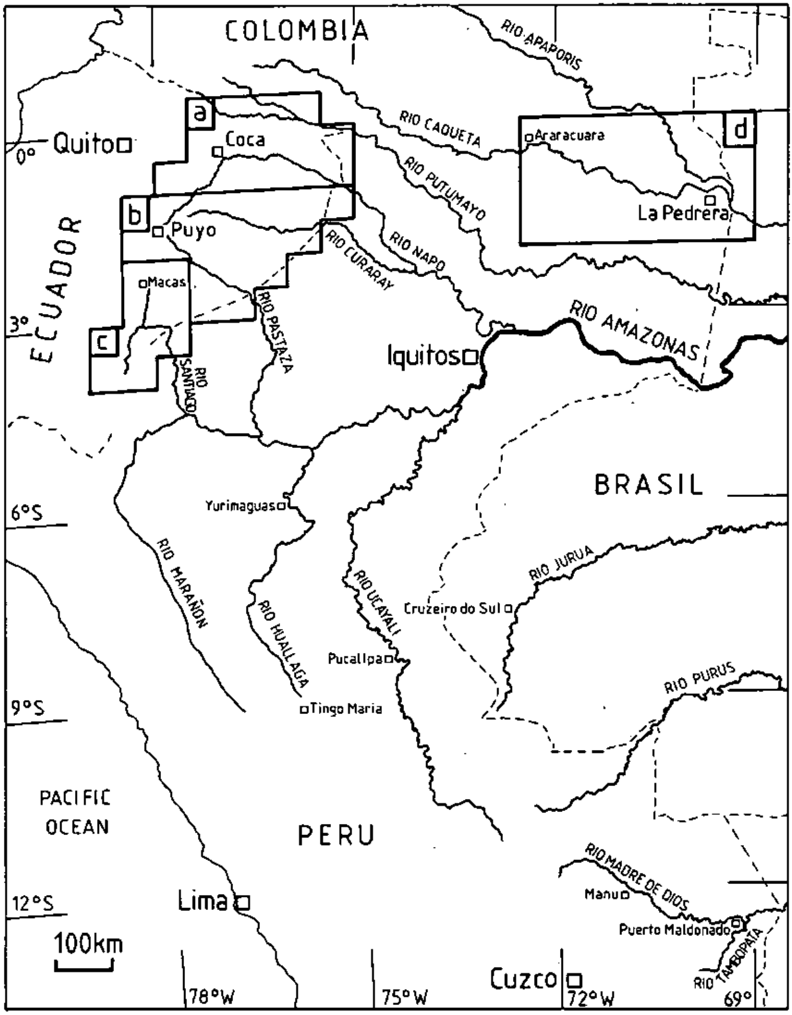
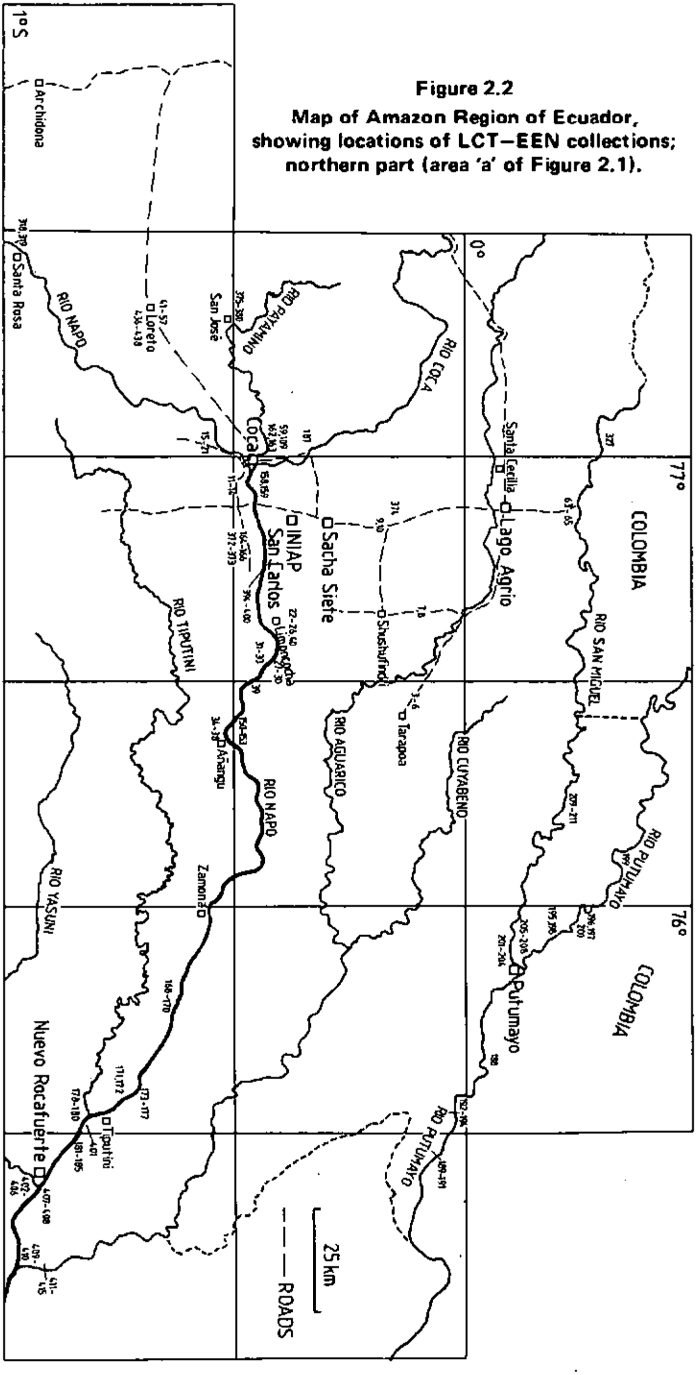


Figure 2.1 **Map of Upper Amazon region, showing areas explored during LCTAP in Ecuador and Colombia. (Areas marked 'a', 'b', 'c', 'd' are shown in greater detail in Figures 2.2 – 2.5).**

Figure 2.2
Map of Amazon Region of Ecuador, showing locations of LCT—EEN collections; northern part (area 'a' of Figure 2.1).



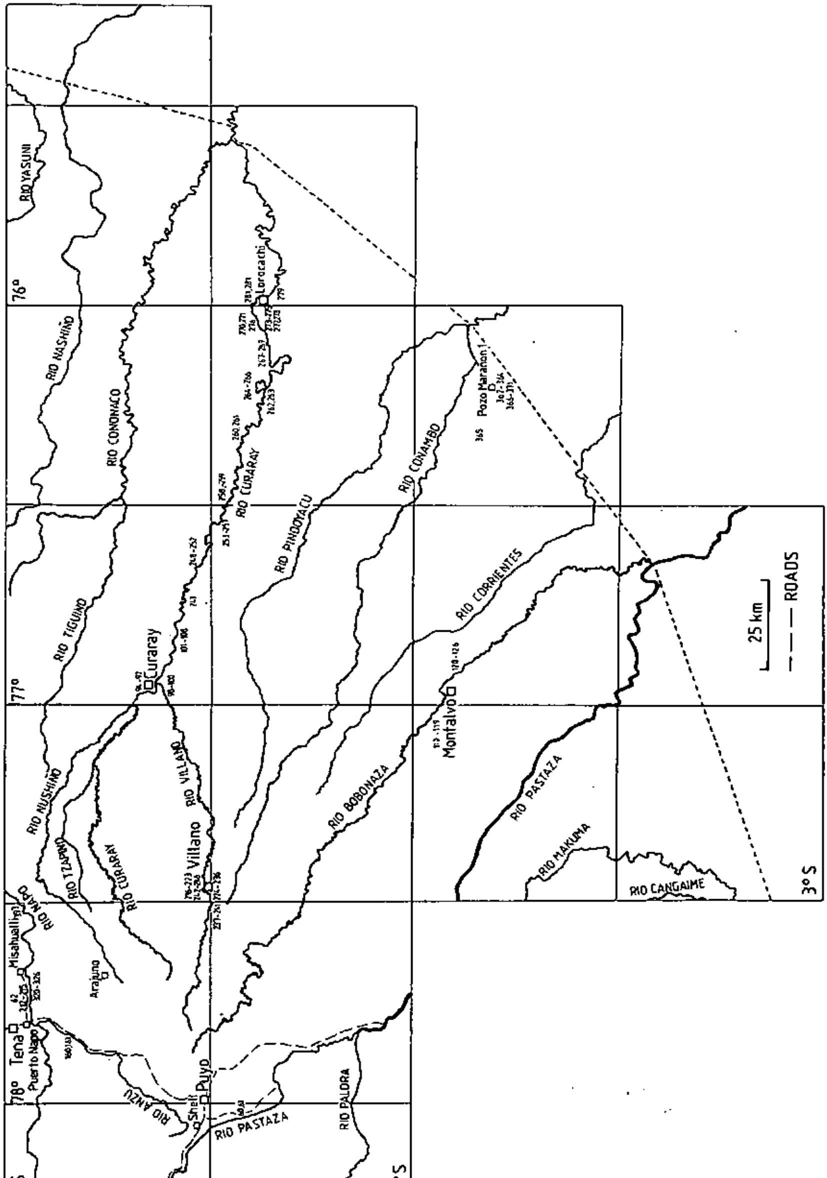


Figure 2.3 Map of Amazon Region of Ecuador, showing locations of LCT–EEN collections; central part (area 'b' of Figure 2.1).

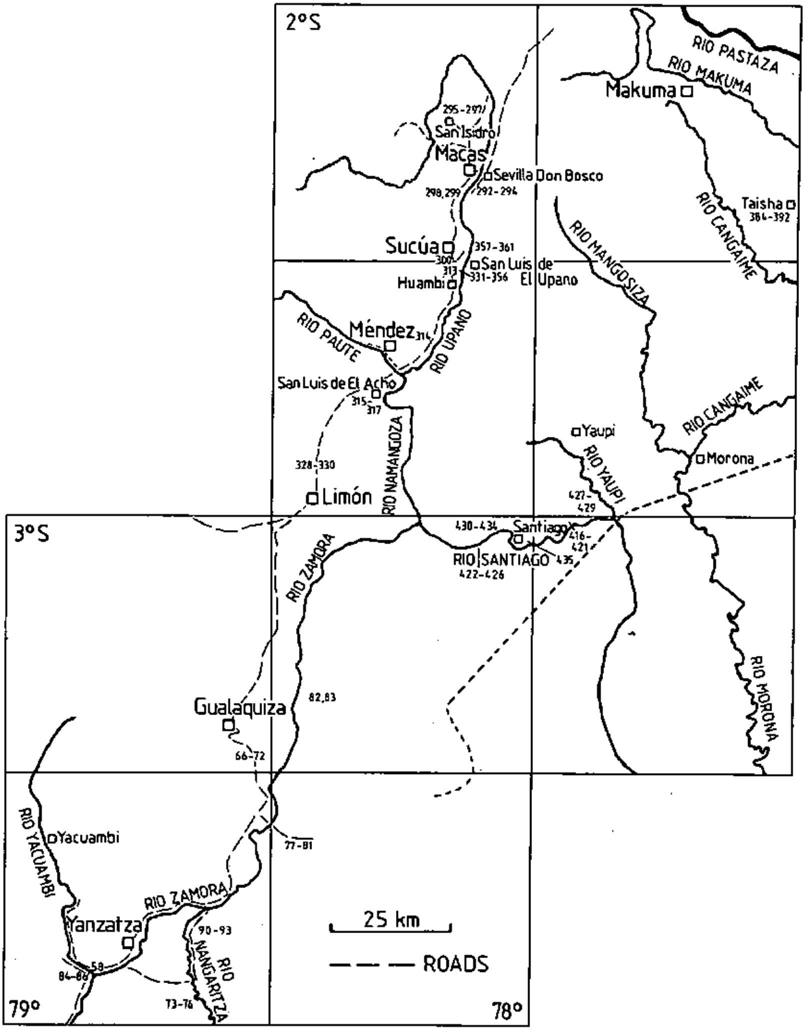


Figure 2.4 **Map of Amazon Region of Ecuador, showing locations of LCT–EEN collections; southern part (area 'c' of Figure 2.1).**

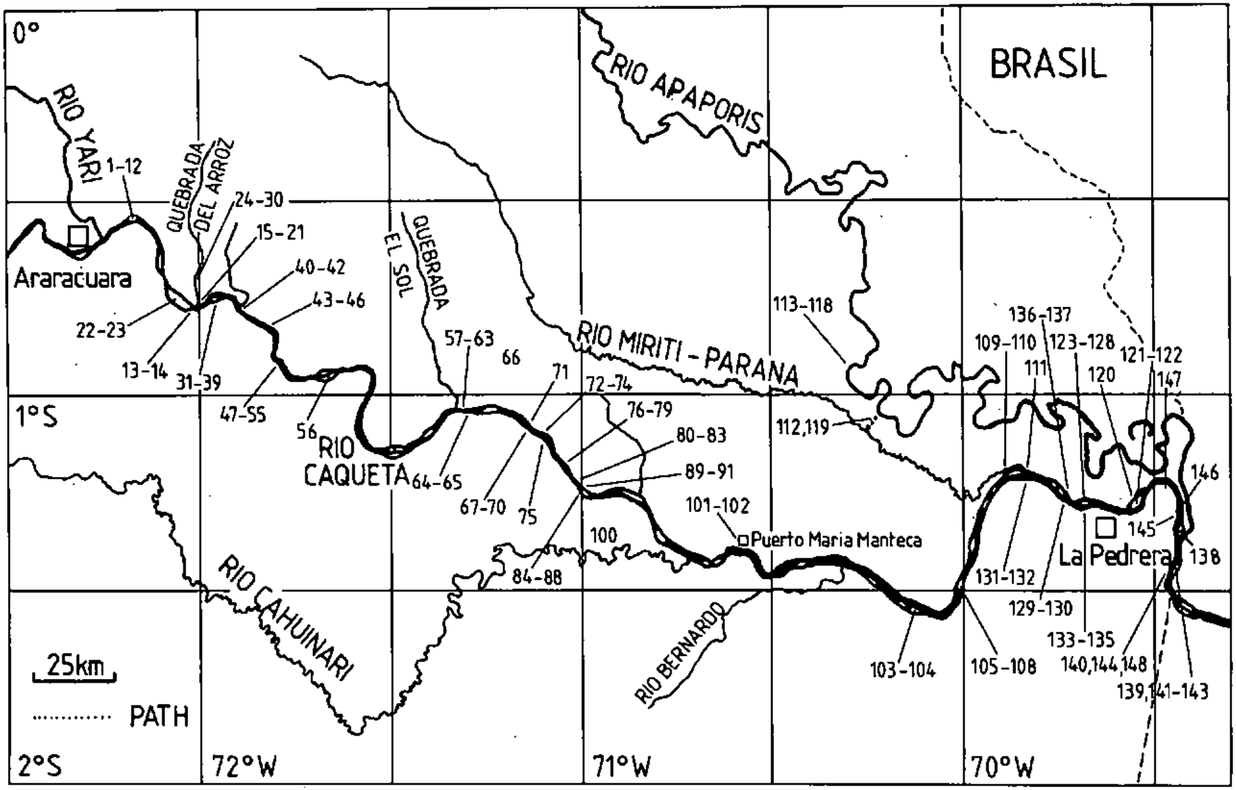


Figure 2.5 **Map of Rio Caquetá region in Colombia, showing locations of EBC collections (area 'd' of Figure 2.1).**

and their herbarium collections (a general sampling of the forest vegetation, made in parallel with the cocoa collections), returned to Araracuara in the 'Santa Catarina'. Part of the next day (9 June) was spent at the Corporación office preparing seeds for transit, while collecting data on pod characteristics, but in the end it proved necessary to complete this task at Tibaitatá, after the weekend, on 11 June. After another day spent checking data on the collections, Ing Mera and John Allen returned to Quito on 13 June, and the next day to San Carlos. Our material was budded or sown on 15 June.

3.2.5 NUMBER OF COLLECTIONS

Including one LCT-EEN collection, the expedition obtained budwood from 99 trees and seed from 33 trees, of T.cacao. The seed was divided between Colombia, Brazil and Ecuador; seed of 31 trees was planted at San Carlos, and 29 of these collections were established. Most of the budwood remained in Colombia, to avoid delays in propagation. Small quantities of budwood from 27 of the later collections were taken to San Carlos; only 9 of these were budded successfully (budding success rate 17%).

3.2.6 METHODS

Expedition members from Colombia, Brazil and Ecuador all had previous experience of collecting wild cocoa germplasm. There were only very minor differences between methods previously used for collecting and storing seed and budwood by these 3 groups.

Three minor departures from LCTAP practice were noted:

a. the Colombian and Brazilian collectors used much damper newspaper (liberally sprinkled with water) to store budwood;

b. Colombian practice included the dipping of pods in melted wax. There was no obvious difference between dipped and undipped pods at the end of the expedition;

c. at the end of the expedition, all seeds were packed using the Brazilian method of mixing the fresh seeds with sawdust and rubbing the seeds vigorously to remove the pulp. This procedure is slightly faster than the LCTAP practice of removing the testa and pulp by hand, but there is some risk of incomplete removal of the pulp and subsequent fermentation.

There were also differences in documentation procedures. In Colombia, ICA uses a standard form for all germplasm collections; this meant that information on descriptors peculiar to cocoa was collected in a somewhat unsystematic fashion, being written in on the back of the standard forms. In Brazil, CEPLAC collecting expeditions use a special form with space for a whole series of more-or-less standard descriptors. The form is accompanied by a booklet with details of the descriptor states and drawings of the fruits of most Theobroma species.

3.2.7 CONCLUSION

The expedition to the Rio Caquetá was a great success not only in terms of the material collected but also in terms of the exchange of techniques and ideas between the 3 active cocoa collecting groups in South America. If this level of contact were maintained, it would greatly facilitate the evaluation of collections of wild cocoa germplasm from the Amazon, and, even more important, the distribution of this material to breeders.

3.2.8 POSTSCRIPT

On my return journey from Barbados and Trinidad in May 1985, I stopped for one night in Bogotá, to visit the Corporación de Araracuara, who organised the 1984 expedition on the Rio Caquetá in Colombia. The specific object of this visit was to find out how much of the material had been successfully established in other countries (collected seed was divided between Colombia, Brazil and Ecuador; budwood, between Colombia and Ecuador only).

The results of this inquiry were alarming. It seems that all material sent to Brazil was lost, for unknown reasons. Within Colombia, propagation was carried out both at San José de Guaviare, at the Corporación's own station, and at Palmira (ICA). Initial establishment of buddings at San José was reasonable (61 collections out of 103; budding success rate 26%), but all material at San Jose was lost during dry weather in January, while still in the nursery. At Palmira, 47 out of 72 collections were successfully budded (budding success rate 17%); these collections and a further 24 seed collections are still alive, as far as I could determine. Allowing for overlap between budded and seed collections, this means that 63 collections were established at Palmira. Four collections were established at San Carlos not Palmira. Including both Ecuador and Colombia, only 67 out of about 132 collections have been established in cultivation, which is discouraging when one considers the resources devoted to the expedition.

3.3 TAISHA: 5-10 DECEMBER 1984 (JBA, RM, Dr Lynton Cox (LATINRECO-NESTLE))

This collecting trip was organised in conjunction with Dr Lynton Cox, who wanted to discuss a possible nutrition survey in the area with Fr Thomas Brown, the doctor in charge of the mission hospital at Taisha. Tom Brown, an American, set up the hospital about 7 years ago; as well as providing medical care, he has built up one of the best medical libraries in South America. Accommodation for our group at Taisha was kindly provided by the Salesian Mission.

The collecting trip to Taisha helped to improve coverage of Morona-Santiago Province. The terrain is similar to that at Makuma, (the object of an abortive expedition in December 1980); it is characterised by a rolling plateau at about 500m altitude, intersected by steep-sided river valleys. Flat alluvial deposits sometimes occur along these rivers, and flat areas which may be old river terraces sometimes interrupt the valley slopes. The main plateau generally has a red lateritic soil (map: Allen and Lass, 1983, p.15; type R);

the river valley soils are variable and difficult to categorise. Most of the main plateau has been converted to pasture for grazing cattle, either by the indigenous Shuar Indians or by mestizo colonists from other parts of Ecuador. There is no road access to the area; cattle are exported by air, via Puyo. There is a large army base at Taisha.

We travelled from Quito to Puyo by road on 5 December and flew to Taisha the next morning, in mission aircraft. The rest of the day, and the 3 following days, were spent searching the area up to about 5km around Taisha, using paths leading to nearby Indian settlements. Wild cocoa was not very common in the area. We found three trees [384, 385, 391] in the undulating terrain of the plateau; the first two of these were in secondary forest in small stream valleys, while the last was in a flat pasture. Five other trees were found on the steeply sloping sides of the large valley (Rio Wawaimi) west of the mission [386-390]. All these were typical wild-type trees, as far as could be determined; only one tree [390) provided a pod, which contained only white seeds. Trees in shade showed only slight witches' broom infection, but the only tree growing in pasture was heavily infected, with many chirimoyas.

Our guide during the first two days, Santa, a boy from another group of Jivaroan Indians across the frontier in Peru, provided a Shuar name for Theobroma cacao, 'wakam', which also applies to Theobroma bicolor, cultivated around houses in the area. We also found a number of trees of Theobroma subincanum, for which the Shuar name was said to be 'uchi wakam' (literally: 'child wakam'). The pods on these trees of T.subincanum were much smaller than on the same species collected at San Jose de Payamino (Section 3.1), so a collection was made [392].

On 10 December, we flew back to Puyo and then drove straight on to Quito. Roger Mera took the collected material to San Carlos on 12 December, and it was budded or planted the next day. All the collections were successfully established.

3.4 NUEVO ROCAFUERTE: 26-30 AUGUST 1985 (JBA, JB, JC, RM)

It had been obvious for some time that one significant gap in the coverage of the collecting programme was the Rio Yasuní, which joins the Rio Napo close to the border with Peru. The Rio Yasuní watershed is a National Park, and permission to collect there was obtained in late 1982, although the collecting trip planned for early 1983 never took place.

In Coca, we hired a canoe, with a boatman who also acted as our guide, at a cost of £200 for five days. We intended to leave early on 26 August, but obtaining permission from the army, which should have been routine, in fact took most of the morning. We set off downstream on the Rio Napo at 11.00 a.m. and spent the night in the hotel at Tiputini. The next day, after making one collection near Tiputini [401], we arrived at Nuevo Rocafuerte at 9.00 a.m. The rest of the day was spent exploring the banks of the Rio Yasuní. Three trees were found and collected in cleared ground near a house not far from the mouth of the Yasuní [403-405]. At this site, we also found a tree of Theobroma glaucum in full flower; An old pod was collected from it but the seed failed to germinate [402]. Another cocoa tree was collected in forest, near the river bank, about half an hour upstream [406]. We explored carefully about two hours up river, and also looked at the banks of a large lake (Jatuncocha, meaning, in Quichua, 'big lake'), but found no more cocoa. We spent the night in a hut belonging to some Indians who were harvesting rice which they had planted in a flooded area a few hundred metres into the forest away from the river; there is no permanent population on the lower part of the Yasuni. We explored the forest near the hut, but again we found no cocoa.

The next day (28 August) was spent exploring a further three hours upstream, but we found no more cocoa. At the furthest point upstream, we walked about 4 km south-east along a path towards a military outpost. Here we found several trees of T.subincanum, one tree of T.glaucum and one tree of T.obovatum. This last species has apparently not been found before in Ecuador; its identification was confirmed from a dry pod, the pods of T.obovatum being distinctive and not readily confused with any other species. Near the river, I found one tree of a Hevea species (wild rubber), the first time I have found any Hevea on LCTAP collecting trips, although David Neill (Missouri Botanic Garden) indicates that a Hevea species is common along the Rio Curaray. Seed of the Hevea was successfully germinated at San Carlos, and also sent to Kew Gardens, UK.

After nearly two full days on the Rio Yasuní, with no cocoa found except near the junction with the Napo, we decided to spend no more time there, but to use our third day (29 August) exploring the Napo below Nuevo Rocafuerte, and the Rio Aguarico near its confluence with the Napo. The area between Nuevo Rocafuerte and the border, which runs across the Napo and up along the middle of the channel of the Aguarico, is regarded as militarily sensitive because of the history of border disputes between Ecuador and Peru. Our explorations were therefore slowed down by having to stop and explain our work at every one of the numerous army posts along the border. However, this was still a productive day, as there were large populations of cocoa in the almost continuous forest along the river banks in this area; eight trees were collected [407-409, 411-415]. We also found one T.bicolor with a distinctively smooth pod [410].

After another night in Nuevo Rocafuerte, we returned to Coca the following day, the upstream journey taking some 12 hours in the canoe. The collections were budded the next day (31 August) at San Carlos, and all except the T.glaucum were successfully established.

It may be worth speculating on why cocoa might be absent from the Rio Yasuní. This river is different in character from other rivers we have explored, being deep and slow-moving, with low-lying banks which are often partly flooded. There are dense stands of a palm species (possibly Euterpe sp) growing in the water near the bank. Beyond these low-lying areas are low hills with red (lateritic) soils.

It is likely that neither the floodable river banks nor the hills beyond offer suitable conditions for cocoa, the latter on account of the soil type, and the former, because cocoa does not tolerate frequent flooding. It is also possible that the sediments deposited along the Rio Yasuní are nutrient-deficient, because the entire watershed of this river lies in the heavily-weathered Tertiary sediments of the Amazon lowlands (in contrast to the main rivers of the region, which carry relatively nutrient-rich sediments from the Andes).

Wild cocoa trees on the Rio Napo below Nuevo Rocafuerte, and on the Rio Aguarico, had smoother pods than is usual for the Oriente. These trees also typically had a tall, single-trunked habit with a moderate number of flower cushions on the trunk and, sometimes, a moderately-pigmented flush. This population could be regarded as distinct from that found elsewhere in the Amazon Region of Ecuador, more resembling some of the wild cocoa seen in 1984 on the Rio Caquetá.

3.5 SANTIAGO: 16-23 SEPTEMBER 1985 (JBA, JB, JC, RM)

To collect in this area, using the Santiago army camp as a base, I had obtained permission from the Ministry of Defence several months earlier. We travelled via Quito, taking the bus from Quito to Shell (near Puyo) on 16 September. We presented ourselves at the army base at Shell the following day, to make arrangements for accommodation at Santiago. On 18 September we flew in a chartered aircraft (Cessna Stationair II 6, cost £80/hour) to Santiago, about an hour's flight to the south. Here we were given a room and meals at the army camp, as well as free use of an army canoe for transport on the Rio Santiago.

The valley of the Rio Santiago here consists of a flat plain at about 240m altitude, through which the river has cut a steep-sided channel. The river itself is about 30m below the level of this plain. For much of its course there are sheer cliffs on both banks of the river, although there are also low-lying (but rarely flooded) areas of land along the river banks where it is possible to land from a canoe. From these landing points one can walk up paths, which are often precipitous, to the main valley plain. The valley, which runs west-east, is bounded to the north by the end of the Cordillera de Cutucu and to the south by the end of the Cordillera del Condor, both of which rise to over 2,000m. These mountains are steeply sloped and covered with mostly undisturbed forest. The valley floor and the flat areas along the river have been partly cleared for small-scale cultivation and pasture for cattle, mostly by the local Shuar Indians, although there are a few mestizo colonists at Santiago itself.

On 19 September, we travelled downstream for about 40 minutes to K:.umaza, on the north bank. Here, on low ground near the river, we collected four trees [416-419] from a large population of wild cocoa which included some young trees (less than five years old). We explored away from the river, following a path up a cliff to the level of the main valley floor, where we found no cocoa. However, in the forest on the steep lower slope of the cordillera, we found two more trees [420, 421]. We returned to Santiago in the late afternoon; in the evening the camp was shaken by a sharp earth tremor.

The next day was spent exploring the area round Tsuis, a Shuar village about 20 minutes upstream from Santiago, on the south bank. Here we collected five trees [422-426]. The following day (21 September) we travelled downstream for about 1 hour to Soldado Monge, the army post on the border with Peru. From here, we explored on foot to the north, parallel with the Rio Yaupi, finding only two trees [427, 428]. A third tree [429] was located while returning by canoe down the Rio Yaupi.

Most of our final day (22 September) at Santiago was spent exploring on foot the main valley plain between the military airstrip and a small, possibly volcanic, lake about 4 km to the west. We collected five trees [430-434]. Although several of these trees were growing in land which had been cleared for pasture, there were numerous wild cocoa trees in a strip of uncleared forest along the steep sides of a small valley. We collected one final tree [435] near the bank of the Rio Santiago, just below the mission.

The next day we flew from Santiago to Shell in an army supply plane, and on to Coca in a chartered aircraft. The collected material was budded or sown at San Carlos on 24 September. Wild cocoa trees seen in the Santiago area were similar to those found in other parts of the Amazon Region of Ecuador. Most Indian and colonist houses also had a few fairly young planted cocoa trees, distinguished by their pigmented flushes. We were told that the seed for these had been brought from the Pacific coast region. Both wild and cultivated cocoa in this area showed few symptoms of witches' broom disease.

3.6 OTHER COLLECTING

3.6.1 ISLA ANACONDA: 15-22 APRIL 1985 (JBA)

In April 1985, the opportunity arose to make a further brief exploration of the upper Rio Napo, based at the Anaconda Hotel, a simple 'jungle lodge' on an island in the river, about one hour downstream from Misahualli. After a complicated journey by road from San Carlos (the Land-Rover's brakes failed, fortunately without disastrous consequences, and had to be repaired in Quito), I arrived at Misahualli on 19 April, and travelled down to Isla Anaconda the same day.

This exploration confirmed an earlier impression (Allen and Lass, 1983, section 4.14) that wild cocoa is much less common along the upper part of the Rio Napo (above Coca), compared to the Rio Napo from Coca downstream to the frontier at Nuevo Rocafuerte. Inspection of the river banks between Misahualli and the Anaconda Hotel, and extensive exploration of the hotel island (mainly secondary forest, with some old cocoa plantings heavily infected with witches' broom and *Moniliophthora* diseases) did not yield a single wild cocoa tree. With the help of a local guide, I did find one tree several hundred metres from the river on the north bank just upstream from the hotel; this was a typical wild-type tree (though with purple seeds), with many pods, growing in the open in a large area of pasture [393]. There was no other cocoa, wild or cultivated, within 200-300 metres of this tree, and the owner of the land (Sr Andres Tapuy) confirmed that wild cocoa was not common there.

3.6.2 PRIMAVERA: 10-12 JULY 1985 (JBA)

I was invited to give a seminar on LCTAP to a group of students from the USA who were on a field course at Primavera, on the north bank of the Rio Napo about two hours downstream from Coca. This provided an opportunity to explore an area of undisturbed forest apparently similar to that at San Carlos. The students' camp was about 5 km. from the river, on land belonging to Don Otto Rodriguez, the owner of a large farm at Primavera. Near the camp, I collected budwood from seven trees [394-400] from a population of at least 20 old wild trees in an area of about 3 ha. It may be of interest to note that Don Otto, an educated man who has spent most of his life in the Amazon, was convinced that the wild cocoa along the Napo is too common to have been introduced, and he was in no doubt that it was truly native to the region.

3.6.3 SAN CARLOS AREA

On 8 November 1984, we explored two sideroads to the west of the main Lago Agrio-Coca road, near the village called Jivino Verde (which used to be known as the Shushufindi Project). Despite searching several patches of forest we found only one wild-type tree, growing in the open, in poor condition with sparse foliage and heavy witches' broom infection [374].

3.6.4 SOUTH OF COCA

On two occasions, we explored near the end of the road from Coca to the south, which has recently been extended beyond the Rio Shiripuno, about 100 km south of Coca. There is a major new oilfield, the Cononaco field, which is operated by Texaco, near this river. Much of this area has recently been occupied by colonists, although the undulating terrain with red (lateritic) soils is not regarded as suitable for intensive agricultural development (Sourdat and Custode, 1980). On 22 November 1983, we explored the forest near the Rio Shiripuno, but failed to find any cocoa. On 23 July 1985, we walked south from the end of the road for about 5 km along a survey line into forest with occasional clearings made by colonists, but again we found no cocoa. We did find one T.subincanum and one T.glaucum tree. The terrain along the road is typical of a large part of the Amazon Region of Ecuador between the Napo and Pastaza rivers, suggesting that wild cocoa is rare in this area; a total of four days exploration along this road, since 1980, has not yielded a single collection.

4. RESULTS: COLLECTING

4.1 QUANTITY OF MATERIAL COLLECTED

Up to 30 September 1985 there were 418 collections, from individual trees of Theobroma cacao in the series LCT-EEN, with collection numbers from LCT-EEN 1 to LCT-EEN 435. The other sixteen numbers in this range were assigned to collections of other Theobroma species and Herrania species. One other number (LCT-EEN 21) was applied to a mixture of seedlings from several collections).

From the 419 LCT-EEN cocoa collections, 281 have been established in the San Carlos genebank. This includes 137 collections established from seed, with up to 10 seedlings of each collection planted in the field genebank. As of 31 July 1986, the genebank contains 1122 seedling genotypes. Each of these seedling genotypes may be considered as a distinct clone, although variation between seedlings of the same collection appears to be much less than the variation between collections. The genebank also includes 154 clones established from collections of budwood. Ten of these collections were also established as seedlings, and have been included in the total of seedling collections given above. About five hundred additional LCT-EEN seedlings are planted in an overflow area adjacent to the main collection; they are not considered as part of the main genebank, although they are available for distribution.

The overall success rate for establishing collections of seed was 93%, while for collections of budwood it was 55%. These figures are based on collections held in the San Carlos genebank on 31 July 1986. Almost all losses occurred during propagation, with less than 1% of collections being lost while growing in the nursery or after transplanting in the field. The establishment rate for collections of budwood is reasonable if one takes into account that for wild trees growing in forest, it was frequently possible to collect only small quantities of poor-quality budwood. The budding success rate for budwood collected in the wild fluctuated widely from expedition to expedition, from around 5% to more than 40%.

The San Carlos genebank also incorporates material from the Rio Caquetá in Colombia, collected by the international team mentioned earlier. This material is distinguished by the prefix EBC (Expedición Botánica Caquetá), and is numbered from EBC 1 to EBC 148. The San Carlos genebank, as of 31 July 1986, contains 27 EBC seed collections, represented by 177 seedling genotypes, and 7 EBC clones established from budwood (one of which is also represented by seedlings). The establishment rate for EBC seed collections was 87%, and for EBC budwood collections, 30%. This material was originally divided between Colombia, Brazil and Ecuador. The initial establishment rate for budded collections in Colombia was better, but many collections there were lost before field planting was completed.

Eleven clones collected during joint INIAP-Trinidad expeditions between 1968 and 1973 by W S Chalmers et al have been established at San Carlos with budwood sent from Pichilingue. These clones, which originated in the Amazon Region of Ecuador, are distinguished by the prefixes AGUARICO, CURARAY, NAPO, SAN MIGUEL and TIPUTINI (referring to the rivers where they were collected). About one hundred clones of these series are held at Pichilingue, but the trees are in bad condition and produce poor-quality budwood; repeated attempts to propagate these clones at San Carlos had minimal success.

Material held in the San Carlos genebank is summarised in Table 2. Considering only material collected during LCTAP, the total of 1460 genotypes derived from 314 trees makes this a large genebank, for cocoa, by world standards. For example, ICG,T (International Cocoa Genebank, Trinidad) contains about 1760 genotypes (Kennedy 1985); however, the main series of wild cocoa germplasm within ICG,T, collected by Pound, consist of only 542 genotypes. Furthermore, it is thought that the Pound genotypes, which mainly originated as seed collections, were derived from only about 50 wild trees (G Lockwood and A F Posnette, personal communication).

Table 2: Summary of material held in the San Carlos field genebank as of 31 July 1986

Series	Budwood Colls/Clones	Seed Collections	Seed Clones	All Collections	All Clones
LCT-EEN	154	137	1122	281	1276
EBC	7	27	177	33	184
Chalmers	11	0	0	11	11
Totals					
All	172	164	1299	325	1471
LCT-EEN + EBC	161	164	1299	314	1460

4.2 COVERAGE OF THE COLLECTING PROGRAMME

Although the planning of individual collecting trips was usually determined by practical considerations such as transport, accommodation and local contacts, it was always intended that the project would achieve systematic coverage of the Amazon Region of Ecuador. Having divided the target region into squares of 1/2° longitude by 1/2° latitude (about 55 km by 55 km), it was intended that every square would be visited at least once.

The map in Figure 3 shows the extent to which this objective was achieved in practice. Out of the total of 42 grid squares, 39 were visited at least once in the course of the collecting programme. Collections were made in 34 squares; despite careful searching, no wild cocoa, and no cultivated cocoa of local origin, was found in the remaining five squares. A further eight grid squares of the same size, in south-eastern Colombia, were visited and sampled during the collecting expedition on the Rio Caquetá in May-June 1984 (Figure 2.1, 2.5).

The effectiveness of this collecting strategy is discussed further in Section 8.

4.3 GENERAL OBSERVATIONS

Full descriptor data for all collections are included in Appendix 5, and analysed in Section 6. For the most part, the features of the wild cocoa trees and populations found during LCTAP Phase Two were similar to those noted during Phase One (Allen and Lass, 1983, Section 5.3, 5.4). Wild trees in Ecuador were generally distinctive by virtue of their strongly-wrinkled pods, high proportion of white beans, and unpigmented flush. Another distinctive feature of the Ecuador material was the absence of flower-cushions on the trunk; in most areas, virtually all pods were found on the branches. Most trees were found in flat areas of relatively fertile soils, with ten or more trees per hectare at some sites, but we continued to find trees growing on steep slopes at various sites in the southern Oriente.

Collections from the Rio Caquetá in Colombia were different from most of the Ecuador material, and included two distinct types of pod (described in Section 3.2). The Rio Caquetá trees also had numerous well-developed flower cushions on their trunks.

4.4 OBSERVATIONS ON OTHER THEOBROMA SPECIES

Apart from Theobroma cacao, three other Theobroma species (bicolor, glaucum and subincanum) were found frequently in the Amazon region of Ecuador. A fourth species (T.obovatum) was found only once. Two further Theobroma species (grandiflorum and microcarpum) were found on the Rio Caquetá in Colombia. Despite two full-length monographs on the taxonomy of Theobroma, the standard treatment of Cuatrecasas (1964) and an unpublished thesis by Soegeng-Reksodihardjo (1964), the identification of Theobroma species in the field is often difficult. This is partly because trees are often found without flowers or fruit, and partly because variation within some species obscures the subtle differences which should separate closely-related species. The following notes are based on observations in the field in Ecuador and on the Rio Caquetá in Colombia. The Spanish name 'cacao de monte' seems to be applied indiscriminately to all these species.

The genus Theobroma can be divided on the basis of branching habit. T.cacao has jorquettes with five branches, whereas all other species have three-branched jorquettes. Some species grow vertically by means of lateral-subterminal shoots which arise just below the jorquette, while others grow vertically from pseudo-apical shoots, which arise in the centre of the jorquette. Another character for species identification is the position of the flowers and pods; in some species these are produced only on the trunk, in others, only on the branches, in yet others, on both trunk and branches. The following species can all be distinguished on these characters together with the appearance of the pod.

Theobroma bicolor Humb. & Bonpl.
Local names: cacao blanco (Spanish), patase (Quichua), wakam (Shuar, also applied to T.cacao).
Distinguishing features: vertical growth continued by lateral-

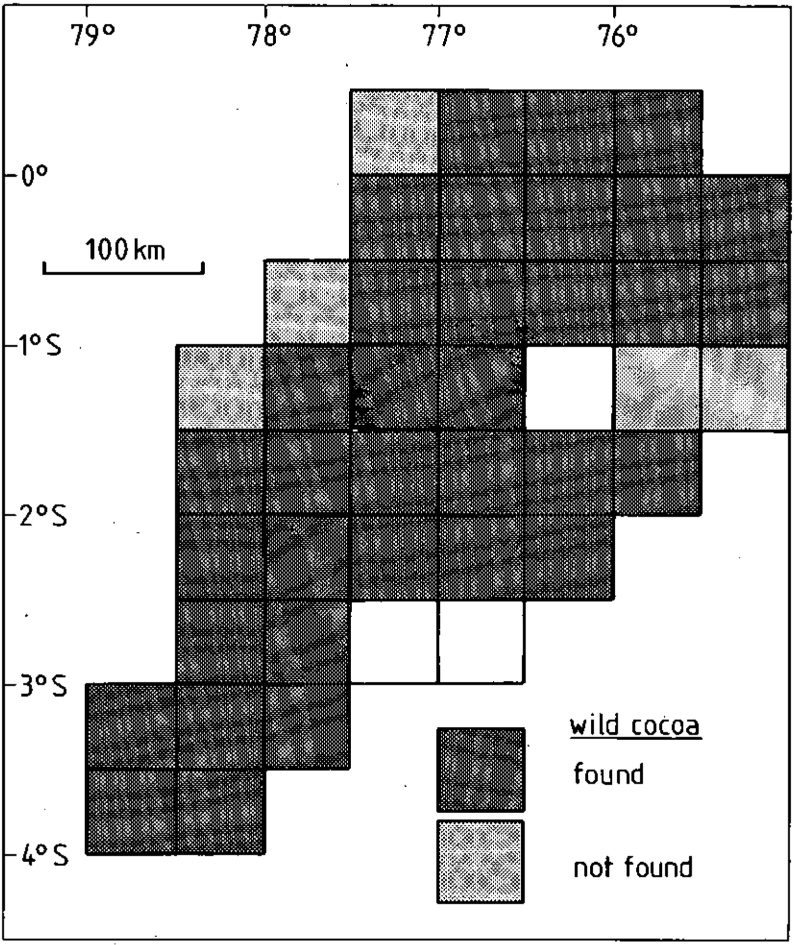


Figure 3 **Coverage of the collecting programme in Ecuador. This map covers the areas 'a', 'b', 'c', in Figure 2.1. Each square is 1/2° longitude by 1/2° latitude about 55 km by 55 km. Shaded squares were visited at least once.**

subterminal shoots, flowers on branches, large pods with a distinctive pattern of reticulate ribs, which fall from the tree when ripe. A common species in the region, but always cultivated. The beans are a valued part of the diet of many Indian groups. Two collections (LCT-EEN 161, 186) were planted at San Carlos in 1982 and grew to more than 10m in four years, yielding heavily from their third year. Old trees may reach 25-30m. The San Carlos trees have some witches' brooms, and many pods are infected, possibly with Crinipellis or Moniliophthora.

Theobroma glaucum Karst.
Distinguishing features: vertical growth continued by lateral-subterminal shoots, flowers in large, showy inflorescences on the trunk, which is typically vertical and unbranched to near the top of the tree, dichotomous division of jorquette branches. Occasional trees in forest in undulating upland areas (red soil). Also found, possibly planted for adornment, near Indian houses. One collection (LCT-EEN 167) at San Carlos, thought to be this species, was planted in 1982 and flowered for the first time in 1986 (height about 3m). However, the inflorescences were borne on the branches, so this may not be T.glaucum.

Theobroma grandiflorum (Willd. ex Spreng.) Schum.
Distinguishing features: vertical growth continued by pseudoapical shoots, flowers on branches, large smooth pods. We found a few trees of this species, cultivated, on the Rio Caquetá. One collection was established at San Carlos (EBC 102).

Theobroma microcarpum Mart.
Distinguishing features: vertical growth continued by pseudoapical shoots, flowers on branches, small ribbed pods. Locally common in forest along the Rio Caquetá, on flat alluvial soils above normal flood level, growing to 10-15m.

Theobroma obovatum Klotzsch ex Bernoulli
Distinguishing features: vertical growth continued by pseudoapical shoots, flowers on branches, small, thin-walled pear-shaped pods covered with sharp, hard warts. Locally common in forest along the Rio Caquetá, on flat alluvial soils above normal flood level. We also found one tree near the Rio Yasuni in Ecuador, in an undulating upland area (red soil). This species typically reaches 10-15m. One collection from Colombia, consisting of uprooted wild seedlings, was established as a single tree at San Carlos (LCT-EEN 383).

Theobroma subincanum Mart. (=T. guianense (Aubl.) Gmelin, according to Soegeng-Reksodihardjo (1964))
Local names: challua cacao (Quichua, also applied to T.cacao), uchi wakam (Shuar).

Distinguishing features: vertical growth continued by pseudoapical shoots, flowers on branches, smooth ellipsoid pods. Pod size was rather variable, with pods collected at San José de Payamino being twice as large as those from Taisha. This species was the most commonly found Theobroma apart from T.cacao and the always-cultivated T.bicolor. Three closely-related species, (T.grandiflorum, T.obovatum and T.subincanum) closely resemble one another in many vegetative characters, and there is some scope for confusion when attempting to identify young trees without flowers or pods. There are three collections of T.subincanum at San Carlos (LCT-EEN 375, 380, 392). Wild trees of this species occasionally carried witches' brooms (Crinipellis infection).

5. RESULTS: QUARANTINE

5.1 NUMBER OF COLLECTIONS IN QUARANTINE

This summary of the transfer of LCTAP material to quarantine is based on a list of collections in quarantine which was collated in October 1986, and which includes a shipment of budwood to Barbados in July 1986. A complete list of collections at each of the quarantine centres at that time is presented as Appendix 3. For the purpose of this summary, material held in Trinidad is counted as if it were in quarantine, although it has now been cleared for distribution.

Of the 281 LCT-EEN collections which have been established at San Carlos, 150 (53%) are represented in at least one of the quarantine centres. Of these, 71 are represented by the original clones, corresponding to the genotype of the original wild tree. The remaining 79 collections are represented by one or more seedling genotypes, usually corresponding to the seedlings held in the San Carlos genebank. In a few cases, seedling genotypes held in quarantine are additional to those held at San Carlos. Although it was agreed in principle that at least 4 seedling genotypes of each seed collection should be established in quarantine, only about 13 collections actually have more than one seedling genotype in quarantine. The point is discussed further in Section 5.3.

The largest collection in quarantine is in Barbados, with 84 LCT-EEN collections, followed by Miami (46), Montpellier (30) and Trinidad (24). It is planned that all LCTAP genotypes held in Barbados and Miami, after a minimum of one year in quarantine, will be duplicated at Trinidad, where they will be added to the International Cocoa Genebank, Trinidad (ICG,T). All material held in ICG,T will in due course be screened for resistance to Crinipellis and Phytophthora, and the response to selection within particular populations will be assessed (Kennedy, 1985).

About twelve EBC collections are also in quarantine, in Barbados and Montpellier.

5.2 EXPERIMENTS ON TECHNIQUES

Almost from the start of LCTAP, there was serious concern about the lack of success in establishing LCTAP material in quarantine. Various fungicide and anti-desiccant treatments were tried out on the shipments of budwood sent to Kew during 1981-1983, but there was no evidence that any of these consistently improved the budding success rate above the overall level of about 5%. There was also heavy mortality at Kew both among complete plants sent from Ecuador, after successful initial establishment, and also among plants grown from seed at Kew. Low budding success rates were also experienced at Miami, although subsequent survival and growth there were quite satisfactory. With these problems in mind, Lizzie Potts (recently graduated from the Horticulture Diploma course at Kew) worked at San Carlos from January to June 1984 on improved storage methods for budwood. The aim of this exercise, which was supported with funds from the Ghana Cocoa Growing Research Association, was to recommend storage treatments which would result in a higher budding success rate for budwood sent to quarantine centres. At the same time, Lizzie Potts collected meteorological data at San Carlos, with the object of defining growing conditions for material held in quarantine (see Appendix 2).

The most conspicuous feature of the results of the experiments on budding was the variation in overall success rate between one experiment and the next. Three of the five experiments had overall budding success rates of more than 50%, and their interpretation is straightforward, leading to the following conclusions:

1. "Storage of budwood" (Table 3): budwood (not treated with fungicide), wrapped in newspaper and stored at 10-15°C, showed no detectable deterioration over a period of 9 days. The budding success rate after 9 days was 60%, which would be more than adequate for establishment of material in quarantine. Budwood in transit to quarantine would normally be stored for no more than 6 days, so 9 day storage is a rigorous test.

2. "Storage of treated budwood II" (Table 3): wrapping the budwood in aluminium foil produced a slightly higher success rate (75%) after 9 days storage, than wrapping in clingfilm (45%).

3. "Pre-treatment of budwood with fungicide II" (Table 3): the control (no fungicide) buddings had a success rate of 80%, which was reduced by treatment with Benlate or Ridomil to only 55%. These buddings were made within 1 hour of cutting the budwood, so this experiment did not test the effect of the fungicides when storing budwood. However, results (1), (2) and (3) together suggest that success rates in excess of 60% are obtainable without fungicide treatment, which may actually damage the budwood.

All these results should be seen in the context of the very much lower budding success rates, typically around 5%, which have been obtained with budwood sent to Kew and other quarantine centres. After detailed consideration of the routine budding techniques in use at San Carlos, the only major difference between San Carlos and Kew noted by Potts (who had worked in the cocoa quarantine unit at Kew) was that the stock plants are kept very much drier both before and after budding at San Carlos. We recommend that quarantine centres should place stock plants on a dry bench, and that they should not be watered from, say, five days before budding until five days after budding, and then only very lightly.

Table 3: Summary of Results of Budding Experiments

a. STORAGE OF BUDWOOD

Treatment	No.buddings	No. takes	% take
0 days storage	20	11	55
3 days storage	20	9	45
6 days storage	20	11	55
9 days storage	20	12	60

b. STORAGE OF TREATED BUDWOOD I (9 days)

Treatment	No.buddings	No. takes	% take
Water soak	20	2	10
Cling-film	20	4	20
Foil	20	3	15
Latex	20	1	5
Unwrapped	20	0	0

c. STORAGE OF TREATED BUDWOOD II (9 days)

Treatment	No.buddings	No. takes	% take
Foil	20	15	75
Cling-film	20	7	45
Unwrapped	20	6	30

d. PRE-TREATMENT OF BUDWOOD WITH FUNGICIDE I

Treatment	No.buddings	No. takes	% take
Ferbam	24	3	13
Control	24	2	8
Saprol	24	8	33
Control	24	4	17
Benlate	24	7	29
Control	24	4	13
Total fungicides	72	18	25
Total controls	72	10	14

e. PRE-TREATMENT OF BUDWOOD WITH FUNGICIDE II

Treatment	No.buddings	No. takes	% take
Benlate	20	11	55
Ridomil	20	11	55
Control	20	16	80

A full account of this work was provided in Potts (1984). The main results are summarised here, (see Table 3) as a corrected version of the table summarising the results of budding experiments.

Although it is difficult to prove, Jose Baquero, who has obtained consistently good results when budding LCTAP material at San Carlos, is of the opinion that the use of stock plants which have not been allowed to dry out leads to failures in budding because their bark contains enough moisture to initiate rotting underneath the grafting tape.

The remaining experiments produced low overall success rates. The experiment "Storage of treated budwood I" (Table 3) had an overall success rate of only 10%; the two best wrapping treatments, aluminium foil and clingfilm, were retested in a second experiment, the results of which have already been described above. The experiment on "Pre-treatment of budwood with fungicide I" (Table 3) had an overall success rate of 19%; fungicide-treated budwood had a higher success rate (25%) than untreated budwood (14%); these results are probably irrelevant in view of the much higher success rates achieved in other experiments with untreated budwood.

One explanation for the difference between experiments was suggested by G A R Wood (Cadbury Schweppes plc), namely that there are consistent differences in budding success between clones. If some experiments contained mainly 'easy' clones and others 'difficult' clones, the latter experiments would tend to have low overall success rates, obscuring treatment effects. On the basis of consistent results in two experiments, it was hypothesized that two clones were 'easy' (236 and 288) and one was 'difficult' (232). Two other clones (165 and 254) were classed as 'difficult' on the basis of low take rates in experiments with high overall success rates. All five clones were tested in a simple experiment by José Baquero, in October 1984. The results of this experiment are presented in Table 4. They show a high overall success rate (64%), and the 'difficult' clones were actually slightly more successful (67%) than the 'easy' clones (60%). It was therefore concluded that differences in overall success rates between experiments were not caused by the inclusion of clones that are inherently easy or difficult to propagate vegetatively.

Table 4: Comparison of 'Easy' and 'Difficult clones

Clone	Easy/difficult	No.buddings	No.takes	% takes
165	Difficult	10	8	80
232	Difficult	10	5	50
236	Easy	10	5	50
254	Difficult	10	7	70
288	Easy	10	7	70
Totals	All	50	32	64
	Difficult	30	20	67
	Easy	20	12	60

Following the death of all the plants in the BARBADOS-1 shipment in May 1985, it was suggested that the basic concept of the despatching complete bare-rooted plants was doubtful. It also appeared possible that the plants had been killed by one of the chemical treatments (particularly the combined nematocide-insecticide treatment with

Furadan). A further suggestion was that plants would establish better if part of each leaf was left on the plant. A simple experiment was therefore set up to investigate these possibilities.

The experiment used 5 groups of 20 plants each (except Group 4 which had only 10 plants), comprising 10 young plants (open-pollinated seedlings of EET-400, sown on 28.11.84) and 10 'old' plants (equal numbers of open-pollinated seedlings of IMC-67 and EET-400, 1-3 years old, which had been used as stock plants for buddings which did not take). All these plants, which had been growing in plastic bags were cut to a total height of 50 cm (including the roots), the soil removed manually, and the roots washed clean. All leaves were removed, except in Group 4; 'old' plants could not be included in Group 4 because the pruning to 50 cm necessarily involved the removal of all leaves. After fungicide and/or nematocide treatment, the plants were packed, in groups of five, in damp newspaper. The paper-wrapped bundles were placed in sealed plastic bags, which were in turn placed in a plastic drum, which was stored in a house. Temperatures in the plastic drum fluctuated between 22.5°C and 24.0°C (days 0-5) and between 19.5°C and 30.5°C (days 6-9). After 5 or 9 days storage, the plants were replanted, in plastic bags, using fresh soil (unmodified forest topsoil), and placed in a well-shaded nursery bed (about 20% daylight). The plants were watered after transplanting, and every 2-3 days subsequently if no rain had fallen. The treatments are shown in Table 5.1 and the results are presented in Table 5.2.

Table 5.1: Treatment combinations for packing experiment

	GROUP				
TREATMENT	Control	1	2	3	4
Storage (days)	5	10	5	5	5
fungicide (30s immersion in 0.3% Difolatan)	+	+	-	+	+
insect/nematocide (sprinkling with 5% Furadan granules)	-	-	-	+	-
removal of only 50% of each leaf	-	-	-	-	+

NOTE:
In effect the Control treatment involves 'short' storage and fungicide only; Groups 1 to 4 test the effects of (1) longer storage, (2) omitting the fungicide, (3) using Furadan and (4) leaving part of every leaf.

Table 5.2: Results of packing experiment

GROUP	No. Live	(Flushing)	No. Dead
Control-old	10	(10)	0
Control-young	10	(10)	0
1-old	10	(10)	0
1-young	10	(10)	0
2-old	10	(10)	0
2-young	10	(10)	0
3-old	10	(10)	0
3-young	6	(6)	4

NOTES:

i) experiment set up on 15.7.86. Results from assessment on 5.10.86.

ii) although all plants were flushing on 5.10.86, the growth of the plants in Treatment 4 (partial leaf removal) was retarded by comparison with other treatments.

These results were most encouraging. All treatments resulted in 100% survival. For the control group and Groups 1-3, the small variation in the proportion of plants flushing suggested that young plants appear to resume growth more rapidly after transplantation. The visible condition of all plants was good, except in Group 4, where the upper parts of the 4 non-flushing plants had became dessiccated. In any case, the leaves left on the plants in Group 4 withered after transplanting. The state of the Group 4 plants tended to confirm the belief that complete leaf removal is desirable. The observation that a longer period of storage does not affect establishment may permit a wider choice of routes for shipping plants.

These results suggest that the basic whole-plant shipment method, described at the beginning of this section, could lead to virtually complete establishment of plants shipped to quarantine. They provide confirmation of the idea that most of the problems in establishing LCTAP material in quarantine were due to unsatisfactory growing conditions in the quarantine greenhouses.

5.3 NUMBER OF SEEDLING GENOTYPES TO BE QUARANTINED

About half the LCTAP collections were collected as seed, and this material is maintained in the field genebank as a group of up to 10 seedlings, usually derived from one pod but sometimes from 2 or 3 pods. In principle, there are likely to be genetic differences among these progeny, and some thought should be given to the question of how many of these seedlings should be transferred to quarantine in order that an adequate representation of the original wild gene pool is maintained.

For the purposes of calculation, it is helpful to consider the extreme (and possibly unusual) case of a locus at which the original wild tree (the female parent) was heterozygous, and to assume that the collected pod resulted from cross-pollination with another tree in which this allele was absent. The probability(s) of finding at least one copy of both maternal alleles among n progeny would then be given by:

$$s = 1 - 2\,(0.5)^n$$

For m loci, the probability (t) of obtaining both alleles at each and every locus is given by:

$$t = s^m$$

Considering progenies of from 2 to 50 seedlings, and from 1 to 100 loci, the probabilities are given in Table 6. From this table, it is seen that with 5 seedlings, there is a rapid decline in the likelihood of conserving all the maternal alleles as the number of loci increases; for example, with 50 loci, there is only a 4 per cent chance of conserving the maternal alleles. With 10 seedlings, the decline is less marked, and for 50 loci, there is only a 4 per cent chance of conserving the maternal alleles. With 10 seedlings, the decline is less marked, and for 50 loci, there is still a 91 per cent probability of retaining the maternal alleles. This would suggest that there is a case for transferring all 10 progeny to quarantine. However, it may be better to ask a slightly different question: what overall proportion of alleles is retained by taking n seedlings? The number of loci at which either maternal allele is lost is given by:

$$2m\,(0.5)^n$$

Since there are 2m maternal alleles altogether, the overall proportion (v) of alleles retained is given by:

$$v = 1 - (0.5)^n$$

This gives values as follows:

n =	1	2	3	4	5	10
v =	.500	.750	.875	.938	.969	.999

Table 6: Probability (t) of obtaining copies of both maternal alleles in seedling progeny

		number of seedlings (n)									
		2	3	4	5	6	7	8	9	10	50
	1	.500	.750	.875	.937	.969	.984	.992	.996	.998	1.00
number of	5	.031	.237	.513	.724	.853	.924	.962	.981	.990	1.00
loci (m)	10	.001	.056	.263	.524	.728	.854	.925	.962	.981	1.00
	20	.000	.003	.069	.275	.530	.730	.855	.925	.962	1.00
	50	.000	.000	.001	.040	.204	.455	.676	.822	.907	1.00
	100	.000	.000	.000	.002	.042	.207	.456	.676	.822	1.00

NOTE:
This table gives values of the probability of obtaining at least one copy of both maternal alleles at each of m loci, given n seedlings. Assumptions and methods of calculations are explained in the text.

Table 8: Collections with high seed index values

(a) LCT-EEN collections with seed index > 2.0

LCT-EEN	seed index	LCT-EEN	seed index	LCT-EEN	seed index	LCT-EEN	seed index
8	3.23	78	2.60	163	2.25	269	2.11
18*	2.10	83	2.25	166*	2.80	280	2.32
19*	2.01	108*	2.48	169*	3.37	281	2.00
23	2.02	113	3.00	218*	2.73	288	5.91
26*	2.11	128	2.80	219	2.28	313	3.06
31	2.35	129	2.13	220	2.05	320	2.42
36	2.88	132*	2.08	237	2.47	329	2.03
37	2.60	133	2.61	239	2.35	330	2.08
38*	2.42	136	2.06	241	2.41	348	2.00
44	2.52	156	2.91	242	2.69	348	2.02
59*	2.75	157*	2.55	244*	2.20	355	2.18
60	2.20	158	2.32	246	2.55	359	2.29
65	2.07	159	2.08	250*	2.19	361	2.06
69*	2.26	160*	2.50	258*	2.05	424	2.64

(b) EBC collections with seed index > 1.5

EBC	seed index
77	1.53
101	1.86
135	1.52
138	1.60
142	1.65
148	1.53

NOTE:
Collections marked * are also in the list of collections with the lowest pod index values (Table 14).

6.2 DESCRIPTORS OF AGRONOMIC SIGNIFICANCE

6.2.1 POD INDEX AND SEED INDEX

Pod index values (number of pods for 1 kg of dry cocoa beans) were estimated from yield data, and are included in Appendix 6. Seed index values (average weight in grammes of one dry fermented bean, with shell) were estimated from descriptor data as:

$$\frac{\text{total weight of wet beans/pod} \times 0.4}{\text{number of beans/pod}}$$

Some collections with high seed index values are listed in Table 8. Collections with low pod index values are listed in Table 14. It should be noted that high values of seed index and low values of pod index are desirable.

6.2.2 SHELL AND FAT CONTENT

In addition to the main descriptor list, shell and fat content analyses were performed on 16 bean samples, from a representative range of LCT-EEN collections. The results, all by the same laboratory, are listed in Table 9; they provide some indication of the range of variation in these values within the LCT-EEN collections. Shell content varied from 10.9% to 23.2%, with a mean of 15.1%. The fat content of the nib varied from 51.6% to 58.6%, with a mean of 55.6%. It was hoped that there might be a consistent relationship between bean weight and shell content, but the weak negative correlation was not statistically significant. The average shell and fat contents are comparable with typical values for Latin America quoted by Wood (1975).

Table 9: Shell and fat percentages in LCT-EEN bean samples.

LCT-EEN	% Shell	% Fat in Nib
38	16.2	55.2
46	13.8	51.6
140	15.9	56.7
148	14.5	54.0
149	16.4	55.5
162	13.8	55.1
163	11.5	55.6
172	23.2	54.1
178	13.2	58.3
179	10.9	56.1
181	15.6	58.0
185	22.6	54.4
219	11.1	58.6
232	14.9	54.6
282	14.4	56.0
283	13.6	55.1

NOTE:
Analytical results supplied by Cadbury Limited, United Kingdom

6.2.3 GENETIC COMPATIBILITY

The results of some pollination experiments are summarised in Table 10. No self-compatible clones were found, although the number of clones tested was small. It should be noted that all clones of Upper Amazon origin so far tested in genebanks have been self-incompatible.

6.2.4 FLOWERING

Flowering data are presented in Figure 4. For the collections recorded, flowering during 1984 - 1986 was concentrated in the period from September to March, with the main peak in October - November and a lower peak in February - March.

Flowering rates were 5-10 times higher in 1984/85 than in 1985/86 possibly because of the unusually hot, dry weather in the earlier year. From April to August, flower production almost completely

These figures indicate that 94% of female alleles would be retained in four seedlings. In practice, it appears that even this argument is unnecessarily pessimistic. As far as can be deduced from variation in visible morphological characters among seedling progenies, there is little evidence of heterozygosity in wild populations, so that in many cases even a single seedling reproduces most of the genotype of its maternal parent. In this situation, the transfer of large numbers of seedling genotypes to quarantine should not have a high priority.

6. RESULTS: DESCRIPTION

6.1 CHARACTERISATION

Data on the characteristics of the LCTAP collections, in terms of a standard descriptor list, is presented in Appendix 5. The methodology for this description was outlined in Section 2.4. Some of this data is summarised in Table 7, together with comparable data from the germplasm collection at Turrialba, Costa Rica, which is the only other large cocoa genebank for which a catalogue has yet been published (Engels 1981).

The quantitative descriptors in Table 7 are listed with their mean values and coefficients of variation (CV), for three groups of collections: (a) LCT-EEN collections at San Carlos, (b) EBC collections at San Carlos and (c) all described collections at Turrialba. The CV values provide a convenient measure of variability for distributions which are approximately normal in form. For the qualitative descriptors in Table 7, the frequences of the descriptor states are given, as absolute values and as percentages.

The Turrialba genebank includes a fair cross-section of cultivated cocoa clones, with only two clones identified as of wild origin. In comparing the mean descriptor values for the LCT-EEN collections and those for the Turrialba clones, the similarities are more striking than the differences; pod size and weight, and seed size and weight, are nearly identical in the two groups. However, the LCT-EEN pods have higher mean values for apex form (i.e. more pointed pods), surface rugosity, primary furrow depth, and diameter: length ratio, although there is considerable overlap for all these characters. Considering the qualitative descriptors, pigmented pods occur in 35% of the Turrialba clones but in only 5% of the LCT-EEN collections, mostly of cultivated origin. White beans are very common (65%) in the LCT-EEN collections, but were recorded in only 17% of the Turrialba clones, although the Turrialba catalogue does note that the bean colour percentages reflect cross-pollination within the genebank.

The EBC descriptor data should be compared with the LCT-EEN data. The EBC collections evidently represent a distinct population or populations, with narrower, smoother pods and smaller beans, which are never white, although light purple beans are common. High CV values for several pod descriptors, notably pod wall thickness, result from the inclusion of a small group of rather distinct collections, having very large pods with unusually thick, hard walls.

Table 7: Summary of Pod and Seed Descriptors

Quantitative Descriptors

DESCRIPTOR	LCT-EEN		EBC		Turrialba	
	mean	CV(%)	mean	CV(%)	mean	CV(%)
POD						
Basal constriction	1.3	138	2.8	61	1.8	100
Apex form	5.2	48	5.0	34	4.6	39
Surface rugosity	5.4	30	2.2	114	3.8	44
Furrow depth	5.2	19	3.6	25	3.9	41
Length (mm)	166.0	18	176.0	27	174.0	15
Diameter (mm)	93.0	15	76.0	20	86.0	8
Diameter : length	0.56	16	0.44	16	0.51	16
Wall	18.0	27	13.0	40	-	-
Weight (g)	574.0	44	475.0	74	570.0	8
SEED						
Fresh peeled wt (g)	2.02	28	1.44	41	1.95	28
Number	28.0	39	36.0	28	34.0	12
Length (mm)	24.7	11	23.1	13	24.4	9
Width (mm)	13.4	12	11.0	15	13.1	13
Thickness (mm)	9.3	15	8.4	12	9.0	13
Width : length	0.54	8	0.47	9	0.54	8
Seed index	1.74	37	1.05	42	-	-

Qualitative Descriptors

DESCRIPTOR	LCT-EEN		EBC		Turrialba	
	f	%	f	%	f	%
Anthocyanin pigment in unripe pods (scale)						
0	188	95	33	100	192	65
>0	10	5	0	0	102	35
White beans						
Present	131	66	0	0	49	17
Absent	67	34	30	100	245	83
Light Purple beans						
Present	74	37	25	83	186	63
Absent	124	63	5	17	108	37
Dark Purple Beans						
Present	86	43	15	50	180	61
Absent	112	57	15	50	114	39

NOTES:

i) Turrialba data are from Engels (1981), Appendix D. These Turrialba descriptors are essentially the same as those used in LCTAP (see Section 2.4). The pod pigment descriptor for Turrialba refers to anthocyanin intensity in the ridges of unripe pods;

ii) wall measurements are the thickness of wall in mm;

iii) codes and symbols: CV = coefficient of variation (standard deviation as a percentage of the mean); f = frequency; "-" = no comparable descriptor.

Figure 4 Daily flower counts for nineteen trees, April 1984 – July 1986 (for methods see Section 2.4).

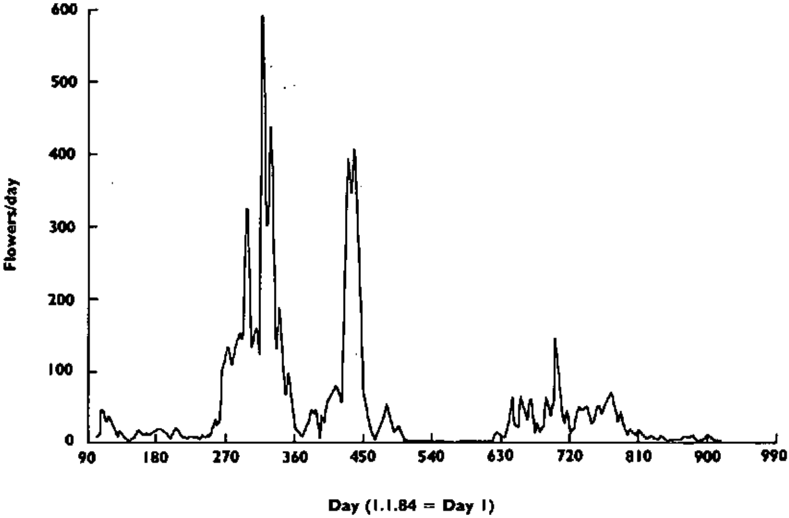
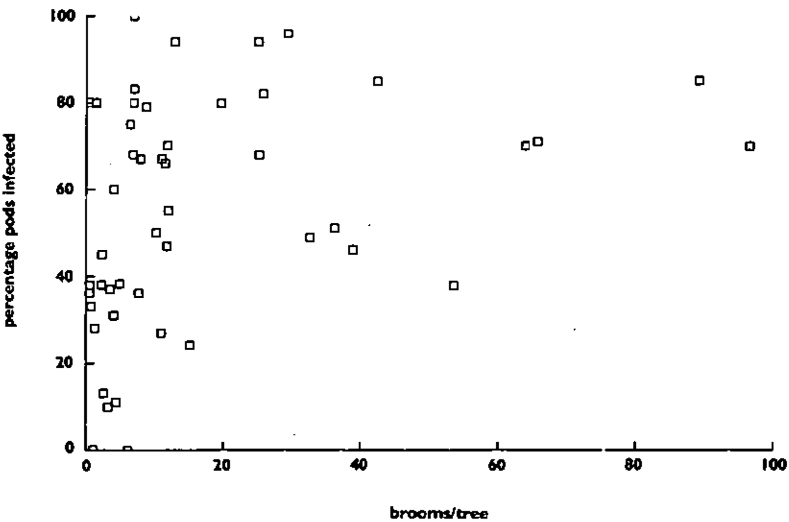


Figure 5 Relationship between broom count and witches' broom pod infection.



Notes:
1. Based on broom counts, July 1984, and production data for 1984.

Table 12: Frequency Distribution of Pod Production/Tree

Pods/Tree	Number of Collections	Per Cent
0 - 9	95	44
10 - 19	39	18
20 - 29	30	14
30 - 39	18	8
40 - 49	13	6
50 -	20	9

NOTES:

i) based on data in Appendix 6, covering all collections for period January 1984 - June 1986.

ii) the total number of pods produced per tree, including both healthy and diseased pods. In view of the high levels of pod infection seen at San Carlos, this may be a more realistic measure of the potential productivity of these genotypes than actual yield;

iii) the estimated yield of dry beans per tree, in kg, assuming that dry weight yield = 0.4 x fresh weight yield; any error resulting from this assumption is likely to be much smaller than the statistical uncertainty which attaches to the fresh weight yield estimates, due to inter-tree variation;

iv) the pod index, calculated as the number of pods needed to produce 1 kg of dry beans, estimated as in (iii). A low pod index is preferable;

v) witches' broom infected pods, as a percentage of the total of healthy pods plus witches' broom infected pods; (see Section 2.5 for definitions of pod infection categories);

vi) Moniliophthora infected pods, as a percentage of the total of healthy pods plus Moniliophthora pods.

vii) for (v) and (vi) the percentages are calculated in this way to avoid distortions caused by a high rate of infection with one of these diseases producing an apparent low rate of infection by the other. The alternative approach, expressing pod loss as a percentage of total pod production (as used in previous LCTAP reports) means that collections with 100% loss by witches' broom were automatically ranked as 0% Moniliophthora, which is unrealistic. Such collections are now excluded from the Moniliophthora ranking.

The most conspicuous features of these data are the high proportion of collections which produced few pods, and the high proportion of diseased pods. From Table 12, it is seen that 44% of the collections produced less than 9 pods/tree over this 30 month period. The proportion of pods infected with witches' broom (and other diseases not distinguished from witches' broom) fluctuated around 50% throughout the whole period (Table 13). The proportion of pods with sporulating Moniliophthora infection increased to 40-50% between August 1984 and July 1985, but later declined to around 20%, with an overall mean of 24%. Only about one-quarter of all pods were free of disease, so that yields were low. Only 20 collections produced more than 0.5 kg/tree of dry beans over this 30 month period.

ceased in these years.

6.2.5 POD WALL THICKNESS

A hard pod wall may produce some degree of resistance to pod-boring insects such as Conomorpha cramerella, a serious pest of cocoa in South-east Asia. Subjective estimation of pod wall hardness proved awkward, but there did seem to be a rough correlation between pod wall thickness and hardness. Pod wall thickness was one of the standard descriptors. Table 11 lists collections with pod wall thickness greater or equal to 20mm.

Table 10: Results of pollination experiments on LCT-EEN clones
(a) attempted self-pollinations (all unsuccessful)

1	74	120	150	223
46	80	125	151	228
60	91	132	156	214/s4
73	107	148	175	214/s5

(b) attempted cross-pollinations (female parent first)

Successful	Unsuccessful
44/s3 x 61/s4	46 x 91
60/s3 x 61/s4	46 x 223
91 x 228	46 x 228
120 x 46	60 x 46
132 x 133	60 x 80
152 x 46	60 x 91
	91 x 46
	133 x 1

7. RESULTS: EVALUATION

7.1 YIELD AND POD INFECTION

The routine recording of yield and the numbers of healthy and diseased pods (Section 2.5) provided the basis for a preliminary assessment of the agronomic performance of the LCTAP material. Data were available for two complete years (1984, 1985) and for the first six months of 1986. The data for each year were analysed separately, as were the data from budded collections and those from seedling collections. Data from collections planted in 1981 was also compared with data from 1982 plantings. There was no marked effect of planting year, propagation method or year of assessment, so it appeared reasonable to present an analysis of the entire data set, covering material from 209 collections which produced pods between January 1984 and June 1986. Six collections were present in the genebank as both budded and seedling trees, so that the yield database has 215 records. The complete database is tabulated in Appendix 6, together with some derived values which are more directly useful in evaluating agronomic performance.

For each of the production and pod infection indicators, the LCTAP collections were ranked in order of merit, and the upper 25% of each

Table 11: Collections with pod wall thickness greater or equal to 20 mm

LCT-EEN	1	LCT-EEN	71	LCT-EEN	239
LCT-EEN	6	LCT-EEN	78	LCT-EEN	243
LCT-EEN	8	LCT-EEN	79	LCT-EEN	244
LCT-EEN	10	LCT-EEN	80	LCT-EEN	246
LCT-EEN	19	LCT-EEN	81	LCT-EEN	248
LCT-EEN	22	LCT-EEN	82	LCT-EEN	251
LCT-EEN	24	LCT-EEN	83	LCT-EEN	252
LCT-EEN	25	LCT-EEN	93	LCT-EEN	258
LCT-EEN	28	LCT-EEN	108	LCT-EEN	271
LCT-EEN	29	LCT-EEN	113	LCT-EEN	313
LCT-EEN	31	LCT-EEN	125	LCT-EEN	326
LCT-EEN	37	LCT-EEN	127	LCT-EEN	342
LCT-EEN	38	LCT-EEN	129	LCT-EEN	424
LCT-EEN	44	LCT-EEN	130	LCT-EEN	430
LCT-EEN	48	LCT-EEN	131	EBC	76
LCT-EEN	58	LCT-EEN	136	EBC	77
LCT-EEN	59	LCT-EEN	158	EBC	101
LCT-EEN	60	LCT-EEN	160	EBC	121
LCT-EEN	61	LCT-EEN	166	EBC	135
LCT-EEN	64	LCT-EEN	169	EBC	138
LCT-EEN	65	LCT-EEN	205	EBC	142
LCT-EEN	69	LCT-EEN	219	EBC	145
LCT-EEN	70	LCT-EEN	237		

list are presented in Tables 14 and 15. For the pod index, records with less than five healthy pods were excluded from the analysis; for the other indicators, records were excluded if they had less than five pods per tree, or less than ten pods in total. These tables provide an objective basis for determining which LCTAP genotypes should be selected for further trials. For general productivity in regions where witches' broom and Moniliophthora diseases are absent, the ranking by pod production per tree is most informative. For trials of resistance to witches' broom or Moniliophthora, the ranking by percentage of pods with these diseases may be informative; this point is discussed further in the next section.

A few collections are obviously of special interest. Considering both pod production and yield, LCT-EEN 46 produces many pods and is relatively free of disease; however, it has a high pod index and small beans. LCT-EEN 27 achieves a high yield despite a high rate of witches' broom infection. Both of these collections were made in Indian gardens and both are very distinct from typical wild-type trees; LCT-EEN 27 has red pods. LCT-EEN 73, LCT-EEN 178 and LCT-EEN 255 are typical wild trees (although 178 has a slightly pigmented flush) and yield relatively well despite high rates of witches' broom infection. LCT-EEN 214 was collected on a farm.

On those collections notable for their relative freedom from disease, and which have not already been mentioned, LCT-EEN 364 was collected in a remote forest area, but has a strongly pigmented flush. LCT-EEN 127 was collected on a colonist's farm, and has small dark purple beans. LCT-EEN 199 was collected on the Colombian side of the Rio Putumayo, and is a very distinct type, with small, partly pigmented, thin-walled pods and very small dark beans.

The pod production and yield results are reasonable for such young trees (planted in 1981 and 1982), but low production means that caution should be exercised in any further interpretation of these data.

Table 13: Monthly counts of healthy and diseased pods

Year	Month	Healthy Pods	Healthy %	WB Pods	WB %	Moniliophthora Pods	Moniliophthora %	Total Pods
1983	Oct	82	38	132	61	2	0	216
	Nov	No data						
	Dec	13	41	18	56	1	3	32
1984	Jan	10	16	44	69	10	16	64
	Feb	19	41	23	50	4	9	46
	Mar	79	49	78	48	5	3	162
	Apr	255	50	230	45	23	5	508
	May	78	55	61	43	3	2	142
	Jun	108	57	72	38	8	4	188
	Jul	141	37	227	60	11	3	379
	Aug	96	23	110	27	209	50	415
	Sep	67	23	162	55	63	22	292
	Oct	105	32	196	59	30	9	331
	Nov	349	37	471	50	115	12	935
	Dec	269	31	461	53	135	16	865
1985	Jan	No data						
	Feb	234	10	1472	60	737	30	2445
	Mar	301	22	719	53	332	25	1352
	Apr	718	30	861	36	811	34	2390
	May	223	16	546	40	613	44	1382
	Jun	31	11	124	44	124	44	279
	Jul	31	5	289	49	269	46	589
	Aug	61	12	280	56	162	32	503
	Sep	149	14	700	67	196	19	1045
	Oct	124	14	541	59	249	27	914
	Nov	70	29	140	58	32	13	242
	Dec	0	0	3	100	0	0	3
1986	Jan	15	5	241	76	62	19	318
	Feb	26	10	191	73	45	17	262
	Mar	64	28	133	58	32	14	229
	Apr	383	29	698	54	220	17	1301
	May	760	34	1077	49	370	17	2207
	Jun	388	24	845	52	401	25	1634
	Totals	5249	24	11145	51	5276	24	21670

NOTE:
Witches' broom (WB) and Moniliophthora percentages calculated as percentages of total number of pods.

Although it would be unwise to draw positive conclusions from these results, it does appear that the more typical wild trees are not notable for being especially productive or free from pod infection when brought into cultivation at San Carlos. There is also some evidence that local cultivated genotypes, apparently imported from other parts of the Amazon basin and possibly selected over many years by Indian farms, are better adapted to cultivation in these conditions.

7.2 WITCHES' BROOM DISEASE VEGETATIVE INFECTION

Complete broom counts for the entire collection were made in July 1984 and November 1985. The interpretation of these data is complex, because collections with low broom counts often turned out to be slow-growing and unproductive, and therefore less interesting than productive collections with moderate broom counts. There is no simple correlation between the broom count for a given collection and the percentage of infected pods for that collection (Figure 5). Collections with high broom counts always have high percentages of infected pods, but collections with low broom counts may have low or high percentages of pod infection. Nonetheless, the range of variation in vegetative infection is striking. For example, for seedling collections planted in 1981, the five most heavily infected collections in 1985 had a mean of 462 brooms/tree, while the five least infected collections averaged only 12 brooms/tree.

8. DISCUSSION AND RECOMMENDATIONS FOR THE FUTURE

From the earliest stages of planning, it was intended that LCTAP would try out a new approach to cocoa germplasm collecting. Whereas most collecting programmes had been organised as relatively short expeditions setting out from research centres far removed from the collecting areas, LCTAP was developed on the concept that the overall objectives of germplasm collecting would be better served by having a collector based for several years at a research station within the Upper Amazon region. It was expected that this would make it possible to collect more thoroughly through the target region, taking advantage of detailed local knowledge acquired by the collector. There would also be close supervision by the collector of the establishment in cultivation of the collected germplasm. In LCTAP Phase Two, this idea was extended to cover some preliminary assessment of the early agronomic performance of the collections.

The concept of a resident collector also made it possible to envisage more comprehensive documentation than has been usual for cocoa germplasm collections. A series of widely circulated reports, and several publications, (listed in Section 10) from this Project have provided accounts of collecting trips, site information and observations on wild cocoa populations, as well as descriptions of the collected genotypes using standard descriptors and some analysis of the geographical data. In IBPGR terminology, this is known as 'ecogeographical survey' (IBPGR, 1985). The location of most of the collections has therefore been well documented.

HOW EFFECTIVE WAS THE LCTAP COLLECTING STRATEGY?

The results presented in Section 4 show that LCTAP has brought into cultivation some 1300 genotypes from Ecuador, derived from about 280 wild trees. It is clear that most of this material can be considered as a sample of the whole Ecuadorian Amazon population, rather than of subpopulations associated with particular localities. There is obviously genetic variation within this population which merits further study and analysis. Such analyses are being undertaken, but are outside the scope of this report. Nonetheless, in terms of the characters normally used to distinguish cocoa

Table 14: Ranking of collections by production indicators

a. Ranking by total pod production per tree

LCT-EEN	Pod/Tree	LCT-EEN	Pod/Tree	LCT-EEN	Pod/Tree	LCT-EEN	Pod/Tree
46 I	175.00	157 I	62.25	148 I	46.50	59 S	40.60
255 I	143.00	62 S	60.30	73 I	46.33	228 I	40.50
178 I	116.00	97 I	60.00	281 I	45.50	2 I	40.00
27 S	88.75	10 S	59.90	249 I	45.00	29 S	39.33
189 I	87.00	253 I	59.33	22 S	43.88	60 I	38.60
325 S	84.75	26 S	55.66	57 I	43.00	144 I	38.00
251 I	78.00	31 I	55.33	254 I	42.75	69 S	37.00
6 S	68.20	38 I	52.00	278 I	41.00	162 I	37.00
158 I	65.00	126 I	52.00	182 S	40.90	151 I	36.40
258 I	63.00	125 I	51.75	23 S	40.70	80 I	36.20

b. Ranking by estimated yield of dry beans per tree

LCT-EEN	Pod/Tree	LCT-EEN	Pod/Tree	LCT-EEN	Pod/Tree	LCT-EEN	Pod/Tree
46 I	3.69	148 I	0.76	10 S	0.50	90 S	0.39
27 S	1.84	77 S	0.72	28 S	0.46	160 S	0.39
73 I	1.37	162 I	0.72	26 S	0.44	199 S	0.39
178 I	1.22	189 I	0.72	74 I	0.44	323 S	0.39
214 S	1.00	62 S	0.69	127 S	0.43	92 S	0.38
38 I	0.88	83 S	0.68	76 S	0.42	215 S	0.38
157 I	0.82	182 S	0.58	68 I	0.40	269 I	0.37
255 I	0.82	69 S	0.57	151 I	0.40	126 I	0.36
202 S	0.81	60 I	0.55	163 I	0.40	158 I	0.34
6 S	0.77	201 S	0.55	188 I	0.40	185 I	0.33

c. Ranking by pod index

LCT-EEN	Pod Index	LCT-EEN	Pod Index	LCT-EEN	Pod Index	LCT-EEN	Pod Index
157 I	11.57	202 S	13.96	19 S	14.79	18 S	16.23
218 I	11.68	59 S	14.04	323 S	14.79	328 S	16.44
169 I	11.79	69 S	14.04	26 S	14.88	22 S	16.55
160 S	11.90	244 S	14.04	258 I	15.06		

LCT-EEN	Pod Index	LCT-EEN	Pod Index	LCT-EEN	Pod Index
88 S	12.50	223 I	14.12	72 S	15.24
166 I	12.75	255 I	14.53	335 S	15.43
28 S	12.95	38 I	14.70	325 S	15.52
342 S	13.08	70 S	14.70	349 S	15.62
5 S	13.81	108 I	14.70	132 S	15.72
86 S	13.81	151 I	14.70	250 I	15.82

NOTES:
S = seedlings, I = clones

Table 15: Ranking of collections by pod infection indicators

a. Ranking by percentage of pods infected with witches' broom

LCT-EEN	% Pods	LCT-EEN	% Pods	LCT-EEN	% Pods	LCT-EEN	% Pods
364 I	18	92 S	37	77 S	49	109 S	56
127 S	19	182 S	39	179 I	50	36 I	58
199 S	20	89 S	42	76 S	51	162 I	58
86 S	23	148 I	42	201 S	51	60 I	59
46 I	28	181 I	42	27 S	52	178 I	60
163 I	30	74 S	43	205 S	53	269 I	60
90 S	33	212 S	43	93 S	54	4 S	61
214 S	33	136 S	45	103 I	54	132 S	63
83 S	36	73 I	46	367 I	54	189 I	63
185 I	36	202 S	48	108 I	56	283 I	63

b. Ranking by percentage of pods infected with <u>Moniliophthora</u>

LCT-EEN	% Pods	LCT-EEN	% Pods	LCT-EEN	% Pods	LCT-EEN	% Pods
36 I	0	107 I	6	28 S	14	367 I	20
127 S	0	185 I	6	201 S	14	4 S	21
181 I	0	92 S	7	89 S	15	136 S	21
199 S	1	46 I	8	108 I	15	145 S	25
73 I	2	76 S	8	163 I	16	282 I	25
90 S	2	91 I	9	148 I	18	205 S	26
74 S	3	130 S	9	188 I	18	295 S	27
86 S	4	182 S	11	214 S	18	68 I	28
93 S	4	212 S	12	364 S	18	189 I	28
83 S	6	77 S	13	27 S	20	37 I	29

NOTES:

i) Witches' broom infected pods, as a percentage of the total of healthy pods plus witches' broom pods;

ii) <u>Moniliopthora</u> infected pods, as a percentage of the total of healthy pods plus pods;

iii) S = seedlings, I = clones.

populations, it is reasonable to treat this as a single population, distinguished from other wild and cultivated cocoa populations by at least three easily observed characters: the strongly wrinkled pod surface, the high frequency of white beans and the unpigmented flush.

If most of the wild cocoa in Ecuador can be treated as one population which is relatively homogenous in many features, does this mean that the population could have been effectively sampled by a simpler and cheaper collecting strategy? This hypothetically more efficient strategy would have concentrated on intensive collecting at a limited number of widely separated sites. In the context of Section 4.2, the target region could have been divided into larger squares, perhaps 1° longitude by 1° latitude (about 110 km x 110 km). With hindsight, it is reasonable to conclude that such an approach to collecting would have produced more material, with at least as much (and probably more) genetic variability, in less time and at lower cost. However, without the fine-scale sampling actually practised, there would be no data to justify such a strategy; indeed, it would have been unwise to plan the project on the assumption that there was little small-scale local variation in the target region. Indeed, it is still conceivable that more detailed study of the LCTAP genotypes will reveal more geographically-related genetic subdivision than is evident on the basis of the present descriptor list and the data so far collected.

IS IT WORTH EVALUATING MATERIAL HELD IN A GENEBANK?

The results presented in Section 7 represent the application of the principle that at an early stage in the exploitation of a large amount of new germplasm, some basic data on the whole collection are as useful as more detailed data on a small part of the collection. With very limited resources, it was possible to initiate a simple system for recording yield, pod infection vegetative growth and vegetative Crinipellis infection, that can be carried on indefinitely by inexperienced staff. These data, together with the descriptor data (Section 6), provide an objective basis for selecting individual genotypes, or groups of genotypes, for breeding programmes. Even though a rigorous statistical interpretation of these data is ruled out by lack of replication, the availability of this information should encourage breeders to make use of this germplasm more rapidly than has been the case with some other collections of wild germplasm, which frequently languish undocumented and undistributed in forgotten corners of research stations until they die naturally from neglect.

RECOMMENDATIONS FOR THE FUTURE

Much of the tropical rain forest of South America remains unexplored from the point of view of cocoa germplasm. Our knowledge of the range of variation in the wild cocoa populations of Brazil, Bolivia, Peru, and the Guyanas, as well as parts of Colombia and much of Venezuela, is based on collections of a very few wild trees or on the observations of travellers. Exploration of this vast area using the intensive sampling strategy employed by LCTAP in Ecuador would be enormously costly, and would occupy a disproportionate part of the limited resources available for cocoa breeding. Even so, it is generally agreed that the breeding of new varieties is the most effective way of increasing cocoa yields: first, by increasing the already high yields obtainable under ideal conditions, with intensive management, above the current ceiling of around 3000 kg/ha; and secondly, by partially closing the gap between these ideal yields and the low yields (often less than 300 kg/ha) currently obtained with minimal management in areas of high disease losses. Breeding programmes will, therefore, probably continue to depend on wild germplasm as a new source of genetic variation.

If the pattern of variation found in wild cocoa in Ecuador is repeated throughout the South American wild populations, with relatively homogeneous subpopulations extending over areas of the order of

100,000 km^2, then a more economical collecting strategy becomes feasible. This strategy would involve intensive collecting around a limited number of bases, spaced perhaps 200-400 km apart. Ideally these bases would make use of pre-existing support facilities such as research stations. Such an approach would enable many gaps in our knowledge of wild cocoa populations to be filled without absorbing resources which are needed for other stages in the breeding process.

In addition, some attention must be given to streamlining the distribution of collected germplasm, via quarantine, to breeders. It will be readily deduced from Sections 2.3 and 5 that the transfer of LCTAP material to quarantine has proved difficult, and this aspect has required far more attention than was envisaged at the start of the project. Indeed, both the traditional technique of shipping budwood, and the LCTAP-developed method of shipping whole plants, have together proved barely adequate for the transfer of the large quantity of germplasm acquired during the project. In the long run, these problems could be overcome by in-vitro techniques (essentially, plants or tissue cultures in test-tubes), which are already promising enough to justify further research expenditure. However, such methods are not presently suitable as the main basis of a collecting project. One short-term solution would be to concentrate on collecting seed. Our experience has shown that seed collections are much more easily established than collections of budwood. In addition, if large enough quantities of seed are collected, the seed can be divided at the time of collection, with part being sent directly to one or more quarantine centres. This approach is already technically feasible, but would be made easier by a new technique for storing cocoa seeds for up to six months in polyethylene glycol solution (Mumford and Brett, 1982).

Finally, in whichever genebank the original collections are held, consideration should be given to the recording of basic agronomic performance data. Systems of data recording should be designed to be as simple as possible, so that they can be maintained for long periods without large-scale financial support. When financial support is being sought or offered for such data recording, it should be remembered that continuity of funding over long periods is more useful than heavy funding for short periods.

These speculations should not cast doubt on the achievements of the London Cocoa Trade Amazon Project. In the seven years since the project was initiated, we have gained much practical experience of the delights and drawbacks of plant collecting in the Amazon rain forest, which remains one of the world's more remote and difficult working environments. In this time, we have assembled one of the two largest collections of wild cocoa germplasm in the world, and we have documented the characteristics and agronomic performance of this material much more fully than for any previous collection of wild cocoa germplasm; the results of this work should be a positive influence on cocoa breeding for several decades to come.

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One, was financed principally by a large donation from the London Cocoa Terminal Market Association. Their original funding was given to mark the 50th Anniversary of the London Cocoa Market, in 1979; their continued support for cocoa germplasm conservation has been widely recognised as a major contribution to the future prosperity of the cocoa industry.

In Ecuador, the project continued to depend on the goodwill and facilities of INIAP, with the support of Dr Julio Delgado and Ing Francisco Cánepa, successive Director-Generals during 1983-1986. Dra Carmen Suarez and Ing Jaime Vera took overall responsibility for the project within INIAP. At the INIAP Napo-Payamino Experimental Station, the project was greatly assisted by the active support of the Director, Ing Victor Hugo Chalá, and by the skilled technical assistance of Agr Jose Baquero. Ing Juvenal Cabrera and Ing Roger Mera participated in the project as counterparts to J B Allen, and are now responsible for the future management of the San Carlos genebank.

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R A Lass continued his role as Technical Coordinator of LCTAP throughout Phase Two and E T Beauchamp (CCCA) continued to be responsible for the administration of the Project in the UK. My thanks to both of them because without them LCTAP would not have happened and would not have achieved its undoubted success.

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APPENDIX 1: GLOSSARY

CCCA	Cocoa, Chocolate and Confectionery Alliance (UK)*
CATIE	Centro Agronómico Tropical de Investigación y Ensenanza (Turrialba, Costa Rica)
CEPLAC	Comissao Executiva do Plano de Lavoura Cacaueira (Brazil)
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (France)
CRU	Cocoa Research Unit (Trinidad)
DAINCO	Departamento Administrativo de Intendencias y Comisarias (Colombia)
EBC	Expedición Botánica Caquetá
IBPGR	International Board for Plant Genetic Resources
ICA	Instituto Colombiano Agropecuario (Colombia)
ICG,T	International Cocoa Genebank, Trinidad
IRCC	Institut de Recherches du Café, du Cacao et autres Plantes Stimulantes
INIAP	Instituto Nacional de Investigaciones Aropecuaries (Ecuador)
LCTAP	London Cocoa Trade Amazon Project
LCT-EEN	London Trade - Estacion Experimental Napo
LCTMA	London Cocoa Terminal Market Association**
USDA	United States Department of Agriculture
UWI	University of the West Indies
VPD	Vapour Pressure Deficit

* Now BCCCA : Biscuit, Cake, Chocolate, Confectionery Alliance

** Now LCTM : London Cocoa Terminal Market

APPENDIX 2: OBSERVATIONS ON THE CLIMATE OF THE AMAZON REGION OF ECUADOR [Note: All temperatures are given in degrees Centigrade]

INTRODUCTION

Data on the climate of the Amazon Region of Ecuador will be important for two reasons. First, when the LCTAP germplasm comes to be used in breeding programmes in other parts of the world, it will be helpful to know about the original climate to which the LCTAP genotypes are presumably adapted. Second, the successful cultivation of LCTAP genotypes in quarantine centres and holding collections may depend on being able to reproduce the climatic conditions in which this material grew in the wild. This second reason is of particular importance in view of the history of weak growth and poor survival of wild genotypes from Ecuador in quarantine centres, while the same genotypes in the field genebank in Ecuador appear healthy and vigorous.

Some useful climatic data have now been collected at the INIAP Napo-Payamino Station. Many of these data were obtained for LCTAP by Lizzie Potts, who spent the first six months of 1984 at San Carlos, with funding from the Ghana Cocoa Growing Research Association. Some reference will also be made to official data from the Ecuadorian national meteorological agency (INERMHI), and to data from other organisations such as the Summer Institute of Linguistics.

Table 16: Representative climatic data for the Amazon Region of Ecuador

Station	Alt. m	Annual Rainfall mn	Temperature Daily Max °C	Temperature Daily Min °C	Daily Sun hr
San Carlos	265	3123	29.7	20.8	-
Payamino	250	3348	29.8	21.2	4.2
Limoncocha	220	3074	-	-	-
Puyo	950	4461	26.2	16.7	2.7

NOTES:

i) these data replace those given in Allen and Lass (1983), Table 3, which contained some errors;

ii) Sources as follows (years of records in brackets): San Carlos, LCTAP (2); Payamino, INIAP (3); Limoncocha, Summer Institute of Linguistics (19); Puyo, INERMHI (2).

REGIONAL DATA

In general terms, the climate of the Amazon Region of Ecuador, below 1200m altitude, can be summarised as follows: mean daily maximum temperatures range from 26° to 30°; mean daily minimum temperatures range from 17° to 21°; annual rainfall totals vary from 2500mm to over 6000mm. The higher temperatures and lower rainfall figures are found in the lowland areas to the east, at 200-300m altitude; travelling towards the mountains which mark the western edge of the region, rainfall increases and temperatures decrease, with increasing altitude. However, the Zamora and Upano river valleys, which are enclosed within the mountains in the south of the region, receive less than 2000 mm of rain annually, because of a rain-shadow effect.

Seasonal differences in temperature are small, with monthly mean temperatures varying only by a degree or so through the year. The months of December, January and February are typically drier than the rest of the year, but this pattern is obscured in many years by much variation in the month by month distribution of rainfall. Atmospheric humidity is above 80% for much of the time, only dropping to around 50-60% for brief periods on sunny days. Climatic data for some representative sites are given in Table 16.

SAN CARLOS AND PAYAMINO

The climate at San Carlos and Payamino may be taken as typical of the main lowland part of the region between 200m and 300m altitude. Temperature and rainfall data for San Carlos covering the period 1984 - 1986 are given in Table 17. Meteorological data collected by INIAP at the Payamino Station are available for the period September 1983 to June 1986. These data are summarised in Table 18. In general, the figures are very similar to those recorded at San Carlos.

The characteristics of the regional climate are well demonstrated by these data: for example, the minimal seasonal variation in temperature, and the marked year to year variation in the rainfall in any given month. The San Carlos figures for the period December 1984 to March 1985 are unusual; these four months were drier than any other four-month period during the nineteen years covered by data from Limoncocha, about 25 km to the east (Allen and Lass, 1983, Table 4). During February and March 1985, the forest floor vegetation, which normally exists in a permanently moisture saturated environment, was showing signs of moisture stress. Monthly rainfall fluctuations are often due to intense local storms. In this case, the dry period appears from the data to have ended in April 1985, when 313 mm of rain were recorded. However, about half this rain (157 mm) fell in a single four-hour storm on the night of 3-4 April, and the dry weather then resumed and continued through until the beginning of June. Local people attributed this unprecedented dry period to the effects of deforestation in the area since the oil company roads opened the area to colonisation in the early 1970's. However, the Limoncocha data show that rainfall in the 1970's (mean annual rainfall 1970-1979: 3230 mm) was consistently higher than in the 1960's (mean annual rainfall 1961-1969; 2898 mm). This difference is statistically significant ($p<0.01$). While it is obvious that replacing large areas of forest with annual crops or pasture produces dramatic changes at the microclimatic level, the data presently available for this region cannot be used in support of the popular hypothesis that large-scale forest clearance will result in a drier regional climate.

Table 17: Meteorological data from INIAP Napo-Payamino Experimental Station, San Carlos site, 1984 - 1986

Month	Rainfall mm	Mean Temperature Daily Max °C	Mean Temperature Daily Min °C
1984			
Jan (16.1-31.1)	98.3	29.9	20.5
Feb	525.6	28.2	20.9
Mar	281.5	29.7	21.4
Apr	386.6	28.7	21.4
May	267.7	30.1	21.3
Jun	236.8	28.7	21.3
Jul	174.2	28.8	20.2
Aug	250.9	29.3	20.2
Sep	265.1	30.2	20.6
Oct	237.2	30.7	21.3
Nov	409.5	30.3	21.0
Dec	172.9	30.6	21.3
1985			
Jan	44.5	32.0	21.3
Feb	90.6	29.5	20.6
Mar	119.1	30.1	21.9
Apr	312.8	29.8	21.2
May	85.9	29.4	20.8
Jun	441.7	26.6	19.9
Jul	334.0	27.4	19.8
Aug	274.1	29.2	20.3
Sep	299.7	30.4	20.4
Oct	276.9	30.5	20.9
Nov	312.9	31.2	21.1
Dec	136.7	31.3	21.4
1986			
Jan	187.9	29.8	21.0
Feb	200.6	29.6	20.3
Mar	379.5	29.5	20.3
Apr	283.2	31.1	21.1
May	384.7	30.3	20.8
Jun	245.8	28.4	20.1
Means	262.7	29.7	20.8

NOTES:
i) the San Carlos site is at 0°20'S, 76° 50'W, altitude 265 m;
ii) data collected by LCTAP and INIAP;
iii) means calculated excluding January 1984 as months data incomplete.

Table 18: Meteorological data from INIAP Napo-Payamino Experimental Station, Payamino site, 1983-1986.

Year	Month	Rainfall mm	Temperature Daily Max. °C	Temperature Daily Min. °C	Humidity Daily Min. %	Sunshine hour/day
1983	Sep	171.4	29.4	19.8	58.8	4.6
	Oct	205.1	28.2	19.7	65.9	3.9
	Nov	426.5	29.0	20.2	64.2	4.4
	Dec	318.4	28.5	19.9	66.0	3.7
1984	Jan	218.0	29.1	19.8	61.9	4.5
	Feb	436.9	28.0	19.8	67.8	2.9
	Mar	402.2	28.6	25.5	67.0	3.2
	Apr	463.8	27.8	20.5	69.9	2.9
	May	506.8	28.2	20.2	65.6	4.8
	Jun	387.3	27.2	20.6	70.5	4.0
	Jul	224.5	27.2	19.7	62.3	4.2
	Aug	186.3	28.2	20.5	60.8	4.4
	Sep	355.3	31.6	23.0	59.2	5.3
	Oct	320.1	32.2	23.5	60.0	5.2
	Nov	326.2	31.0	23.3	64.8	4.6
	Dec	154.4	32.4	24.0	62.0	4.5
1985	Jan	32.2	34.0	23.5	50.0	6.2
	Feb	106.9	30.5	21.1	54.8	3.9
	Mar	165.4	30.5	21.9	56.1	3.6
	Apr	171.6	30.2	21.8	58.4	4.2
	May	117.2	29.6	20.8	58.7	4.0
	Jun	443.3	26.4	20.2	64.7	3.0
	Jul	363.8	28.6	19.1	66.4	3.6
	Aug	312.7	29.7	19.6	65.3	4.3
	Sep	276.6	31.5	20.1	60.2	4.5
	Oct	277.0	31.4	20.8	58.5	5.4
	Nov	244.7	31.3	21.2	59.1	6.3
	Dec	127.5	31.6	21.4	55.0	5.5
1986	Jan	253.4	30.5	21.4	62.2	3.8
	Feb	391.7	30.2	21.5	68.9	3.4
	Mar	354.9	29.8	21.1		3.1
	Apr	267.5	31.2	21.6		4.6
	May	384.1	30.3	21.4		4.3
	Jun	243.6	28.7	21.0		2.7
	Means	283.5	29.8	21.2	62.2	4.2

NOTES:

i) the Payamino site is located at 0°27'S, 76°59'W, altitude 250m.

ii) the data, other than rainfall data, for the following months are incomplete: July 1984 (22 days only); August 1984 (5 days only). The means have been calculated to exclude the months with incomplete data.

MICROCLIMATE

Some data were collected at San Carlos for the purpose of comparing the microclimates of areas with differing levels of shade. It was felt that this might provide further help in defining appropriate growing conditions for quarantine centres. The humidity data are presented here as vapour pressure deficits. The saturated vapour pressure deficit (usually referred to as the vapour pressure deficit or VPD) is the difference between the actual vapour pressure of water in the atmosphere and the saturated vapour pressure of water in air at the same temperature. The VPD, in kiloPascals (kPa), can be calculated from wet and dry bulb thermometer readings. The VPD can be considered as a measure of the drying capacity of the atmosphere; the drier the atmosphere, the higher the VPD value. It is known that transpiration rates are more closely correlated with VPD than with relative humidity. The difference between these two measures of atmospheric humidity is illustrated in Table 19, which shows that at constant relative humidity, VPD increases by a factor of nearly three over the environmental temperature range of from 20 to 35°. Relative humidity data can therefore be misleading, as a cocoa plant's response to growing conditions at a particular site will be a function of both relative humidity and temperature.

The data for San Carlos are summarised in Table 20. As might be expected, increased shade was associated with small but consistent reductions in temperature and increases in humidity, relative to conditions in the unshaded clearing around the nursery. Average midday values for VPD were 0.8 - 0.9 kPa, which are still fairly low. These measurements were made at fixed times, and could not be used to estimate maximum daily VPD values in different areas. However, thermohygrograph readings from the main San Carlos meteorological station were used to calculate maximum daily VPD values for comparison. The mean maximum daily VPD, for 91 days during January - May 1984, was 1.43 kPa, with daily maximum ranging from 0.25 kPa to 2.98 kPa. A similar calculation using data from Payamino indicated that daily maximum VPD values averaged around 1.6 kPa.

Table 19: RELATIONSHIP BETWEEN RELATIVE HUMIDITY AND VAPOUR PRESSURE DEFICIT (VPD)

	Relative humidity (%)		
	60	75	90
Temperature (°C)		VPD (kPa)	
20	0.9	0.6	0.2
25	1.3	0.8	0.3
30	1.7	1.1	0.4
35	2.3	1.4	0.6

NOTE:
Saturated vapour pressures calculated using Equation (8) from Buck (1981).

Table 20: EFFECT OF INCREASING SHADE ON TEMPERATURE AND HUMIDITY. DATA COLLECTED AT SAN CARLOS ON 44 DAYS DURING JANUARY - MARCH 1984

Time	Mean of	Unshaded	Light Shade	Heavy Shade
			Shade Level	
0700	Temp. (°C)	22.8	22.8	22.8
	VPD (kPa)	0.17	0.15	0.14
1200	Temp. (°C)	27.2	27.1	26.8
	VPD (kPa)	0.95	0.91	0.78
1700	Temp. (°C)	26.4	25.7	25.3
	VPD (kPa)	0.54	0.41	0.29

NOTES:

i) details of methods are described in Potts (1984);

ii) measurements were taken at three locations within the field genebank site, at 1.5m above ground level;

iii) humidity data are presented as vapour pressure deficits in kiloPascals (kPa), see text for explanation.

GROWING CONDITIONS IN QUARANTINE CENTRES

It has proved difficult to obtain systematic data on temperature and humidity in quarantine centres for comparison. A representative selection of thermohygrograph charts were available for two greenhouses at Kew which have housed LCTAP material sent for quarantine. Data from these charts are summarised in Table 21. These show average daily maximum VPD values ranging from 1.0 kPa (December) to 1.7 kPa (March, April, September) and 2.1 kPa (August). Data were not available for other months. Daily maximum VPD values ranged from 0.7 kPa to 3.9 kPa. Mean daily maximum temperatures reached 35° in August.

It is clear from these data that the Kew greenhouses, during much of the year, were much hotter and drier than San Carlos. If, as seems likely, comparable conditions are found in many quarantine centres, this would go some way to explain the poor growth and survival of the LCTAP material in quarantine.

Table 21: TEMPERATURE AND HUMIDITY DATA FOR COCOA QUARANTINE HOUSES AT KEW, WITH SAN CARLOS DATA FOR COMPARISON

Means of daily values for	Dec	Kew Mar, Apr and Sep	Kew Aug	San Carlos (a)	San Carlos (b)
Max. VPD (kPa)	1.03	1.71	2.07	1.43	0.78
Range: from	0.75	0.72	1.24	0.25	0.00
to	1.41	3.94	2.93	2.98	1.91
Max. Temp (°C)	24.10	31.70	34.90	29.30	26.8
Min. Temp (°C)	20.60	22.50	22.90	20.90	-

NOTE:

San Carlos data are (a) measurements at main meteorological station in unshaded area, (b) measurements at 1200 in heavily shaded area in field genebank.

APPENDIX 3: SUMMARY OF MATERIAL IN QUARANTINE, SEPTEMBER 1986

	ESTABLISHED AT			
LCT-EEN	Barbados	Trinidad	Miami	Montpellier
2	1	0	0	0
10	0	0	1	0
11	1	1	1	0
14	1	0	0	0
15	1	0	0	0
19	1	0	0	0
20	0	0	1	0
21	1	0	1	0
22	1	0	0	0
23	0	1	0	0
24	0	0	0	1
26	1	0	0	0
27	1	0	0	1
29	1	0	1	0
30	0	1	0	0
31	1	0	0	0
32	1	0	0	1
36	1	0	0	0
37	1	0	1	1
38	0	0	0	1
46	0	0	0	1
52	1	0	0	1
59	0	0	0	1
60	1	0	0	0
61	1	0	0	0
62	0	1	0	0
63	1	0	0	0
64	1	0	0	0
65	1	0	0	0
66	0	1	1	0
67	0	0	1	0
68	1	0	1	0
69	0	0	1	0
70	1	0	0	0
71	1	0	0	0
72	0	1	0	0
73	1	0	1	0
74	1	0	0	1
80	0	0	1	1
82	0	1	1	0
83	0	1	0	0
84	0	1	0	0
85	0	1	0	0
86	0	1	0	0
87	0	1	0	0
90	1	1	0	0
91	1	0	0	0
101	0	0	0	1
103	1	0	0	1
107	1	0	0	0
108	1	0	0	0

APPENDIX 3 (continued)

LCT-EEN	Barbados	ESTABLISHED AT Trinidad	Miami	Montpellier
109	0	1	0	0
120	1	0	0	1
121	0	0	0	1
122	1	0	0	0
123	1	0	0	0
125	1	0	0	1
126	0	0	0	1
127	0	1	0	0
130	1	0	1	0
131	1	0	0	0
133	0	0	0	1
136	1	1	0	0
137	1	0	0	1
141	0	0	0	1
142	0	0	0	1
145	0	0	0	1
146	1	0	0	0
148	1	0	1	0
149	1	0	0	0
150	1	0	0	0
151	1	0	0	0
152	1	0	0	0
154	1	0	0	0
155	1	0	0	0
156	1	0	0	0
157	0	0	0	1
158	0	0	1	0
160	0	0	1	1
162	0	1	1	0
163	1	0	1	0
164	1	0	0	0
165	0	0	0	1
172	0	0	1	0
175	1	0	0	0
178	1	0	0	0
182	0	1	1	0
185	1	0	0	0
189	0	0	1	0
195	1	0	0	0
196	0	0	1	0
199	0	1	0	0
201	0	0	1	0
202	0	1	1	0
215	1	0	0	0
217	1	0	0	0
218	1	0	0	0
219	1	0	0	0
220	1	0	0	0
223	1	0	0	0
234	1	0	0	0
241	0	0	1	0
246	0	1	0	0

APPENDIX 3 (continued)

LCT-EEN	ESTABLISHED AT Barbados	Trinidad	Miami	Montpellier
249	0	0	0	1
251	1	0	0	0
253	1	0	0	0
255	0	0	0	1
258	0	0	1	0
267	1	0	0	0
281	1	0	0	0
282	1	0	0	0
283	0	0	1	0
295	1	0	0	0
300	0	0	1	0
302	0	0	1	0
320	0	1	0	0
324	1	0	0	0
325	0	1	0	0
326	0	1	0	0
328	1	0	1	0
329	1	0	0	0
331	1	0	0	1
332	0	0	1	0
334	1	0	0	0
335	0	0	1	0
336	1	0	0	1
337	1	0	1	0
338	0	0	1	0
339	0	0	1	0
340	0	0	1	0
341	1	0	1	0
342	0	0	1	0
343	0	0	1	0
344	1	0	0	0
345	1	0	0	0
346	0	0	1	0
348	0	0	1	0
349	1	0	0	0
351	1	0	1	0
354	1	0	0	0
355	0	0	0	1
357	0	0	1	0
358	1	0	0	0
360	1	0	0	0
368	0	0	0	1
369	1	0	1	0
371	1	0	0	0
372	1	0	1	0
373	1	0	0	0
385	1	0	0	0

NOTES:

i) Based on: Barbados and Trinidad, "Operations at the CRU Quarantine Station, Barbados" by T N Sreenivasan, March

1986, plus BARBADOS-8; Miami, letter from E.J. Garvey, 6 March 1986; Montpellier, letter from G.Blaha, 10 April 1986 plus MONTPELLIER-4.

ii) Headings:
Barbados: Cocoa Research Unit Quarantine Station, Ministry of Agriculture, Graeme Hall, Christ Church, Barbados (attached to Cocoa Research Unit, Trinidad);
Trinidad: International Cocoa Genebank, Trinidad (run by Cocoa Research Unit, Faculty of Agriculture, UWI);
Miami: Subtropical Horticulture Research Station, Miami, Florida (USDA);
Montpellier: IRCC, CIRAD, Montpellier, France.

iii) Codes:
0 = not established
1 = established, including both original genotypes (clones) and seedlings

APPENDIX 4: DESCRIPTOR LIST AND DESCRIPTOR STATES

a. PASSPORT DATA

FIELD	HEADING	DESCRIPTOR	DESCRIPTOR STATES
1	Collection	Collection prefix	LCT-EEN = London Cocoa Trade - Estacion Experimental Napo EBC = Expedicion Botanica Caqueta
		Collection number	for LCT-EEN, 1...435 for EBC, 1...148
2	Sp	Species	_Theobroma_ c = _cacao_ b = _bicolor_ g = _glaucum_ m = _microcarpum_ o = _obovatum_ r = _grandiflorum_ s = _subincanum_ _Herrania_ h = _various spp_
3	Date	Collection date	day/month/year
4	Country	Country	
5	Province	Province	
6	Area	Locality 1	general area
7	Location	Locality 2	specific location
8	Alt	Altitude	altitude in metres
9	St	Status	1 = wild 2 = weedy 3 = primitive 4 = advanced cultivar
10	Mat	Material	1 = budwood or cuttings 2 = seed 3 = both
11	Surv	Survival	1 = in San Carlos genebank 0 = not at San Carlos

b. POD AND SEED DESCRIPTORS

FIELD	HEADING	DESCRIPTOR	DESCRIPTOR STATES
1	Collection	as for passport data	

(POD CHARACTERS)

APPENDIX 4 (continued)

2	Bas	Basal constriction	0 = absent 3 = slight 5 = intermediate 7 = strong
3	Apx	Apex form	0 = round 1 = slightly obtuse 3 = obtuse 5 = slightly acute 7 = acute 9 = attenuate
4	Sur	Surface rugosity	0 = absent 3 = slight 5 = intermediate 7 = intense
5	Fur	Primary furrow depth	3 = superficial 5 = intermediate 7 = deep
6	Prd	Furrows paired	1 = yes 2 = no
7	Pig	Anthocyanin pigment in unripe pod	0 = absent 3 = slight 5 = intermediate 7 = intense
8	Len	Length	in millimetres
9	Dia	Diameter	in millimetres
10	D:L	Diameter: length ratio	
11	Thk	Wall thickness	at thickest point, in mm (including endocarp)
12	Wgt	Weight	in grammes
(BEAN CHARACTERS)			
13	Num	Number	
14	Wgt	Weight	fresh peeled weight (g)
15	Len	Length	in millimetres
16	Wid	Width	in millimetres
17	Thk	Thickness	in millimetres
18	W:L	Width: length ratio	

19	Wht	White beans	1 = present 0 = absent
20	Ltp	Light purple beans	1 = present 0 = absent
21	Dkp	Dark purple beans	1 = present 0 = absent
22	Data Source	Source of pod and seed data	1 = data recorded at time of original collection 2 = data recorded in genebank

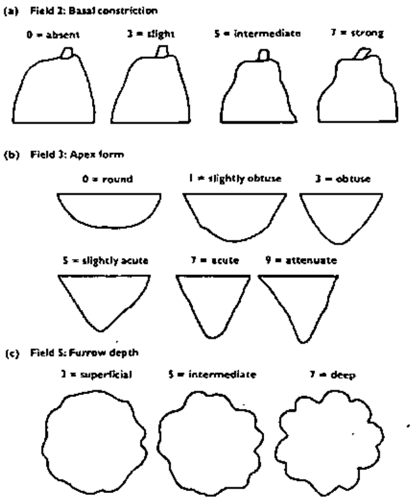
NOTES:

i) the list of descriptors is based on the following sources:
  a. Hobbs (undated). IBPGR standardised format for descriptor lists. IBPRGR document AGP:IBPGR/82/46.
  b. IBPGR (1981). Genetic resources of cocoa. IBPGR document AGP: IBPGR/80/56.
  c. Engels, Bartley and Enriquez (1980). Cacao descriptors, their states and modus operandi. Turrialba 30 (2), 209-218.
  d. Engels (1981). Genetic resources of cacao: a catalogue of the Turrialba collection. CATIE Technical Bulletin No.7;

ii) for convenience in the use of the microcomputer database package dBaseII (or any other appropriate software) the data was divided between two files. However, the number and content of these files is quite flexible and can easily be varied even after the data have been entered. The descriptor states can also be changed, although this involves more work;

iii) fields 2, 3, 5 are illustrated in the diagram which follows.

FIGURE 6: Examples of Pod Descriptor States



After Engels 1981

APPENDIX 5: SUMMARY DESCRIPTION OF COLLECTIONS

Appendix 5. Summary descriptions of collections
(a) Passport data

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Nat (10)	Surv (11)
LCT-EEN	1 c	30.4.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	2	1
LCT-EEN	2 c	30.4.80	Ecuador	Napo	Coca - Lago Agrio	San Carlos	260	1	1	1
LCT-EEN	3 c	3.5.80	Ecuador	Napo	Lago Agrio	camino Tarapoa - Fanny km2	200	1	1	0
LCT-EEN	4 c	3.5.80	Ecuador	Napo	Lago Agrio	Via Tarapoa - Lago Agrio km4	200	1	2	1
LCT-EEN	5 c	4.5.80	Ecuador	Napo	Lago Agrio	Via Lago Agrio - Tarapoa km43	200	1	2	1
LCT-EEN	6 c	4.5.80	Ecuador	Napo	Lago Agrio	Via Lago Agrio - Tarapoa km43	200	1	2	1
LCT-EEN	7 c	6.5.80	Ecuador	Napo	Coca - Lago Agrio	Via Shushufindi - Rio Aguarico	250	1	1	0
LCT-EEN	8 c	6.5.80	Ecuador	Napo	Coca - Lago Agrio	Via Shushufindi - Rio Aguarico	250	1	2	1
LCT-EEN	9 c	17.5.80	Ecuador	Napo	Coca - Lago Agrio	Via Lago Agrio - Coca km33	250	1	1	0
LCT-EEN	10 c	17.5.80	Ecuador	Napo	Coca - Lago Agrio	Via lago Agrio - Coca km32	250	1	2	1
LCT-EEN	11 c	19.5.80	Ecuador	Napo	Coca	Via Auca km2	200	1	2	1
LCT-EEN	12 c	19.5.80	Ecuador	Napo	Coca	Via Auca	200	1	1	0
LCT-EEN	13 c	19.5.80	Ecuador	Napo	Coca	Via Auca	200	1	1	0
LCT-EEN	14 c	19.5.80	Ecuador	Napo	Coca	Via Auca km14	200	1	2	1
LCT-EEN	15 c	20.5.80	Ecuador	Napo	Coca	S de Rio Napo camino al O km4	200	1	1	1
LCT-EEN	16 c	20.5.80	Ecuador	Napo	Coca	S de Rio Napo camino al O km4	200	1	1	0
LCT-EEN	17 c	20.5.80	Ecuador	Napo	Coca	S de Rio Napo camino al O km11	200	1	1	0
LCT-EEN	18 c	20.5.80	Ecuador	Napo	Coca	S de Rio Napo camino al O km11	200	1	2	1
LCT-EEN	19 c	20.5.80	Ecuador	Napo	Coca	S de Rio Napo camino al O	200	1	2	1
LCT-EEN	20 c	20.5.80	Ecuador	Napo	Coca	S de Rio Napo camino al O	200	1	2	1
LCT-EEN	21 c	20.5.80	Ecuador	Napo	Coca	S de Rio Napo	200	1	2	1
LCT-EEN	22 c	3.6.80	Ecuador	Napo	Rio Napo	Limoncocha	220	1	2	1
LCT-EEN	23 c	3.6.80	Ecuador	Napo	Rio Napo	Limoncocha	220	1	2	1
LCT-EEN	24 c	3.6.80	Ecuador	Napo	Rio Napo	Limoncocha	220	1	2	1
LCT-EEN	25 c	3.6.80	Ecuador	Napo	Rio Napo	Limoncocha	220	1	2	1
LCT-EEN	26 c	3.6.80	Ecuador	Napo	Rio Napo	Limoncocha	220	1	2	1
LCT-EEN	27 c	4.6.80	Ecuador	Napo	Rio Napo	Itaya (Rio Capocuy)	220	3	3	1
LCT-EEN	28 c	4.6.80	Ecuador	Napo	Rio Napo	Itaya (Rio Capocuy)	220	1	2	1
LCT-EEN	29 c	4.6.80	Ecuador	Napo	Rio Napo	Itaya (Rio Capocuy)	220	1	2	1
LCT-EEN	30 c	4.6.80	Ecuador	Napo	Rio Napo	Itaya (Rio Capocuy)	220	1	1	1
LCT-EEN	31 c	4.6.80	Ecuador	Napo	Rio Napo	Rio Indillama	220	1	1	1
LCT-EEN	32 c	4.6.80	Ecuador	Napo	Rio Napo	Rio Indillama	220	1	1	1
LCT-EEN	33 c	4.6.80	Ecuador	Napo	Rio Napo	Rio Indillama	220	1	1	1
LCT-EEN	34 c	5.6.80	Ecuador	Napo	Rio Napo	Rio Anangu	220	1	1	0
LCT-EEN	35 c	5.6.80	Ecuador	Napo	Rio Napo	Rio Anangu	220	1	1	0
LCT-EEN	36 c	5.6.80	Ecuador	Napo	Rio Napo	Rio Anangu	220	1	2	1
LCT-EEN	37 c	5.6.80	Ecuador	Napo	Rio Napo	Rio Anangu	220	1	3	1
LCT-EEN	38 c	5.6.80	Ecuador	Napo	Rio Napo	Rio Anangu	220	1	3	1
LCT-EEN	39 c	5.6.80	Ecuador	Napo	Rio Napo	Providencia	220	1	2	0
LCT-EEN	40 h	5.6.80	Ecuador	Napo	Rio Napo	Limoncocha	220	1	2	1
LCT-EEN	41 c	10.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	42 c	10.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	43 c	10.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	44 c	11.6.80	Ecuador	Napo	Loreto		450	1	2	1
LCT-EEN	45 c	11.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	46 c	11.6.80	Ecuador	Napo	Loreto		450	3	1	1
LCT-EEN	47 c	11.6.80	Ecuador	Napo	Loreto		450	1	1	1
LCT-EEN	48 c	11.6.80	Ecuador	Napo	Loreto		450	1	1	1
LCT-EEN	49 c	11.6.80	Ecuador	Napo	Loreto		450	1	1	1
LCT-EEN	50 c	11.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	51 c	12.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	52 c	12.6.80	Ecuador	Napo	Loreto		450	1	1	1
LCT-EEN	53 c	12.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	54 c	12.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	55 c	12.6.80	Ecuador	Napo	Loreto		450	1	1	0

APPENDIX 5 (continued)

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
LCT-EEN	56 c	12.6.80	Ecuador	Napo	Loreto		450	1	1	0
LCT-EEN	57 c	12.6.80	Ecuador	Napo	Loreto		450	1	1	1
LCT-EEN	58 c	16.6.80	Ecuador	Zamora-Chinchipe	Rio Zamora	Punguinza	800	1	2	1
LCT-EEN	59 c	3.7.80	Ecuador	Napo	Coca	INIAP Payamino	250	1	2	1
LCT-EEN	60 c	10.7.80	Ecuador	Pastaza	Puyo	Via Palora km7	900	3	1	1
LCT-EEN	61 c	10.7.80	Ecuador	Pastaza	Puyo	Via Palora km7	900	3	2	1
LCT-EEN	62 c	11.7.80	Ecuador	Napo	Rio Napo	Via Misahualli-Puerto Napo	400	3	2	1
LCT-EEN	63 c	22.7.80	Ecuador	Napo	Rio San Miguel	Puerto San Miguel	300	1	2	1
LCT-EEN	64 c	22.7.80	Ecuador	Napo	Rio San Miguel	Puerto San Miguel	300	1	2	1
LCT-EEN	65 c	22.7.80	Ecuador	Napo	Rio San Miguel	Puerto San Miguel	300	1	3	1
LCT-EEN	66 c	8.8.80	Ecuador	Morona-Santiago	Rio Zamora	Gualaquiza-Zamora km5	800	1	2	1
LCT-EEN	67 c	8.8.80	Ecuador	Morona-Santiago	Rio Zamora	Gualaquiza-Zamora km5	800	3	2	1
LCT-EEN	68 c	8.8.80	Ecuador	Morona-Santiago	Rio Zamora	Gualaquiza-Zamora km5	800	1	3	1
LCT-EEN	69 c	8.8.80	Ecuador	Morona-Santiago	Rio Zamora	Gualaquiza-Zamora km11	800	1	2	1
LCT-EEN	70 c	8.8.80	Ecuador	Morona-Santiago	Rio Zamora	Gualaquiza-Zamora km11	800	1	2	1
LCT-EEN	71 c	8.8.80	Ecuador	Morona-Santiago	Rio Zamora	Via Chuchumbleza km3	800	1	2	1
LCT-EEN	72 c	8.8.80	Ecuador	Morona-Santiago	Rio Zamora	Via Chuchumbleza km3	800	1	2	1
LCT-EEN	73 c	9.8.80	Ecuador	Zamora-Chinchipe	Rio Nangaritza	La Guinza	900	1	1	1
LCT-EEN	74 c	9.8.80	Ecuador	Zamora-Chinchipe	Rio Nangaritza	La Guinza	900	1	3	1
LCT-EEN	75 c	9.8.80	Ecuador	Zamora-Chinchipe	Rio Nangaritza	La Guinza	900	1	1	0
LCT-EEN	76 c	9.8.80	Ecuador	Zamora-Chinchipe	Rio Nangaritza	La Guinza	900	1	2	1
LCT-EEN	77 c	11.8.80	Ecuador	Morona-Santiago	Rio Zamora	Chuchumbleza	800	1	2	1
LCT-EEN	78 c	11.8.80	Ecuador	Morona-Santiago	Rio Zamora	Chuchumbleza	700	1	2	1
LCT-EEN	79 c	11.8.80	Ecuador	Morona-Santiago	Rio Zamora	Rio Zamora-Tundaime km2	750	1	2	1
LCT-EEN	80 c	11.8.80	Ecuador	Morona-Santiago	Rio Zamora	Rio Zamora-Tundaime km1	750	1	1	1
LCT-EEN	81 c	11.8.80	Ecuador	Morona-Santiago	Rio Zamora	Rio Zamora-Tandaime km1	750	1	1	1
LCT-EEN	82 c	12.8.80	Ecuador	Morona-Santiago	Rio Zamora	Proveduria	700	1	2	1
LCT-EEN	83 c	12.8.80	Ecuador	Morona-Santiago	Rio Zamora	Arenal (2km N de Proveduria)	700	1	2	1
LCT-EEN	84 c	13.8.80	Ecuador	Zamora-Chinchipe	Rio Yacuambi	Via Guadalupe km7	800	1	2	1
LCT-EEN	85 c	13.8.80	Ecuador	Zamora-Chinchipe	Rio Yacuambi	Via Guadalupe km7	800	1	2	1
LCT-EEN	86 c	13.8.80	Ecuador	Zamora-Chinchipe	Rio Yacuambi	Via Guadalupe km5	800	1	2	1
LCT-EEN	87 c	13.8.80	Ecuador	Zamora-Chinchipe	Rio Yacuambi	Via Guadalupe km 2	800	1	2	1
LCT-EEN	88 c	13.8.80	Ecuador	Zamora-Chinchipe	Rio Yacuambi	Via orilla oeste km1	800	1	2	1
LCT-EEN	89 c	13.8.80	Ecuador	Zamora-Chinchipe	Rio Yacuambi	Via orilla oeste km1	800	1	2	1
LCT-EEN	90 c	14.8.80	Ecuador	Zamora-Chinchipe	Rio Nangaritza	Los Encuentros-Paquisha km16	800	1	3	1
LCT-EEN	91 c	14.8.80	Ecuador	Zamora-Chinchipe	Rio Nangaritza	Los Encuentros-Paquisha km16	800	1	1	1
LCT-EEN	92 c	14.8.80	Ecuador	Zamora-Chinchipe	Rio Nangaritza	Los Encuentros-Paquisha km1	800	1	2	1
LCT-EEN	93 c	14.8.80	Ecuador	Zamora-Chinchipe	Rio Zamora	Los Encuentros orilla E, 1km N	800	1	2	1
LCT-EEN	94 c	30.9.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	1
LCT-EEN	95 c	30.9.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	96 c	30.9.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	97 c	30.9.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	98 c	1.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	99 c	1.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	100 c	1.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	101 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	3	1
LCT-EEN	102 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	103 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	1
LCT-EEN	104 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	105 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	106 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	0
LCT-EEN	107 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	1
LCT-EEN	108 c	2.10.80	Ecuador	Pastaza	Rio Curaray	Curaray	200	1	1	1
LCT-EEN	109 c	16.10.80	Ecuador	Napo	Coca	INIAP Payamino	250	1	2	1
LCT-EEN	110 c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	0
LCT-EEN	111 c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	0
LCT-EEN	112 c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	0
LCT-EEN	113 c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	2	1

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
LCT-EEN 114	c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	0
LCT-EEN 115	c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	2	1
LCT-EEN 116	c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	0
LCT-EEN 117	c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	0
LCT-EEN 118	h	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	2	0
LCT-EEN 119	c	22.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	0
LCT-EEN 120	c	23.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	1
LCT-EEN 121	c	23.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	1
LCT-EEN 122	c	23.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	1
LCT-EEN 123	c	23.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	1
LCT-EEN 124	c	23.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	1
LCT-EEN 125	c	23.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	1
LCT-EEN 126	c	23.10.80	Ecuador	Pastaza	Rio Bobonaza	Montalvo	260	1	1	1
LCT-EEN 127	c	22.10.80	Ecuador	Napo	Coca - Lago Agrio	Shushufindi: km6 al S	250	1	2	1
LCT-EEN 128	c	22.10.80	Ecuador	Napo	Coca - Lago Agrio	km7 al S	250	1	2	1
LCT-EEN 129	c	22.10.80	Ecuador	Napo	Coca - Lago Agrio	km11 al S	250	1	2	0
LCT-EEN 130	c	22.10.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	3	1
LCT-EEN 131	c	22.10.80	Ecuador	Napo	Coca - Lago Agrio	Lago Agrio - Coca km33	250	1	2	1
LCT-EEN 132	c	2.10.81	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	2	1
LCT-EEN 133	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 134	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	2	1
LCT-EEN 135	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 136	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	2	1
LCT-EEN 137	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 138	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 139	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 140	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 141	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 142	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	3	1
LCT-EEN 143	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 144	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 145	c	12.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	3	1
LCT-EEN 146	c	10.11.80	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 147	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 148	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 149	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 150	c	25.11.80	Ecuador	Napo	Rio Napo	Anangu	250	1	1	1
LCT-EEN 151	c	25.11.80	Ecuador	Napo	Rio Napo	Anangu	250	1	1	1
LCT-EEN 152	c	26.11.80	Ecuador	Napo	Rio Napo	Anangu	250	1	1	1
LCT-EEN 153	c	26.11.80	Ecuador	Napo	Rio Napo	Itaya	250	1	1	1
LCT-EEN 154	c	27.11.80	Ecuador	Napo	Rio Napo	Paroto Yacu	250	1	1	1
LCT-EEN 155	c	27.11.80	Ecuador	Napo	Rio Napo	Paroto Yacu	250	1	1	1
LCT-EEN 156	c	28.11.80	Ecuador	Napo	Rio Napo	El Descanso	250	1	1	1
LCT-EEN 157	c	28.11.80	Ecuador	Napo	Rio Napo	El Descanso	250	1	1	1
LCT-EEN 158	c	28.11.80	Ecuador	Napo	Rio Napo	Comuna San Carlos	250	1	1	1
LCT-EEN 159	c	29.11.80	Ecuador	Napo	Rio Napo	Comuna San Jose	250	1	2	1
LCT-EEN 160	c	11.12.80	Ecuador	Pastaza	Rio Anzu	Via Puyo-Tena km46	550	3	2	1
LCT-EEN 161	b	11.12.80	Ecuador	Pastaza	Rio Anzu	Via Puyo-Tena km44	550	1	2	1
LCT-EEN 162	c	18.2.81	Ecuador	Napo	Coca	INIAP Payamino	250	1	3	1
LCT-EEN 163	c	18.2.81	Ecuador	Napo	Coca	INIAP Payamino	250	1	1	1
LCT-EEN 164	c	18.2.81	Ecuador	Napo	Rio Napo	Via Coca-Yuca km12	250	1	1	1
LCT-EEN 165	c	18.2.81	Ecuador	Napo	Rio Napo	Via Coca-Yuca km13	250	1	1	1
LCT-EEN 166	c	18.2.81	Ecuador	Napo	Yuca	Via Coca-Yuca km21	250	1	1	1
LCT-EEN 167	g	30.3.81	Ecuador	Napo	Rio Tzapino		300	1	2	1
LCT-EEN 168	c	11.4.81	Ecuador	Napo	Rio Napo	Chiru Isla	220	1	1	0
LCT-EEN 169	c	11.4.81	Ecuador	Napo	Rio Napo	Chiru Isla	220	1	1	1
LCT-EEN 170	c	11.4.81	Ecuador	Napo	Rio Napo	Chiru Isla	220	1	1	0
LCT-EEN 171	c	12.4.81	Ecuador	Napo	Rio Napo	Sinchi Chicta	220	1	1	0

APPENDIX 5 (continued)

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
LCT-EEN 172	c	12.4.81	Ecuador	Napo	Rio Napo	Sinchi Chicta	220	1	1	1
LCT-EEN 173	c	13.4.81	Ecuador	Napo	Rio Napo	Sinchi Chicta	220	1	1	0
LCT-EEN 174	c	13.4.81	Ecuador	Napo	Rio Napo	Sinchi Chicta	220	1	1	0
LCT-EEN 175	c	13.4.81	Ecuador	Napo	Rio Napo	Sinchi Chicta	220	1	1	1
LCT-EEN 176	c	13.4.81	Ecuador	Napo	Rio Napo	Sinchi Chicta	220	1	1	0
LCT-EEN 177	c	14.4.81	Ecuador	Napo	Rio Napo	Puerto Quinche	220	1	1	0
LCT-EEN 178	c	15.4.81	Ecuador	Napo	Rio Napo	Boca Tiputini	220	1	1	1
LCT-EEN 179	c	15.4.81	Ecuador	Napo	Rio Napo	Boca Tiputini	220	1	1	1
LCT-EEN 180	c	15.4.81	Ecuador	Napo	Rio Napo	Boca Tiputini	220	1	1	0
LCT-EEN 181	c	16.4.81	Ecuador	Napo	Rio Napo	Santa Rosa	220	1	1	1
LCT-EEN 182	c	16.4.81	Ecuador	Napo	Rio Napo	Santa Rosa	220	1	2	1
LCT-EEN 183	c	16.4.81	Ecuador	Napo	Rio Napo	Santa Rosa	220	1	1	0
LCT-EEN 184	s	16.4.81	Ecuador	Napo	Rio Napo	Santa Rosa	220	1	1	0
LCT-EEN 185	c	16.4.81	Ecuador	Napo	Rio Napo	Santa Rosa	220	1	1	1
LCT-EEN 186	b	18.4.81	Ecuador	Napo	Rio Napo	Chiru Isla	220	1	2	0
LCT-EEN 187	c	29.4.81	Ecuador	Napo	Coca	Palmoriente (Huashito)	220	1	2	1
LCT-EEN 188	c	16.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	1
LCT-EEN 189	c	16.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	1
LCT-EEN 190	c	16.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	0
LCT-EEN 191	c	16.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	0
LCT-EEN 192	c	16.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	0
LCT-EEN 193	c	16.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	1
LCT-EEN 194	c	16.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	2	0
LCT-EEN 195	c	17.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	1
LCT-EEN 196	c	17.5.81	Colombia	Putumayo	Rio Putumayo	Puerto El Carmen	200	1	2	1
LCT-EEN 197	c	17.5.81	Colombia	Putumayo	Rio Putumayo	Puerto El Carmen	200	1	2	0
LCT-EEN 198	c	17.5.81	Ecuador	Napo	Rio Putumayo	Puerto El Carmen	200	1	1	0
LCT-EEN 199	c	17.5.81	Colombia	Putumayo	Rio Putumayo	Puerto El Carmen	200	1	2	1
LCT-EEN 200	c	17.5.81	Colombia	Putumayo	Rio Putumayo	Puerto El Carmen	200	1	1	0
LCT-EEN 201	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	2	1
LCT-EEN 202	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	2	1
LCT-EEN 203	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	2	1
LCT-EEN 204	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	1	0
LCT-EEN 205	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	2	1
LCT-EEN 206	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	1	0
LCT-EEN 207	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	1	0
LCT-EEN 208	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	1	0
LCT-EEN 209	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	1	0
LCT-EEN 210	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	1	0
LCT-EEN 211	c	18.5.81	Ecuador	Napo	Rio San Miguel	Puerto El Carmen	200	1	1	0
LCT-EEN 212	c	15.5.81	Ecuador	Napo	Rio Napo	Via Misahualli-Puerto Napo	400	3	2	1
LCT-EEN 213	c	15.7.81	Ecuador	Napo	Rio Napo	Via Misahualli-Puerto Napo	400	3	2	0
LCT-EEN 214	c	15.7.81	Ecuador	Napo	Rio Napo	Via Misahualli-Puerto Napo	400	3	2	1
LCT-EEN 215	c	15.7.81	Ecuador	Napo	Rio Napo	Via Misahualli-Puerto Napo	400	3	2	1
LCT-EEN 216	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 217	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 218	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 219	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 220	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 221	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 222	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 223	c	17.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 224	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0
LCT-EEN 225	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0
LCT-EEN 226	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0
LCT-EEN 227	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 228	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 229	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
LCT-EEN 230	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0
LCT-EEN 231	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 232	c	18.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 233	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0
LCT-EEN 234	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 238	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 236	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 237	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 238	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	1
LCT-EEN 239	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0
LCT-EEN 240	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	1	0
LCT-EEN 241	c	19.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	3	1
LCT-EEN 242	c	20.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	2	1
LCT-EEN 243	c	20.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	2	1
LCT-EEN 244	c	20.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	2	1
LCT-EEN 245	c	20.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	2	0
LCT-EEN 246	c	20.7.81	Ecuador	Pastaza	Rio Villano	Villano	330	1	2	1
LCT-EEN 247	c	27.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 248	c	27.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 249	c	27.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 250	c	27.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 251	c	27.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 252	c	27.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 253	c	27.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 254	c	28.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 255	c	28.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 256	c	28.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 257	c	28.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 258	c	28.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 259	c	28.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 260	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 261	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 262	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 263	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 264	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 265	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 266	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 267	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 268	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 269	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 270	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 271	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	2	1
LCT-EEN 272	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 273	c	29.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 274	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 275	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 276	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 277	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 278	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 279	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	0
LCT-EEN 280	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 281	c	30.8.81	Ecuador	Pastaza	Rio Curaray	entre Curaray y Lorocachi	200	1	1	1
LCT-EEN 282	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 283	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 284	h	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	2	0
LCT-EEN 285	c	24.12.81	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 286	c	24.12.81	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0
LCT-EEN 287	c	10.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	0	0

APPENDIX 5 (continued)

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
LCT-EEN 288	c	20.3.82	Ecuador	Napo	Coca - Lago Agrio	INIAP San Carlos	260	1	1	1
LCT-EEN 289	a	28.8.82	Ecuador	Los Rios	Quevedo	INIAP Pichilingue		3	2	0
LCT-EEN 290	c	4.11.81	Ecuador	Napo	Rio Payamino	1hr rio arriba de INIAP	250	1	1	0
LCT-EEN 291	c	4.11.81	Ecuador	Napo	Rio Payamino	1hr rio arriba de INIAP	250	1	1	0
LCT-EEN 292	c	20.11.81	Ecuador	Morona-Santiago	Rio Upano	Sevilla Don Bosco	950	1	1	0
LCT-EEN 293	c	20.11.81	Ecuador	Morona-Santiago	Rio Upano	Sevilla Don Bosco	950	1	1	0
LCT-EEN 294	c	20.11.81	Ecuador	Morona-Santiago	Rio Upano	Sevilla Don Bosco	950	1	1	0
LCT-EEN 295	c	21.11.81	Ecuador	Morona-Santiago	Rio Upano	San Isidro	1120	3	2	1
LCT-EEN 296	c	21.11.81	Ecuador	Morona-Santiago	Rio Upano	San Isidro	1120	3	2	1
LCT-EEN 297	c	21.11.81	Ecuador	Morona-Santiago	Rio Upano	San Isidro	1120	3	1	1
LCT-EEN 298	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Macas	910	1	1	0
LCT-EEN 299	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Macas	910	1	1	0
LCT-EEN 300	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Huambi	760	1	3	1
LCT-EEN 301	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Huambi	760	1	1	0
LCT-EEN 302	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Huambi	760	1	2	1
LCT-EEN 303	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Huambi	760	1	1	0
LCT-EEN 304	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	700	1	1	0
LCT-EEN 304	c	23.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	800	1	1	1
LCT-EEN 306	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	850	1	2	1
LCT-EEN 307	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	800	1	1	0
LCT-EEN 308	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	800	1	1	0
LCT-EEN 309	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	800	1	1	0
LCT-EEN 310	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	800	1	1	0
LCT-EEN 311	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	750	1	1	0
LCT-EEN 312	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	750	1	1	1
LCT-EEN 313	c	24.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	800	1	1	1
LCT-EEN 314	c	25.11.81	Ecuador	Morona-Santiago	Rio Upano	Sucua	600	1	1	0
LCT-EEN 315	c	26.11.81	Ecuador	Morona-Santiago	Rio Upano	Mendez	480	1	1	0
LCT-EEN 316	c	26.11.81	Ecuador	Morona-Santiago	Rio Upano	Mendez	480	1	1	0
LCT-EEN 317	c	26.11.81	Ecuador	Morona-Santiago	Rio Upano	Mendez	480	1	1	0
LCT-EEN 318	b	20.2.82	Ecuador	Napo	Rio Napo	Campanacocha	350	1	2	0
LCT-EEN 319	c	21.2.82	Ecuador	Napo	Rio Napo	Santa Rosa	350	1	1	0
LCT-EEN 320	c	22.2.82	Ecuador	Napo	Rio Napo	Misahualli-Puerto Napo km5	400	1	2	1
LCT-EEN 321	c	22.2.82	Ecuador	Napo	Rio Napo	Misahualli-Puerto Napo km5	400	1	2	1
LCT-EEN 322	c	23.2.82	Ecuador	Napo	Rio Napo	Misahualli-Puerto Napo km16	400	3	2	0
LCT-EEN 323	c	23.2.82	Ecuador	Napo	Rio Napo	Misahualli-Puerto Napo km16	400	3	2	1
LCT-EEN 324	c	23.2.82	Ecuador	Napo	Rio Napo	Misahualli-Puerto Napo km16	400	3	2	1
LCT-EEN 325	c	23.2.82	Ecuador	Napo	Rio Napo	Misahualli-Puerto Napo km12	400	3	2	1
LCT-EEN 326	c	23.2.82	Ecuador	Napo	Rio Napo	Misahualli-Puerto Napo km6	400	1	2	1
LCT-EEN 327	c	31.3.82	Colombia	Putumayo	Rio San Miguel	2hr rio arriba de Puerto Colon	290	3	1	1
LCT-EEN 328	c	15.7.82	Ecuador	Morona-Santiago	Rio Upano	Via Limon-Mendez km8	950	1	2	1
LCT-EEN 329	c	15.7.82	Ecuador	Morona-Santiago	Rio Upano	Via Limon-Mendez km8	950	1	2	1
LCT-EEN 330	c	15.7.82	Ecuador	Morona-Santiago	Rio Upano	Via Limon-Mendez km8	950	1	2	0
LCT-EEN 331	c	17.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: camino a Bellavista	800	1	2	1
LCT-EEN 332	c	17.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: camino a Ballavista	800	1	2	1
LCT-EEN 333	c	17.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: camino a Ballavista	800	1	1	1
LCT-EEN 334	c	17.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: camino a Bellavista	800	1	2	1
LCT-EEN 335	c	18.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km1 al N	800	1	2	1
LCT-EEN 336	c	18.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	750	1	2	1
LCT-EEN 337	c	18.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	750	1	2	1
LCT-EEN 338	c	18.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	750	1	2	1
LCT-EEN 339	c	18.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	750	1	2	1
LCT-EEN 340	c	18.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	750	1	2	1
LCT-EEN 341	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	750	1	2	1
LCT-EEN 342	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	800	1	2	1
LCT-EEN 343	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	800	1	2	1
LCT-EEN 344	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	800	1	2	1
LCT-EEN 345	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	800	1	2	1

APPENDIX 5 (continued)

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
LCT-EEN 346	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	800	1	2	1
LCT-EEN 347	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Huambi: km2 al N	800	1	2	1
LCT-EEN 348	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Sucua: hacia Rio Upano	800	1	2	1
LCT-EEN 349	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Sucua: hacia Rio Upano	800	1	2	1
LCT-EEN 350	c	20.7.82	Ecuador	Morona-Santiago	Rio Upano	Sucua: hacia Rio Upano	800	1	2	1
LCT-EEN 351	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	San Luis de El Upano	700	1	2	1
LCT-EEN 352	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	camino a San Luis de El Upano	700	1	2	1
LCT-EEN 353	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	camino a San Luis de El Upano	700	1	2	1
LCT-EEN 354	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	camino a San Luis de El Upano	700	1	2	1
LCT-EEN 355	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	camino a San Luis de El Upano	700	1	2	1
LCT-EEN 356	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	camino a San Luis de El Upano	700	1	2	1
LCT-EEN 357	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	San Luis de El Upano	750	1	2	1
LCT-EEN 358	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	San Luis de El Upano	750	1	2	1
LCT-EEN 359	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	San Luis de El Upano	750	1	2	1
LCT-EEN 360	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	San Luis de El Upano	750	1	2	1
LCT-EEN 361	c	21.7.82	Ecuador	Morona-Santiago	Rio Upano	San Luis de El Upano	750	1	2	1
LCT-EEN 362	c	10.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 363	c	10.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	0
LCT-EEN 364	c	11.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 365	c	12.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Muito 1	200	1	1	0
LCT-EEN 366	c	12.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 367	c	12.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 368	c	12.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 369	c	13.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 370	c	13.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 371	c	13.12.82	Ecuador	Pastaza	Rio Conambo	Pozo Maranon 1	200	1	1	1
LCT-EEN 372	c	16.2.83	Ecuador	Napo	Rio Napo	Yuca: camino al E km2	250	1	2	1
LCT-EEN 373	c	16.2.83	Ecuador	Napo	Rio Napo	Yuca: camino al E km2	250	1	1	1
LCT-EEN 374	c	8.11.83	Ecuador	Napo	Coca - Lago Agrio	Lago Agrio-Coca km32, km6 al O	250	1	1	1
LCT-EEN 375	s	23.2.84	Ecuador	Napo	Rio Payamino	Comuna San Jose de Payamino	350	1	1	1
LCT-EEN 376	c	24.2.84	Ecuador	Napo	Rio Payamino	Comuna San Jose de Payamino	350	1	1	1
LCT-EEN 377	c	24.2.84	Ecuador	Napo	Rio Payamino	Comuna San Jose de Payamino	350	1	1	0
LCT-EEN 378	c	25.2.84	Ecuador	Napo	Rio Payamino	Comuna San Jose de Payamino	350	1	1	1
LCT-EEN 379	c	25.2.84	Ecuador	Napo	Rio Payamino	Comuna San Jose de Payamino	350	1	1	1
LCT-EEN 380	s	9.5.84	Ecuador	Napo	Rio Payamino	Comuna San Jose de Payamino	350	1	1	1
LCT-EEN 381	b	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas	100	1	2	1
LCT-EEN 382	c	4.6.84	Colombia	Amazonas	Rio Apaporis	Centro Providencia	100	1	1	1
LCT-EEN 383	o	7.6.84	Colombia	Amazonas	Rio Caqueta	Puerto Cordoba	100	1	1	1
LCT-EEN 384	c	6.12.84	Ecuador	Morona-Santiago	Taisha	camino a Tutinentza	500	1	1	1
LCT-EEN 385	c	6.12.84	Ecuador	Morona-Santiago	Taisha	camino a Tutinentza	500	1	1	1
LCT-EEN 386	c	7.12.84	Ecuador	Morona-Santiago	Taisha	camino hacia SD	500	1	1	1
LCT-EEN 387	c	8.12.84	Ecuador	Morona-Santiago	Taisha	camino hacia Rio Mawaimi	500	1	1	1
LCT-EEN 388	c	8.12.84	Ecuador	Morona-Santiago	Taisha	camino hacia Rio Nawaimi	500	1	1	1
LCT-EEN 389	c	8.12.84	Ecuador	Morona-Santiago	Taisha	camino hacia Rio Mawaimi	500	1	1	1
LCT-EEN 390	c	8.12.84	Ecuador	Morona-Santiago	Taisha	camino Rio Mawaimi-Mision	500	1	1	1
LCT-EEN 391	c	8.12.84	Ecuador	Morona-Santiago	Taisha	camino al S de la Mision	500	1	2	1
LCT-EEN 392	s	9.12.84	Ecuador	Morona-Santiago	Taisha	carretera al NO, N de San Luis	500	1	2	1
LCT-EEN 393	c	19.4.85	Ecuador	Napo	Rio Napo	frente Isla Anaconda	350	1	2	1
LCT-EEN 394	c	11.7.85	Ecuador	Napo	Rio Napo	Hacienda Primavera: 5km al N	230	1	1	0
LCT-EEN 395	c	11.7.85	Ecuador	Napo	Rio Napo	Hacienda Primavera: 5km al N	230	1	1	1
LCT-EEN 396	c	11.7.85	Ecuador	Napo	Rio Napo	Hacienda Primavera: 5km al N	230	1	1	0
LCT-EEN 397	c	11.7.85	Ecuador	Napo	Rio Napo	Hacienda Primavera: 5km al N	230	1	1	0
LCT-EEN 398	c	11.7.85	Ecuador	Napo	Rio Napo	Hacienda Primavera: 5km al N	230	1	1	0
LCT-EEN 399	c	11.7.85	Ecuador	Napo	Rio Napo	Hacienda Primavera: 5km al N	230	1	1	1
LCT-EEN 400	c	11.7.85	Ecuador	Napo	Rio Napo	Hacienda Primavera: 5km al N	230	1	1	1
LCT-EEN 401	c	27.8.85	Ecuador	Napo	Rio Napo	1km rio abajo de Tiputini	200	1	1	1
LCT-EEN 402	g	27.8.85	Ecuador	Napo	Rio Yasuni	1km de la desembocadura	200	1	2	0
LCT-EEN 403	c	27.8.85	Ecuador	Napo	Rio Yasuni	1km de la desembocadura	200	1	3	1

APPENDIX 5 (continued)

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
LCT-EEN 404	c	27.8.85	Ecuador	Napo	Rio Yasuni	1km de la desembocadura	200	1	2	1
LCT-EEN 405	c	27.8.85	Ecuador	Napo	Rio Yasuni	1km de la desembocadura	200	1	2	1
LCT-EEN 406	c	27.8.85	Ecuador	Napo	Rio Yasuni	media hora de la desembocadura	200	1	1	1
LCT-EEN 407	c	29.8.85	Ecuador	Napo	Rio Napo	abajo de Nuevo Rocafuerte	200	1	1	0
LCT-EEN 408	c	29.8.85	Ecuador	Napo	Rio Napo	abajo de Nuevo Rocafuerte	200	1	3	1
LCT-EEN 409	c	29.8.85	Ecuador	Napo	Rio Napo	abajo de Nuevo Rocafuerte	200	1	1	1
LCT-EEN 410	b	29.8.85	Ecuador	Napo	Rio Napo	abajo de Nuevo Rocafuerte	200	3	1	1
LCT-EEN 411	c	29.8.85	Ecuador	Napo	Rio Aguarico	media hora de la desembocadura	200	1	1	1
LCT-EEN 412	c	29.8.85	Ecuador	Napo	Rio Aguarico	una hora de la desembocadura	200	1	1	1
LCT-EEN 413	c	29.8.85	Ecuador	Napo	Rio Aguarico	una hora de la desembocadura	200	1	1	1
LCT-EEN 414	c	29.8.85	Ecuador	Napo	Rio Aguarico	una hora de la desembocadura	200	1	1	1
LCT-EEN 415	c	29.8.85	Ecuador	Napo	Rio Aguarico	una hora de la desembocadura	200	1	1	1
LCT-EEN 416	c	19.9.85	Ecuador	Morona-Santiago	Rio Santiago	Kusumaza: abajo de Santiago	210	1	1	0
LCT-EEN 417	c	19.9.85	Ecuador	Morona-Santiago	Rio Santiago	Kusumaza: abajo de Santiago	210	1	1	0
LCT-EEN 418	c	19.9.85	Ecuador	Morona-Santiago	Rio Santiago	Kusumaza: abajo de Santiago	210	1	2	1
LCT-EEN 419	c	19.9.85	Ecuador	Morona-Santiago	Rio Santiago	Kusumaza: abajo de Santiago	210	1	1	1
LCT-EEN 420	c	19.9.85	Ecuador	Morona-Santiago	Rio Santiago	Kusumaza: abajo de Santiago	260	1	1	1
LCT-EEN 421	c	19.9.85	Ecuador	Morona-Santiago	Rio Santiago	Kusumaza: abajo de Santiago	260	1	1	1
LCT-EEN 422	c	20.9.85	Ecuador	Morona-Santiago	Rio Santiago	Tsuis: arriba de Santiago	260	1	1	1
LCT-EEN 423	c	20.9.85	Ecuador	Morona-Santiago	Rio Santiago	Tsuis: arriba de Santiago	260	1	1	0
LCT-EEN 424	c	20.9.85	Ecuador	Morona-Santiago	Rio Santiago	Tsuis: arriba de Santiago	260	1	2	1
LCT-EEN 425	c	20.9.85	Ecuador	Morona-Santiago	Rio Santiago	Tsuis: arriba de Santiago	260	1	1	0
LCT-EEN 426	c	20.9.85	Ecuador	Morona-Santiago	Rio Santiago	Tsuis: arriba de Santiago	260	1	1	1
LCT-EEN 427	c	21.9.85	Ecuador	Morona-Santiago	Rio Yaupi	cerca desembocadura	210	1	1	1
LCT-EEN 428	c	21.9.85	Ecuador	Morona-Santiago	Rio Yaupi	cerca desembocadura	210	1	1	1
LCT-EEN 429	c	21.9.85	Ecuador	Morona-Santiago	Rio Yaupi	media hora de la desembocadura	200	1	1	1
LCT-EEN 430	c	22.9.85	Ecuador	Morona-Santiago	Rio Santiago	4km al oeste de Santiago	260	1	2	1
LCT-EEN 431	c	22.9.85	Ecuador	Morona-Santiago	Rio Santiago	4km al oeste de Santiago	260	1	1	0
LCT-EEN 432	c	22.9.85	Ecuador	Morona-Santiago	Rio Santiago	4km al oeste de Santiago	260	1	1	1
LCT-EEN 433	c	22.9.85	Ecuador	Morona-Santiago	Rio Santiago	4km al oeste de Santiago	260	1	1	0
LCT-EEN 434	c	22.9.85	Ecuador	Morona-Santiago	Rio Santiago	4km al oeste de Santiago	260	1	1	1
LCT-EEN 435	c	22.9.85	Ecuador	Morona-Santiago	Rio Santiago	Santiago: cerca de la Mision	210	1	1	0
EBC 1	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	1	0
EBC 2	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	1	0
EBC 3	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	1	0
EBC 4	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	1	0
EBC 5	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	2	1
EBC 6	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	2	1
EBC 7	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	1	0
EBC 8	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	2	0
EBC 9	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	2	1
EBC 10	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	2	1
EBC 11	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	2	0
EBC 12	c	23.5.84	Colombia	Amazonas	Rio Caqueta	Isla Clemencia	100	1	1	1
EBC 13	b	24.5.84	Colombia	Amazonas	Rio Caqueta	Casa de Sebastian	100	3	2	0
EBC 14	b	24.5.84	Colombia	Amazonas	Rio Caqueta	Casa de Sebastian	100	3	2	0
EBC 15	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Punta Sebastian	100	1	1	0
EBC 16	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Punta Sebastian	100	1	1	0
EBC 17	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Punta Sebastian	100	1	1	0
EBC 18	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Punta Sebastian	100	1	1	0
EBC 19	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Punta Sebastian	100	1	1	0
EBC 20	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Punta Sebastian	100	1	1	0
EBC 21	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Punta Sebastian	100	1	1	0
EBC 22	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Isla Mariname	100	1	1	0
EBC 23	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Isla Mariname	100	1	1	0
EBC 24	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Quebrada del Arroz	100	1	1	0
EBC 25	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Quebrada del Arroz	100	1	1	0
EBC 26	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Quebrada del Arroz	100	1	1	0

APPENDIX 5 (continued)

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
EBC 27	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Quebrada del Arroz	100	1	1	0
EBC 28	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Quebrada del Arroz	100	1	1	0
EBC 29	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Quebrada del Arroz	100	1	2	1
EBC 30	c	24.5.84	Colombia	Amazonas	Rio Caqueta	Quebrada del Arroz	100	1	2	1
EBC 31	b	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	3	2	1
EBC 32	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	1
EBC 33	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	0
EBC 34	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	0
EBC 35	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	0
EBC 36	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	0
EBC 37	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	0
EBC 38	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	0
EBC 39	c	25.5.84	Colombia	Amazonas	Rio Caqueta	fr Isla Ma Cristina	100	1	1	0
EBC 40	c	25.5.84	Colombia	Amazonas	Rio Caqueta	Puerto Engano	100	1	1	0
EBC 41	c	25.5.84	Colombia	Amazonas	Rio Caqueta	Puerto Engano	100	1	1	0
EBC 42	c	25.5.84	Colombia	Amazonas	Rio Caqueta	Puerto Engano	100	1	1	0
EBC 43	c	25.5.84	Colombia	Amazonas	Rio Caqueta	El Bufeo	100	1	1	0
EBC 44	c	25.5.84	Colombia	Amazonas	Rio Caqueta	El Bufeo	100	1	1	0
EBC 45	c	25.5.84	Colombia	Amazonas	Rio Caqueta	El Bufeo	100	1	1	0
EBC 46	c	25.5.84	Colombia	Amazonas	Rio Caqueta	El Bufeo	100	1	1	0
EBC 47	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	1	0
EBC 48	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	2	1
EBC 49	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	2	0
EBC 50	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	1	0
EBC 51	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	1	0
EBC 52	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	2	0
EBC 53	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	1	0
EBC 54	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	1	0
EBC 55	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Raudal Quinche	100	1	2	0
EBC 56	c	26.5.84	Colombia	Amazonas	Rio Caqueta	Dos Islas	100	1	2	0
EBC 57	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Cano Coca	100	1	1	0
EBC 58	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Cano Coca	100	1	2	1
EBC 59	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Cano Coca	100	1	1	0
EBC 60	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Cano Coca	100	1	1	0
EBC 61	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Cano Coca	100	1	1	0
EBC 62	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Cano Coca	100	1	1	0
EBC 64	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Remanso de Tijereta	100	1	1	0
EBC 65	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Remanso de Tijereta	100	1	1	0
EBC 66	c	27.5.84	Colombia	Amazonas	Rio Caqueta	Raudal de Tijereta	100	1	1	0
EBC 67	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Venado	100	1	1	0
EBC 68	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Venado	100	1	1	0
EBC 69	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Venado	100	1	1	0
EBC 70	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Venado	100	1	1	0
EBC 71	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Venado	100	1	1	0
EBC 72	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Brazuelo	100	1	1	0
EBC 73	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Brazuelo	100	1	1	0
EBC 74	c	28.5.84	Colombia	Amazonas	Rio Caqueta	El Brazuelo	100	1	1	0
EBC 75	h	29.5.84	Colombia	Amazonas	Rio Caqueta	Bellavista	100	1	1	0
EBC 76	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Solarte: E Mirana	100	1	2	1
EBC 77	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Solarte: E Mirana	100	1	2	1
EBC 78	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Solarte: E Mirana	100	1	2	1
EBC 79	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Solarte: E Mirana	100	1	2	1
EBC 80	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas	100	1	1	0
EBC 81	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas	100	1	1	0
EBC 82	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas	100	1	1	0
EBC 83	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas	100	1	1	0
EBC 84	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas: J Bora	100	1	2	1
EBC 85	c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas: J Bora	100	1	2	1

APPENDIX 5 (continued)

Collection (1)	Sp (2)	Date (3)	Country (4)	Province (5)	Area (6)	Location (7)	Alt (8)	St (9)	Mat (10)	Surv (11)
EBC	86 c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas: J Bora	100	1	2	1
EBC	88 c	29.5.84	Colombia	Amazonas	Rio Caqueta	Las Palmas: J Bora	100	1	1	0
EBC	89 c	29.5.84	Colombia	Amazonas	Rio Caqueta	casa A Mirana	100	1	1	0
EBC	90 c	29.5.84	Colombia	Amazonas	Rio Caqueta	casa A Mirana	100	1	1	0
EBC	91 c	29.5.84	Colombia	Amazonas	Rio Caqueta	casa A Mirana	100	1	2	1
EBC	100 c	30.5.84	Colombia	Amazonas	Rio Caqueta	fr Islas Miranas	100	1	2	1
EBC	101 c	31.5.84	Colombia	Amazonas	Rio Caqueta	Puerto Maria Manteca	100	1	2	1
EBC	102 g	31.5.84	Colombia	Amazonas	Rio Caqueta	Puerto Maria Manteca	100	3	2	0
EBC	103 c	1.6.84	Colombia	Amazonas	Rio Caqueta	Isla Manacaro	100	1	1	0
EBC	104 c	1.6.84	Colombia	Amazonas	Rio Caqueta	Isla Manacaro	100	1	1	0
EBC	105 c	2.6.84	Colombia	Amazonas	Rio Caqueta	Isla Zumaeta	100	1	1	0
EBC	106 c	2.6.84	Colombia	Amazonas	Rio Caqueta	Isla Zumaeta	100	1	1	0
EBC	107 c	2.6.84	Colombia	Amazonas	Rio Caqueta	Isla Zumaeta	100	1	1	0
EBC	108 c	2.6.84	Colombia	Amazonas	Rio Caqueta	Isla Zumaeta	100	1	1	0
EBC	109 c	2.6.84	Colombia	Amazonas	Rio Caqueta	Puerto Miriti	100	1	1	0
EBC	110 c	2.6.84	Colombia	Amazonas	Rio Caqueta	Puerto Miriti	100	1	1	0
EBC	111 h	2.6.84	Colombia	Amazonas	Rio Caqueta	Isla Miriti	100	1	1	0
EBC	112 c	4.6.84	Colombia	Amazonas	Rio Apaporis	Centro Providencia	100	1	1	0
EBC	113 c	4.6.84	Colombia	Amazonas	Rio Apaporis	cerca Providencia	100	1	1	0
EBC	114 c	4.6.84	Colombia	Amazonas	Rio Apaporis	cerca Providencia	100	1	1	1
EBC	115 c	4.6.84	Colombia	Amazonas	Rio Apaporis	cerca Providencia	100	1	1	0
EBC	116 c	4.6.84	Colombia	Amazonas	Rio Apaporis	cerca Providencia	100	1	1	0
EBC	117 c	4.6.84	Colombia	Amazonas	Rio Apaporis	cerca Providencia	100	1	1	0
EBC	118 c	4.6.84	Colombia	Amazonas	Rio Apaporis	cerca Providencia	100	1	1	1
EBC	119 c	4.6.84	Colombia	Amazonas	Rio Apaporis	Centro Providencia	100	1	1	0
EBC	120 c	6.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Baranoa	100	1	1	0
EBC	121 c	6.6.84	Colombia	Amazonas	Rio Caqueta	Isla Baranoa	100	1	2	1
EBC	122 c	6.6.84	Colombia	Amazonas	Rio Caqueta	Isla Baranoa	100	1	1	1
EBC	123 c	3.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Cordoba	100	1	2	1
EBC	124 c	3.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Cordoba	100	1	1	0
EBC	125 c	3.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Cordoba	100	1	2	1
EBC	126 c	3.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Cordoba	100	1	2	1
EBC	127 c	3.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Cordoba	100	1	1	0
EBC	128 c	3.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Cordoba	100	1	1	0
EBC	129 c	4.6.84	Colombia	Amazonas	Rio Caqueta	fr Puerto Cordoba	100	1	1	0
EBC	130 c	4.6.84	Colombia	Amazonas	Rio Caqueta	fr Puerto Cordoba	100	1	1	0
EBC	131 c	4.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Miriti	100	1	1	0
EBC	132 c	4.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Miriti	100	1	1	0
EBC	133 c	4.6.84	Colombia	Amazonas	Rio Caqueta	Remanso de Cordoba	100	1	1	0
EBC	134 c	4.6.84	Colombia	Amazonas	Rio Caqueta	Remanso de Cordoba	100	1	1	0
EBC	135 c	4.6.84	Colombia	Amazonas	Rio Caqueta	Remanso de Cordoba	100	1	2	1
EBC	136 c	4.6.84	Colombia	Amazonas	Rio Caqueta	Puerto Cordoba	100	1	1	0
EBC	138 c	5.6.84	Colombia	Amazonas	Rio Caqueta	Isla Guillermina	100	1	2	1
EBC	139 c	5.6.84	Colombia	Amazonas	Rio Caqueta	Isla Colombia	100	1	1	0
EBC	140 c	5.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Colombia	100	1	1	0
EBC	141 c	5.6.84	Colombia	Amazonas	Rio Caqueta	Isla Colombia	100	1	1	1
EBC	142 c	5.6.84	Colombia	Amazonas	Rio Caqueta	Isla Colombia	100	1	2	1
EBC	143 c	5.6.84	Colombia	Amazonas	Rio Caqueta	Isla Colombia	100	1	1	0
EBC	144 c	5.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Colombia	100	1	1	0
EBC	145 c	6.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Barahona	100	1	1	1
EBC	146 c	6.6.84	Colombia	Amazonas	Rio Caqueta	Isla Barahona	100	1	1	0
EBC	147 c	6.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Barahona	100	1	2	1
EBC	148 c	5.6.84	Colombia	Amazonas	Rio Caqueta	fr Isla Colombia	100	1	2	1

Notes:

1. See Appendix 4 for explanation of descriptors and descriptor states

(b) pod and seed descriptors

Collection (1)		POD Bas (2)	Apx (3)	Sur (4)	Fur (5)	Prd (6)	Pig (7)	Len (8)	Dia (9)	D:L (10)	Thk (11)	Wgt (12)	BEAN Num (13)	Wgt (14)	Len (15)	Wid (16)	Thk (17)	N:L (18)	Wht (19)	Ltp (20)	Dkp (21)	Data From (22)
LCT-EEN	1	3	5	7	5	1	0	181	85	0.46	21	543	25	2.08	24.3	12.0	10.5	0.49	1	1	0	1
LCT-EEN	4	5	1	5	5	1	0	163	81	0.49	16	482	36	1.53	22.6	13.2	8.2	0.58	0	0	1	1
LCT-EEN	5	3	5	7	7	1	0	168	99	0.58	18	625	33	1.79	26.2	13.3	8.4	0.50	1	1	1	1
LCT-EEN	6	0	5	7	5	1	0	163	105	0.64	22	710	19	2.16	25.4	12.5	9.8	0.49	1	1	1	1
LCT-EEN	8	0	5	5	5	1	0	170	103	0.60	25	771	12	2.00	23.3	12.3	10.0	0.52	0	0	1	1
LCT-EEN	10	3	5	7	5	1	0	149	87	0.58	21	497	16	2.50	24.2	14.1	9.3	0.58	0	0	1	1
LCT-EEN	11	0	5	7	5	5	0	116	79	0.68	16	298	13	1.83	23.3	12.8	10.4	0.54	1	0	0	1
LCT-EEN	14	0	1	7	5	1	0	108	100	0.92	18	412	14	1.71	22.8	12.7	9.3	0.55	1	0	0	1
LCT-EEN	15	3	5	7	5	1	0	136	87	0.63	16	420	23	1.55	23.0	12.1	8.4	0.52	1	1	1	1
LCT-EEN	18	0	5	7	5	1	0	155	80	0.51	16	431	20	1.79	23.5	13.4	9.8	0.57	0	1	0	1
LCT-EEN	19	0	1	7	5	1	0	205	110	0.53	20	981	33	2.29	24.8	13.6	10.9	0.54	0	1	0	1
LCT-EEN	20	3	5	7	5	1	0	158	84	0.53	17	459	22	2.06	22.9	13.8	9.7	0.60	1	1	0	1
LCT-EEN	22	0	5	7	7	1	0	178	95	0.53	21	661	36	1.59	23.0	11.9	8.7	0.51	0	0	1	1
LCT-EEN	23	3	1	5	7	1	0	190	96	0.50	18	788	38	2.38	26.0	13.1	9.7	0.50	0	1	1	1
LCT-EEN	24	0	1	5	7	1	0	170	95	0.55	22	550	29	1.50	22.6	13.6	9.0	0.60	1	1	0	1
LCT-EEN	25	0	5	7	5	1	0	161	101	0.62	25	705	25	2.28	26.2	14.8	8.9	0.56	0	1	0	1
LCT-EEN	26	0	5	5	5	1	0	180	103	0.57	17	713	40	1.84	27.6	12.9	7.7	0.46	0	0	1	1
LCT-EEN	27	3	5	0	3	1	5	151	74	0.49	14	364	30	1.00	20.6	11.2	7.7	0.54	0	0	1	1
LCT-EEN	28	3	5	5	5	1	0	160	88	0.55	22	525	20	1.93	22.7	13.4	9.1	0.59	0	1	0	1
LCT-EEN	29	0	1	7	5	1	0	120	96	0.80	22	542	21	1.93	25.2	15.0	8.3	0.59	0	1	1	1
LCT-EEN	31	3	5	5	5	1	0	215	107	0.49	21	988	37	2.82	26.8	14.9	11.3	0.55	1	1	0	2
LCT-EEN	36	0	5	7	7	1	0	160	91	0.56	18	571	14	2.20	25.1	13.6	10.1	0.54	1	1	1	2
LCT-EEN	37	0	1	7	7	1	0	220	121	0.55	26	1325	37	2.28	27.3	13.3	10.2	0.48	0	0	1	2
LCT-EEN	38	5	5	5	5	1	0	260	120	0.46	27	1450	31	2.88	30.3	13.9	11.3	0.45	0	1	0	2
LCT-EEN	39	3	1	5	5	1	0	147	78	0.53	15	435	29	-1.00	23.4	13.4	8.2	0.57	0	1	1	1
LCT-EEN	44	0	5	5	5	1	0	150	89	0.59	22	453	10	3.20	27.9	14.9	11.8	0.53	1	1	0	1
LCT-EEN	46	3	9	7	7	1	0	176	84	0.47	17	348	21	1.35	21.1	11.4	9.0	0.54	0	0	1	2
LCT-EEN	48	0	5	5	5	1	0	163	96	0.58	22	632	30	-1.00	-1.0	-1.0	-1.0	-1.00	1	1	0	1
LCT-EEN	58	0	1	0	1	1	0	135	91	0.67	20	451	14	1.86	23.8	13.3	9.4	0.55	1	0	0	1
LCT-EEN	59	0	9	7	7	1	0	210	112	0.53	34	1315	28	2.53	28.6	13.9	9.8	0.48	0	1	0	1
LCT-EEN	60	0	9	7	5	1	0	190	110	0.57	21	937	38	2.26	24.6	13.8	10.3	0.56	0	1	0	2
LCT-EEN	61	0	5	5	5	1	0	183	90	0.49	21	683	22	1.74	24.1	13.2	9.6	0.54	0	1	1	1
LCT-EEN	62	5	5	5	3	1	5	118	63	0.53	4	140	40	1.11	19.2	11.1	6.2	0.57	0	0	1	1
LCT-EEN	64	0	1	7	5	1	0	130	83	0.63	20	501	11	1.63	25.6	11.5	9.4	0.44	1	0	0	1
LCT-EEN	65	0	5	7	7	1	0	145	100	0.68	20	640	16	2.75	26.3	15.1	10.9	0.57	1	0	0	1
LCT-EEN	66	0	1	5	5	1	0	151	91	0.60	18	532	32	1.40	24.5	12.9	6.8	0.52	1	0	0	1
LCT-EEN	67	0	5	5	5	1	5	138	83	0.60	15	450	36	1.35	23.3	13.5	7.1	0.57	1	0	1	1
LCT-EEN	68	0	5	5	5	1	0	147	87	0.59	18	435	23	1.85	23.7	12.6	10.2	0.53	0	0	1	1
LCT-EEN	69	0	5	5	5	1	0	158	102	0.64	28	590	15	2.31	24.7	12.9	10.8	0.52	1	0	0	1
LCT-EEN	70	3	5	5	3	1	0	153	87	0.56	20	530	31	1.50	-1.0	-1.0	-1.0	-1.00	1	0	1	1
LCT-EEN	71	0	5	5	5	1	0	143	82	0.57	20	412	14	1.75	25.1	13.5	10.1	0.53	1	0	1	1
LCT-EEN	72	0	1	5	5	1	0	188	102	0.54	19	725	36	1.89	25.6	12.5	11.7	0.48	1	1	1	1
LCT-EEN	73	0	5	5	5	1	0	165	99	0.60	19	704	46	1.92	25.8	14.0	8.3	0.54	0	1	1	2
LCT-EEN	74	0	1	5	5	1	0	130	102	0.78	15	354	17	1.80	27.5	12.0	7.3	0.43	1	0	1	1
LCT-EEN	76	0	1	5	5	1	0	160	88	0.55	17	492	41	1.00	23.4	12.7	7.9	0.54	0	0	1	1
LCT-EEN	77	0	5	5	5	1	0	165	97	0.58	19	670	34	2.14	25.1	13.3	9.0	0.52	1	0	1	1
LCT-EEN	78	0	5	0	5	1	3	160	100	0.62	28	745	10	2.22	24.8	12.4	9.6	0.50	1	0	1	1
LCT-EEN	79	3	5	5	5	1	0	167	86	0.51	20	543	26	1.74	23.0	12.5	9.0	0.54	1	0	1	1
LCT-EEN	80	0	5	7	7	1	0	240	95	0.39	25	928	34	2.00	23.1	13.2	11.4	0.57	0	1	0	2
LCT-EEN	81	0	9	7	7	1	0	195	87	0.44	21	762	73	2.00	25.2	13.4	8.9	0.53	1	1	0	2
LCT-EEN	82	3	1	5	7	1	0	167	98	0.58	27	675	14	1.75	24.6	13.5	10.1	0.54	1	1	1	1
LCT-EEN	83	0	5	5	5	1	0	161	100	0.62	20	770	32	2.25	25.8	13.8	9.2	0.53	0	0	1	1
LCT-EEN	84	0	5	0	5	1	0	129	88	0.68	19	483	24	1.67	23.4	13.1	8.8	0.55	0	1	1	1
LCT-EEN	85	0	1	5	5	1	0	156	96	0.61	19	633	30	1.75	24.5	14.2	9.6	0.57	1	1	1	1
LCT-EEN	86	0	5	5	5	1	0	153	91	0.59	16	638	45	1.75	22.6	12.8	8.3	0.56	0	0	1	1

APPENDIX 5 (continued)

	POD											BEAN									Data
Collection (1)	Bas (2)	Apx (3)	Sur (4)	Fur (5)	Prd (6)	Pig (7)	Len (8)	Dia (9)	D:L (10)	Thk (11)	Wgt (12)	Num (13)	Wgt (14)	Len (15)	Wid (16)	Thk (17)	W:L (18)	Wht (19)	Ltp (20)	Dkp (21)	From (22)
LCT-EEN 87	0	5	5	5	1	0	125	77	0.61	11	345	23	2.14	24.4	14.1	9.1	0.57	1	0	1	1
LCT-EEN 88	0	1	5	5	1	0	159	95	0.59	16	575	36	2.25	26.1	14.4	8.6	0.55	1	0	0	1
LCT-EEN 89	0	5	5	5	1	0	151	99	0.65	16	628	33	2.50	28.7	14.7	9.0	0.51	1	1	0	1
LCT-EEN 90	3	1	5	5	1	0	135	86	0.63	16	353	24	1.50	23.1	12.6	8.3	0.54	0	0	1	1
LCT-EEN 92	0	1	5	5	1	0	200	98	0.49	18	850	43	1.50	22.6	12.6	8.4	0.55	0	0	1	1
LCT-EEN 93	0	5	5	5	1	0	150	102	0.68	24	783	28	2.25	26.3	14.5	8.5	0.55	1	0	1	1
LCT-EEN 94	3	7	7	7	1	0	193	86	0.44	15	522	38	1.80	20.0	12.7	8.1	0.63	0	1	1	2
LCT-EEN 97	5	9	5	5	1	0	175	90	0.51	18	558	35	1.98	23.2	13.9	9.6	0.59	1	1	0	2
LCT-EEN 101	0	5	7	5	1	0	140	85	0.60	17	409	27	1.50	21.5	12.2	9.4	0.56	1	0	0	1
LCT-EEN 107	5	7	7	7	1	0	218	85	0.38	16	582	41	1.80	24.3	11.7	8.6	0.48	0	1	1	2
LCT-EEN 108	5	5	7	7	1	0	197	91	0.46	20	700	34	2.30	24.5	14.9	9.8	0.60	0	1	1	2
LCT-EEN 109	0	5	7	5	1	0	120	86	0.71	13	282	15	1.67	24.3	12.3	9.3	0.50	1	0	0	1
LCT-EEN 113	0	1	5	5	1	0	150	118	0.78	35	968	4	3.00	24.5	15.0	13.0	0.61	1	0	0	1
LCT-EEN 115	0	5	5	3	1	0	185	99	0.53	18	-1	-1	2.57	26.7	16.7	8.8	0.62	1	1	0	1
LCT-EEN 123	3	5	5	5	1	0	180	84	0.46	18	510	10	3.12	27.3	15.3	12.2	0.56	1	1	0	2
LCT-EEN 125	0	5	5	5	1	0	220	127	0.57	29	1215	27	2.50	27.3	15.2	10.5	0.55	0	1	0	2
LCT-EEN 127	0	5	5	5	1	0	190	108	0.56	22	828	42	1.40	25.5	11.8	8.5	0.46	0	0	1	1
LCT-EEN 128	0	5	5	3	1	0	110	90	0.81	17	310	4	3.00	29.3	15.3	12.0	0.52	1	0	0	1
LCT-EEN 129	0	5	7	5	1	0	140	98	0.70	20	424	9	2.88	29.6	15.2	11.8	0.51	1	0	0	1
LCT-EEN 130	3	5	5	5	1	0	180	108	0.60	20	668	29	2.10	27.0	13.3	9.8	0.49	1	0	0	1
LCT-EEN 131	0	5	7	5	1	0	150	98	0.65	22	500	17	2.36	24.3	14.6	10.6	0.60	1	0	0	1
LCT-EEN 132	5	9	7	5	1	0	180	107	0.59	19	686	25	2.66	25.4	15.2	9.7	0.59	1	0	1	1
LCT-EEN 133	0	0	7	7	1	0	192	106	0.55	18	867	34	2.40	25.2	15.0	9.3	0.59	1	1	1	2
LCT-EEN 134	0	9	7	5	1	0	155	91	0.58	14	356	22	2.00	24.6	13.3	9.4	0.54	1	1	0	1
LCT-EEN 136	0	1	7	5	1	0	168	106	0.63	24	895	33	2.50	25.8	14.6	8.8	0.56	1	0	0	1
LCT-EEN 142	0	1	5	5	1	0	143	100	0.69	18	431	23	1.23	23.0	12.1	8.8	0.52	1	0	0	1
LCT-EEN 145	0	9	7	5	1	0	185	92	0.49	15	549	24	2.20	24.9	13.9	9.6	0.55	1	0	0	1
LCT-EEN 148	0	5	5	5	1	0	125	76	0.60	12	269	21	1.09	20.6	11.5	7.9	0.55	1	0	0	2
LCT-EEN 151	3	5	7	5	1	0	177	97	0.54	13	479	34	2.53	26.6	14.5	9.7	0.54	0	1	1	2
LCT-EEN 152	0	1	0	3	1	0	139	92	0.66	17	547	34	1.65	25.9	12.7	7.6	0.49	1	0	0	2
LCT-EEN 154	3	5	5	5	1	0	160	89	0.55	14	563	40	1.55	25.2	11.9	7.6	0.47	1	0	1	2
LCT-EEN 156	3	9	7	7	1	0	195	91	0.46	19	714	14	2.15	22.8	13.5	11.5	0.59	1	0	0	2
LCT-EEN 157	0	5	5	3	1	0	165	105	0.63	15	648	32	2.72	29.3	15.6	9.5	0.53	1	0	1	2
LCT-EEN 158	0	5	7	7	1	0	216	113	0.52	24	1041	32	2.16	25.4	14.0	9.9	0.55	1	0	0	2
LCT-EEN 159	0	5	5	5	1	0	105	88	0.83	19	413	10	3.25	27.0	15.1	11.4	0.55	1	0	0	1
LCT-EEN 160	0	5	7	7	1	0	210	122	0.58	25	1369	38	-1.00	-1.0	-1.0	-1.0	-1.00	-1	-1	1	1
LCT-EEN 162	3	5	7	5	1	0	150	94	0.62	17	552	26	2.40	24.7	14.6	9.7	0.59	1	0	0	1
LCT-EEN 163	0	5	5	5	1	0	155	90	0.58	18	557	22	2.09	23.6	13.9	10.5	0.58	1	0	0	2
LCT-EEN 166	0	5	5	5	1	0	189	118	0.62	22	1008	35	2.92	29.0	16.1	10.1	0.55	1	1	0	2
LCT-EEN 169	0	5	7	7	1	0	208	128	0.61	20	1437	41	2.90	29.8	15.2	9.0	0.51	1	0	1	2
LCT-EEN 175	5	9	7	7	1	0	170	93	0.54	17	521	34	1.92	23.3	12.4	8.4	0.53	0	0	1	2
LCT-EEN 178	0	5	5	5	5	0	149	87	0.58	14	431	40	1.76	25.0	13.0	8.8	0.52	1	1	1	2
LCT-EEN 179	0	5	7	5	1	0	195	99	0.50	18	726	37	1.67	25.2	12.9	8.2	0.51	1	0	0	2
LCT-EEN 181	0	1	0	5	1	0	190	100	0.52	16	270	40	2.00	26.3	12.4	9.2	0.47	0	1	0	2
LCT-EEN 182	3	9	7	5	1	0	156	81	0.51	15	360	38	1.05	20.7	10.3	7.4	0.49	1	1	1	1
LCT-EEN 185	5	5	5	5	1	0	207	83	0.40	12	547	36	1.75	25.6	11.7	8.3	0.45	1	0	1	2
LCT-EEN 188	3	5	5	5	1	0	145	74	0.51	11	354	41	1.20	21.9	10.9	7.1	0.49	0	1	1	2
LCT-EEN 189	5	9	5	5	1	0	177	68	0.38	13	318	32	0.97	19.3	10.2	8.3	0.52	1	1	1	2
LCT-EEN 194	0	9	5	3	1	0	126	72	0.57	-1	-1	-1	-1.00	-1.0	-1.0	-1.0	-1.00	-1	-1	-1	1
LCT-EEN 196	3	5	3	5	0	0	142	68	0.47	14	316	23	0.82	16.8	8.7	7.4	0.51	0	0	1	1
LCT-EEN 197	0	9	0	3	0	5	76	46	0.60	6	57	12	0.53	14.9	8.3	6.7	0.55	0	1	1	1
LCT-EEN 199	3	9	0	3	0	3	150	67	0.44	8	240	49	0.86	19.3	9.3	6.4	0.48	0	0	1	1
LCT-EEN 201	3	5	7	5	1	0	180	97	0.53	19	688	38	1.78	25.9	12.2	8.3	0.47	0	1	0	1
LCT-EEN 202	3	5	7	5	1	0	185	115	0.62	18	812	40	2.29	28.1	14.3	8.5	0.50	0	0	1	1
LCT-EEN 203	0	1	7	5	1	0	110	92	0.83	17	432	27	1.52	24.8	13.5	8.0	0.54	1	1	1	1
LCT-EEN 205	0	5	7	5	1	0	145	96	0.66	20	497	12	2.25	25.8	12.6	9.9	0.48	0	1	1	1
LCT-EEN 212	3	5	0	5	-1	3	-1	-1	-1.00	-1	-1	-1	-1.00	-1.0	-1.0	-1.0	-1.00	0	0	1	1

APPENDIX 5 (continued)

	POD											BEAN									Data
Collection (1)	Bas (2)	Apx (3)	Sur (4)	Fur (5)	Prd (6)	Pig (7)	Len (8)	Dia (9)	D:L (10)	Thk (11)	Wgt (12)	Num (13)	Wgt (14)	Len (15)	Wid (16)	Thk (17)	W:L (18)	Wht (19)	Ltp (20)	Dkp (21)	From (22)
LCT-EEN 213	0	5	5	7	-1	0	-1	-1	-1.00	-1	-1	-1	-1.00	-1.0	-1.0	-1.0	-1.00	0	1	0	1
LCT-EEN 214	3	5	7	7	-1	0	-1	-1	-1.00	-1	-1	-1	-1.00	-1.0	-1.0	-1.0	-1.00	0	1	1	1
LCT-EEN 215	3	5	0	3	-1	3	-1	-1	-1.00	-1	-1	-1	-1.00	-1.0	-1.0	-1.0	-1.00	0	0	1	1
LCT-EEN 218	0	7	5	5	1	0	184	105	0.57	16	752	39	2.80	26.8	16.2	9.1	0.60	1	1	0	2
LCT-EEN 219	3	5	7	7	1	0	174	109	0.62	22	730	29	2.60	25.1	15.5	9.8	0.61	1	0	0	2
LCT-EEN 220	0	9	7	5	1	0	178	85	0.47	18	587	27	1.25	23.2	11.5	9.1	0.49	1	1	0	1
LCT-EEN 223	3	5	5	5	-1	0	170	92	0.54	15	548	36	2.09	25.9	14.5	8.8	0.55	1	0	0	2
LCT-EEN 237	3	5	7	5	1	0	215	112	0.52	25	974	32	2.90	27.9	16.0	9.1	0.57	0	1	1	2
LCT-EEN 239	0	1	7	3	1	-1	185	110	0.59	25	960	35	-1.00	-1.0	-1.0	-1.0	-1.00	-1	-1	-1	1
LCT-EEN 241	0	5	7	7	1	0	180	104	0.57	19	782	32	2.58	25.0	16.3	11.1	0.65	1	0	0	2
LCT-EEN 242	0	9	5	5	1	0	170	93	0.54	16	597	23	2.75	27.7	13.8	11.5	0.49	1	0	0	1
LCT-EEN 243	0	5	0	5	1	0	110	84	0.76	20	334	-1	1.50	23.0	11.6	8.6	0.50	1	0	0	1
LCT-EEN 244	3	9	7	5	1	0	205	110	0.53	21	689	28	2.44	26.2	13.7	10.5	0.52	1	0	0	1
LCT-EEN 245	0	5	7	7	1	0	193	-1	-1.00	-1	932	-1	-1.00	-1.0	-1.0	-1.0	-1.00	1	0	0	1
LCT-EEN 246	3	5	7	7	1	0	165	89	0.53	20	461	13	2.90	26.5	14.8	11.4	0.55	1	0	0	1
LCT-EEN 248	0	5	5	7	1	0	180	107	0.59	25	847	18	1.47	20.5	11.3	9.6	0.55	1	1	1	1
LCT-EEN 249	0	7	7	7	1	0	235	88	0.37	14	970	-1	2.49	24.2	14.0	11.4	0.57	0	0	1	2
LCT-EEN 250	0	5	5	5	1	0	165	108	0.65	19	802	40	1.84	26.3	13.8	8.0	0.52	0	0	1	2
LCT-EEN 251	3	5	5	5	1	0	182	107	0.58	20	904	45	1.85	27.2	13.6	8.3	0.50	1	0	0	2
LCT-EEN 252	0	5	5	7	1	0	215	108	0.50	24	986	34	2.16	26.1	13.8	9.5	0.52	1	0	1	2
LCT-EEN 254	0	5	5	7	1	0	165	92	0.55	14	441	37	2.05	24.6	15.1	8.5	0.61	0	1	1	2
LCT-EEN 257	5	9	5	5	1	0	230	95	0.41	19	873	48	2.35	28.6	14.3	9.3	0.50	1	0	1	2
LCT-EEN 258	0	5	5	7	1	0	222	103	0.46	22	937	46	2.12	24.9	15.1	8.5	0.60	1	1	0	2
LCT-EEN 269	0	5	5	5	1	0	148	92	0.62	16	527	32	2.00	25.2	12.5	8.9	0.49	1	1	0	2
LCT-EEN 271	0	5	5	5	1	0	183	112	0.61	22	863	30	1.76	21.9	13.3	9.4	0.60	1	0	0	1
LCT-EEN 280	0	5	5	5	1	0	178	95	0.53	16	675	36	2.00	23.4	13.0	9.0	0.55	1	1	1	2
LCT-EEN 281	3	5	7	7	1	0	174	89	0.51	16	489	24	1.92	23.1	13.6	9.6	0.58	0	1	1	2
LCT-EEN 288	0	5	7	5	1	0	175	104	0.59	17	477	27	2.29	24.1	14.0	9.8	0.58	1	0	0	1
LCT-EEN 295	3	9	5	5	1	0	173	79	0.45	13	352	40	1.34	21.2	11.6	8.8	0.54	1	0	0	1
LCT-EEN 296	3	5	5	5	1	0	165	88	0.53	11	398	38	1.75	24.3	13.0	8.7	0.53	1	0	0	1
LCT-EEN 300	0	9	0	3	0	0	180	97	0.53	15	497	24	2.67	26.0	14.3	11.1	0.55	1	0	0	1
LCT-EEN 302	0	9	7	5	1	0	175	92	0.52	12	400	38	2.09	23.7	15.0	9.5	0.63	1	0	0	1
LCT-EEN 306	0	1	5	5	1	0	143	88	0.61	13	506	-1	1.70	24.8	13.5	8.0	0.54	1	0	0	1
LCT-EEN 313	0	5	5	5	1	0	165	98	0.59	22	585	12	3.25	32.1	14.2	11.2	0.44	1	0	0	1
LCT-EEN 320	0	5	5	5	1	0	155	85	0.54	16	448	15	2.40	27.1	14.1	10.8	0.52	1	0	0	1
LCT-EEN 321	3	9	5	5	1	0	185	96	0.51	15	527	30	1.91	22.9	14.0	9.2	0.61	1	1	1	1
LCT-EEN 322	3	5	5	5	1	0	173	90	0.52	16	505	34	1.73	23.1	12.4	9.0	0.53	0	0	1	1
LCT-EEN 323	5	5	5	5	1	0	218	97	0.44	19	697	38	2.14	27.4	14.1	8.8	0.51	1	1	0	1
LCT-EEN 324	3	5	5	5	1	0	159	83	0.52	16	395	29	1.25	21.1	11.4	8.0	0.54	1	0	1	1
LCT-EEN 325	0	9	5	5	1	0	208	87	0.41	18	541	27	2.13	22.2	13.7	11.3	0.61	1	0	0	1
LCT-EEN 326	0	1	5	5	1	3	223	123	0.55	25	1182	40	1.53	21.5	12.7	9.1	0.59	1	0	1	1
LCT-EEN 328	0	5	5	5	1	0	162	97	0.59	14	527	26	2.48	26.1	14.6	10.1	0.55	1	0	0	1
LCT-EEN 329	3	9	5	5	1	0	145	87	0.60	14	346	13	2.36	26.8	13.0	10.3	0.48	1	0	0	1
LCT-EEN 330	0	5	5	5	1	0	135	78	0.57	13	280	9	3.28	27.3	15.5	12.5	0.56	1	0	0	1
LCT-EEN 331	3	5	5	7	1	0	126	75	0.59	15	315	18	1.86	22.2	14.9	9.9	0.67	1	0	0	1
LCT-EEN 332	0	1	5	5	1	0	170	95	0.55	18	645	35	2.80	26.9	15.9	10.2	0.59	1	0	0	1
LCT-EEN 335	0	5	5	3	1	0	165	86	0.52	11	407	39	1.86	23.8	13.7	9.2	0.57	1	0	0	1
LCT-EEN 336	-1	-1	-1	-1	-1	-1	-1	-1	-1.00	-1	-1	-1	1.33	21.3	12.6	8.5	0.59	1	1	0	1
LCT-EEN 337	0	5	7	5	1	0	210	106	0.50	19	830	38	2.40	24.2	14.6	9.7	0.60	1	0	0	1
LCT-EEN 338	0	5	5	5	1	0	155	90	0.58	15	505	43	1.85	23.7	14.1	7.5	0.59	1	0	0	1
LCT-EEN 339	3	9	5	5	1	0	190	99	0.52	17	656	40	2.18	24.5	14.0	9.3	0.57	0	1	0	1
LCT-EEN 340	0	9	5	5	1	0	145	86	0.59	11	328	27	1.90	25.5	13.2	8.0	0.51	1	0	0	1
LCT-EEN 341	0	9	5	3	1	0	148	77	0.52	10	296	34	1.65	22.1	13.2	8.1	0.59	1	0	0	1
LCT-EEN 342	0	1	5	5	1	0	160	90	0.56	20	486	21	2.50	25.1	13.8	11.7	0.54	1	0	0	1
LCT-EEN 343	0	9	5	5	1	0	155	76	0.49	10	313	41	1.30	21.2	12.9	7.1	0.60	1	0	0	1
LCT-EEN 344	0	5	5	5	1	0	170	97	0.57	18	535	23	2.32	24.8	14.2	10.7	0.57	1	0	0	1
LCT-EEN 345	3	9	5	5	1	0	165	73	0.44	10	279	16	2.43	25.7	13.6	10.6	0.52	1	0	0	1

Collection		POD											BEAN									Data
Collection (1)		Bas (2)	Apx (3)	Sur (4)	Fur (5)	Prd (6)	Pig (7)	Len (8)	Dia (9)	D:L (10)	Thk (11)	Wgt (12)	Num (13)	Wgt (14)	Len (15)	Wid (16)	Thk (17)	W:L (18)	Wht (19)	Ltp (20)	Dkp (21)	From (22)
LCT-EEN	346	0	9	5	3	1	0	152	88	0.57	10	368	41	1.98	26.8	14.7	8.1	0.54	1	0	0	1
LCT-EEN	347	3	5	5	5	1	0	132	81	0.61	12	253	14	2.31	25.8	14.6	11.8	0.56	1	1	0	1
LCT-EEN	348	0	5	5	5	1	0	135	86	0.63	17	349	18	1.91	27.2	14.2	9.3	0.52	1	0	0	1
LCT-EEN	349	0	5	0	5	1	0	150	89	0.59	16	397	13	2.64	26.6	14.7	11.2	0.55	0	1	0	1
LCT-EEN	350	0	9	7	5	1	0	172	87	0.50	16	353	15	2.65	25.7	14.7	11.5	0.57	0	1	0	1
LCT-EEN	351	3	5	5	5	1	0	135	88	0.65	11	343	25	2.26	26.1	15.3	9.6	0.58	1	1	0	1
LCT-EEN	352	0	9	5	5	1	0	180	88	0.48	10	438	42	2.14	27.3	15.5	8.6	0.56	1	0	0	1
LCT-EEN	353	3	1	7	7	1	0	140	90	0.64	18	383	11	2.49	24.2	14.9	12.6	0.61	1	0	0	1
LCT-EEN	354	0	5	5	3	1	0	145	91	0.62	14	404	26	2.49	26.7	15.8	9.3	0.59	1	0	0	1
LCT-EEN	355	0	9	5	5	1	0	205	106	0.51	19	802	37	2.36	25.2	14.2	9.8	0.56	1	0	0	1
LCT-EEN	356	0	5	5	5	1	0	130	88	0.67	15	355	37	1.54	24.4	13.8	7.2	0.56	1	0	0	1
LCT-EEN	357	0	5	5	5	1	0	175	109	0.62	18	725	41	2.35	26.7	15.3	9.9	0.57	1	0	0	1
LCT-EEN	358	0	9	7	5	1	0	152	88	0.57	14	373	19	2.45	27.2	14.8	10.9	0.54	1	1	0	1
LCT-EEN	359	3	5	5	5	1	0	148	99	0.66	18	464	15	2.91	28.6	14.8	11.4	0.51	1	0	0	1
LCT-EEN	360	3	5	5	5	1	0	168	82	0.48	11	357	35	1.85	24.1	13.9	8.7	0.57	1	0	0	1
LCT-EEN	361	0	9	7	5	1	0	150	92	0.61	16	365	18	3.04	30.4	17.2	9.7	0.56	1	0	0	1
LCT-EEN	362	5	5	5	5	1	0	125	66	0.52	9	200	42	0.80	19.7	9.1	5.4	0.46	0	1	1	2
LCT-EEN	364	5	5	5	5	1	0	122	58	0.47	9	165	19	0.80	18.6	8.6	6.9	0.46	0	0	1	2
LCT-EEN	367	5	5	5	5	1	0	139	61	0.43	11	314	32	1.09	22.6	10.7	7.4	0.47	0	0	1	2
LCT-EEN	369	5	0	5	5	1	0	141	68	0.48	9	278	37	0.90	18.9	9.4	7.1	0.49	0	0	1	2
LCT-EEN	371	3	7	5	5	1	0	137	58	0.42	14	325	37	0.75	18.0	8.8	7.1	0.48	0	0	1	2
LCT-EEN	372	3	5	5	5	1	0	180	110	0.61	18	752	39	2.03	28.4	14.5	8.0	0.51	1	0	0	1
LCT-EEN	391	5	1	5	5	1	0	110	85	0.77	19	309	7	2.00	24.8	15.8	12.2	0.63	1	0	0	1
LCT-EEN	393	3	5	5	5	1	0	154	97	0.62	16	516	31	2.31	26.8	14.9	8.7	0.55	0	1	1	1
LCT-EEN	403	3	9	7	7	1	0	160	75	0.46	15	311	29	1.10	18.4	9.8	7.9	0.53	0	1	0	1
LCT-EEN	404	3	5	5	5	1	0	150	72	0.48	11	302	34	1.15	22.3	10.5	6.9	0.47	1	0	1	1
LCT-EEN	405	3	5	5	5	1	0	150	65	0.43	14	264	19	1.06	20.4	9.9	8.0	0.48	0	1	0	1
LCT-EEN	408	3	5	0	3	-1	0	140	65	0.46	11	-1	-1	-1.00	-1.0	-1.0	-1.0	-1.00	0	1	1	1
LCT-EEN	418	-1	-1	-1	-1	-1	-1	-1	-1	-1.00	-1	-1	-1	1.49	21.5	14.0	7.9	0.65	1	0	0	1
LCT-EEN	424	0	9	7	7	1	0	255	125	0.49	24	1385	35	2.90	28.7	15.8	9.9	0.55	1	0	1	1
LCT-EEN	430	0	5	5	5	1	0	215	104	0.48	20	883	34	2.68	29.3	14.4	10.1	0.49	1	0	1	1
EBC	5	3	5	0	3	1	0	122	60	0.49	7	165	29	0.71	19.9	9.0	7.6	0.45	0	1	0	1
EBC	6	5	5	0	3	1	0	135	64	0.47	9	170	35	0.77	20.1	8.7	7.2	0.43	0	1	0	1
EBC	8	3	5	0	3	1	0	135	62	0.45	9	-1	34	0.77	19.7	9.0	7.0	0.45	-1	-1	-1	1
EBC	9	3	1	0	3	1	0	124	67	0.54	9	185	36	1.00	21.1	10.5	7.7	0.49	0	1	1	1
EBC	10	3	5	5	3	1	0	177	67	0.37	10	280	38	1.03	21.2	9.9	8.1	0.46	0	1	1	1
EBC	11	3	5	0	3	1	0	118	59	0.50	6	-1	28	0.81	19.4	10.0	7.3	0.51	0	1	1	1
EBC	29	0	5	0	3	1	0	120	62	0.51	8	150	32	1.05	21.4	10.4	8.0	0.48	0	0	1	1
EBC	30	3	5	5	3	1	0	144	68	0.47	11	215	40	0.64	19.4	9.2	6.6	0.47	0	1	1	1
EBC	48	0	5	0	3	1	0	147	66	0.44	10	230	38	0.91	19.9	9.8	8.0	0.49	0	1	0	1
EBC	49	3	5	5	3	1	0	145	68	0.46	11	-1	35	0.58	17.7	8.7	6.8	0.49	0	1	0	1
EBC	56	0	5	0	3	1	0	136	58	0.42	10	-1	41	0.60	19.1	8.7	6.5	0.45	0	1	0	1
EBC	58	5	5	0	3	1	0	144	67	0.46	8	185	38	0.95	21.1	10.2	7.4	0.48	0	1	0	1
EBC	76	3	5	5	5	1	0	265	100	0.37	20	1050	50	2.28	26.7	13.6	10.4	0.50	0	0	1	1
EBC	77	3	5	5	5	1	0	247	84	0.34	20	825	23	2.62	25.5	10.6	8.9	0.41	0	1	0	1
EBC	78	5	9	5	5	1	0	175	62	0.35	11	250	20	1.40	22.2	11.8	9.8	0.53	0	1	1	1
EBC	79	3	5	5	5	1	0	238	90	0.37	19	875	49	1.57	25.8	12.4	8.9	0.48	0	1	0	1
EBC	84	5	5	5	5	1	0	180	77	0.42	12	400	39	1.45	24.7	10.0	8.1	0.40	0	1	0	1
EBC	85	3	9	0	3	1	0	171	67	0.39	10	300	39	0.96	20.1	10.1	8.1	0.50	0	1	0	1
EBC	86	3	5	5	3	1	0	147	60	0.40	7	185	34	0.96	20.7	9.0	7.7	0.43	0	1	0	1
EBC	91	5	5	0	3	1	0	104	58	0.55	8	120	24	0.94	18.8	10.1	8.5	0.53	0	1	0	1
EBC	100	3	5	0	3	1	0	139	65	0.46	10	200	16	1.63	25.0	10.3	8.2	0.41	0	1	0	1
EBC	101	3	5	0	3	1	0	268	106	0.39	23	1375	54	2.21	28.3	13.4	10.0	0.47	0	1	1	1
EBC	113	5	5	5	5	1	0	125	65	0.52	14	215	9	-1.00	-1.0	-1.0	-1.0	-1.00	0	1	0	1
EBC	121	3	5	0	3	1	0	223	90	0.40	20	900	-1	2.20	24.4	11.3	9.3	0.46	0	0	1	1
EBC	123	-1	-1	-1	-1	-1	-1	185	72	0.38	14	-1	-1	1.43	25.3	11.0	8.7	0.43	-1	-1	-1	1
EBC	125	3	5	0	3	1	0	200	86	0.43	15	600	35	1.89	24.8	12.3	9.8	0.49	0	1	1	1

APPENDIX 5 (continued)

Collection (1)		POD Bas (2)	Apx (3)	Sur (4)	Fur (5)	Prd (6)	Pig (7)	Len (8)	Dia (9)	D:L (10)	Thk (11)	Wgt (12)	BEAN Num (13)	Wgt (14)	Len (15)	Wid (16)	Thk (17)	W:L (18)	Wht (19)	Ltp (20)	Dkp (21)	Data From (22)
EBC	126	0	5	3	3	1	0	207	81	0.39	11	575	48	1.39	24.4	10.7	7.3	0.43	0	1	0	1
EBC	135	0	5	0	5	1	0	224	94	0.41	20	850	47	1.49	24.1	12.4	8.7	0.51	0	1	1	1
EBC	138	3	1	5	5	1	0	172	90	0.52	20	650	20	2.11	26.2	12.6	8.7	0.48	0	0	1	1
EBC	141	5	5	5	3	1	0	154	63	0.40	9	220	-1	-1.00	-1.0	-1.0	-1.0	-1.00	-1	-1	-1	1
EBC	142	0	5	0	3	1	0	172	99	0.57	22	825	28	2.15	26.7	14.0	8.7	0.52	0	1	1	1
EBC	145	3	5	0	3	1	0	196	84	0.42	21	625	-1	1.47	22.9	12.3	8.9	0.53	-1	-1	-1	1
EBC	147	0	5	5	3	1	0	163	81	0.49	18	500	31	-1.00	-1.0	-1.0	-1.0	-1.00	0	1	1	1
EBC	148	3	5	5	3	1	0	203	95	0.46	16	750	43	2.36	27.1	13.8	9.1	0.50	0	0	1	1

Notes:

1. See Appendix 4 for explanation of descriptors and descriptor states.

APPENDIX 6: SUMMARY OF YIELD AND POD INFECTION DATA

LCT- EEN (1)	PROP METH (2)	PLANT YEAR (3)	NUM.OF TREES (4)	PODS/ TREE (5)	YIELD/ TREE (6)	POD INDEX (7)	% PODS INFECTED WB (8)	MON (9)
1	S	81	10	3	0.00	-1.00	67	32
2	I	81	1	40	0.14	14.28	55	40
4	S	81	10	8	0.07	38.46	55	9
5	S	81	10	23	0.18	13.81	42	47
6	S	81	10	68	0.77	21.00	46	29
10	S	81	10	59	0.50	20.00	57	25
11	S	81	10	10	0.00	-1.00	65	34
14	S	81	8	10	0.04	17.12	58	34
15	S	81	8	32	0.32	17.36	56	26
18	S	81	8	16	0.08	16.23	62	28
19	S	81	8	18	0.11	14.79	62	28
20	S	81	9	25	0.15	17.85	71	17
21	S	81	9	19	0.09	20.00	69	20
22	S	81	9	43	0.02	16.55	80	11
23	S	81	10	40	0.25	25.77	66	17
24	S	81	8	25	0.18	20.83	68	16
25	S	81	1	4	0.00	-1.00	100	0
26	S	81	3	55	0.44	14.88	74	13
27	S	81	4	88	1.84	20.66	46	10
28	S	81	1	20	0.46	12.95	65	5
29	S	81	3	39	0.03	17.85	65	33
31	I	81	3	55	0.04	14.28	31	66
33	I	81	3	4	0.00	-1.00	84	15
36	I	81	2	6	0.11	21.18	58	0
37	I	81	5	10	0.13	17.85	67	9
38	I	81	1	52	0.88	14.70	63	11
44	S	81	7	6	0.05	22.52	64	16
46	I	81	4	175	3.69	32.05	26	6
48	S	81	9	8	0.02	26.59	77	13
49	I	81	1	24	0.07	40.98	54	33
52	I	81	2	2	0.00	-1.00	60	40
57	I	81	1	43	0.06	33.33	51	44
58	S	81	10	6	0.02	16.66	86	6
59	S	81	10	40	0.04	14.04	64	34
60	I	81	5	38	0.55	18.51	38	35
61	S	81	7	27	0.18	20.66	67	18
62	S	81	10	60	0.69	24.27	50	21
63	I	81	2	0	0.00	-1.00	0	100
64	S	81	4	6	0.02	20.83	76	16
65	I	81	4	14	0.01	41.66	50	46
65	S	81	8	12	0.07	19.37	70	18
66	S	81	9	16	0.15	17.85	58	24
67	S	81	10	19	0.16	32.05	59	13
68	I	81	5	34	0.40	23.14	62	10
68	S	81	5	21	0.18	26.31	67	10
69	S	81	3	37	0.57	14.04	56	21
70	S	81	6	9	0.11	14.70	53	28
71	S	81	8	4	0.02	35.71	68	14
72	S	81	10	9	0.07	15.24	76	11

APPENDIX 6 (continued)

LCT-EEN (1)	PROP METH (2)	PLANT YEAR (3)	NUM.OF TREES (4)	PODS/ TREE (5)	YIELD/ TREE (6)	POD INDEX (7)	% PODS INFECTED WB (8)	MON (9)
73	I	81	3	46	1.37	17.73	46	1
74	I	81	5	35	0.44	23.14	56	13
74	S	81	7	12	0.03	23.14	42	2
76	S	81	6	16	0.42	17.98	48	4
77	S	81	8	27	0.72	17.73	45	7
78	S	81	7	4	0.13	18.79	25	16
79	S	81	10	4	0.04	21.18	53	23
80	I	81	5	36	0.06	20.49	59	36
81	I	81	5	17	0.30	16.66	57	13
82	S	81	10	1	0.00	32.89	83	0
83	S	81	10	22	0.68	20.16	35	4
84	S	81	9	3	0.20	24.50	32	0
85	S	81	10	1	0.05	22.52	33	0
86	S	81	6	5	0.27	13.81	22	3
87	S	81	8	4	0.09	18.24	51	8
88	S	81	7	7	0.14	12.50	57	16
89	S	81	8	6	0.17	19.37	38	9
90	S	81	9	12	0.39	20.32	32	1
91	I	81	5	19	0.19	20.66	77	2
92	S	81	9	11	0.38	18.38	35	4
93	S	81	9	6	0.13	20.00	53	1
97	I	81	1	60	0.29	23.80	51	36
101	S	82	10	29	0.30	18.51	51	28
103	I	82	1	23	0.26	18.93	26	52
107	I	82	3	25	0.18	26.04	80	1
108	I	81	3	9	0.24	14.70	51	7
109	S	82	10	10	0.14	28.08	47	15
113	S	82	3	6	0.04	21.55	61	22
115	S	82	9	2	0.08	19.37	18	18
120	I	81	1	18	0.00	-1.00	94	5
121	I	81	1	1	0.00	-1.00	0	100
122	I	81	1	4	0.14	13.51	50	0
123	I	81	2	19	0.10	23.14	74	12
125	I	81	4	51	0.21	22.93	62	28
126	I	81	1	52	0.36	16.66	38	50
127	S	82	10	11	0.43	21.92	19	0
130	I	81	3	22	0.07	26.88	50	40
130	S	81	10	6	0.09	22.12	68	2
132	S	82	10	13	0.21	15.72	44	30
134	S	82	5	20	0.11	20.83	46	42
136	S	82	10	6	0.14	20.66	39	12
137	I	81	1	1	0.00	-1.00	100	0
142	S	82	5	2	0.01	25.00	80	0
144	I	81	2	38	0.00	-1.00	39	60
145	I	81	1	20	0.06	15.62	50	45
145	S	81	1	27	0.23	25.51	70	7
146	I	82	1	29	0.07	41.66	68	20
148	I	82	2	46	0.76	30.86	37	11
149	I	82	3	14	0.06	32.05	53	32

APPENDIX 6 (continued)

LCT-EEN (1)	PROP METH (2)	PLANT YEAR (3)	NUM.OF TREES (4)	PODS/ TREE (5)	YIELD/ TREE (6)	POD INDEX (7)	% PODS INFECTED WB (8)	MON (9)
150	I	81	3	25	0.04	31.25	60	34
151	I	81	5	36	0.40	14.70	46	36
152	I	81	5	33	0.19	18.93	75	13
154	I	81	5	7	0.03	15.33	63	27
155	I	81	5	6	0.00	31.25	44	52
156	I	81	5	15	0.02	16.66	45	51
157	I	81	4	62	0.82	11.57	48	36
158	I	81	1	65	0.34	17.48	46	44
159	S	82	7	9	0.00	83.33	70	23
160	S	82	9	33	0.39	11.90	35	50
162	I	82	1	37	0.72	17.85	48	16
162	S	82	9	7	0.04	21.55	63	23
163	I	82	3	13	0.40	20.49	26	12
164	I	82	2	1	0.00	-1.00	100	0
165	I	82	3	2	0.06	14.45	50	0
166	I	82	3	11	0.15	12.75	74	8
169	I	82	4	13	0.17	11.79	77	7
172	I	82	5	9	0.05	19.23	69	19
175	I	82	2	6	0.03	26.31	46	38
178	I	82	2	116	1.22	26.04	41	31
179	I	82	3	13	0.26	21.73	41	17
181	I	82	5	5	0.17	17.60	42	0
182	S	82	10	40	0.58	39.06	36	7
185	I	82	5	9	0.33	18.11	34	4
187	I	82	1	11	0.14	13.88	72	9
188	I	82	1	29	0.40	22.52	62	6
189	I	82	1	87	0.72	39.06	55	12
196	S	82	7	20	0.05	46.29	33	54
199	S	82	8	21	0.39	43.10	19	1
201	S	82	5	23	0.55	19.23	47	7
202	S	82	10	30	0.81	13.96	35	27
203	S	82	3	17	0.06	25.00	65	25
205	S	82	6	16	0.27	23.36	45	14
212	S	82	10	11	0.25	22.93	40	7
214	S	82	4	32	1.00	18.93	29	12
215	S	82	5	32	0.38	19.23	43	33
217	I	82	4	0	0.00	-1.00	100	0
218	I	82	5	4	0.08	11.68	65	13
219	I	82	5	8	0.04	16.12	80	9
220	I	82	4	4	0.01	22.72	70	23
221	I	82	5	0	0.00	-1.00	100	0
222	I	82	4	27	0.03	25.00	79	18
223	I	82	4	28	0.21	14.12	50	39
227	I	82	1	9	0.00	-1.00	100	0
228	I	82	2	40	0.02	20.83	66	32
231	I	82	3	6	0.00	-1.00	70	30
232	I	82	3	8	0.08	15.62	64	20
234	I	82	4	20	0.13	18.38	58	29
236	I	82	2	7	0.06	14.70	66	20

APPENDIX 6 (continued)

LCT-EEN (1)	PROP METH (2)	PLANT YEAR (3)	NUM.OF TREES (4)	PODS/ TREE (5)	YIELD/ TREE (6)	POD INDEX (7)	% PODS INFECTED WB (8)	MON (9)
237	I	82	2	30	0.20	24.75	36	46
238	I	82	1	4	0.04	25.00	25	50
241	I	82	2	23	0.03	13.15	27	70
241	S	82	2	15	0.00	-1.00	23	76
242	S	82	8	5	0.05	18.11	61	21
244	S	82	8	12	0.05	14.04	52	41
246	S	82	10	26	0.04	21.73	55	41
248	S	82	9	20	0.03	33.78	70	23
249	I	82	3	45	0.09	17.85	44	51
250	I	82	1	26	0.31	15.82	65	15
251	I	82	1	78	0.18	16.33	41	55
253	I	82	3	59	0.00	-1.00	44	55
254	I	82	4	42	0.02	18.51	60	38
255	I	82	1	143	0.82	14.53	51	40
257	I	82	5	9	0.01	13.15	45	52
258	I	82	2	63	0.20	15.06	50	45
259	I	82	1	1	0.00	-1.00	100	0
264	I	82	2	5	0.00	-1.00	90	10
267	I	82	1	18	0.00	-1.00	44	55
269	I	82	1	30	0.37	21.36	40	33
271	S	82	5	5	0.00	22.72	55	41
278	I	82	1	41	0.15	13.15	75	19
281	I	82	2	45	0.09	21.73	56	39
282	I	82	3	10	0.17	17.24	61	9
283	I	82	4	9	0.13	19.84	48	23
288	S	82	10	15	0.15	21.36	52	26
295	S	82	9	5	0.05	17.60	76	6
296	S	82	10	1	0.01	10.63	58	29
300	I	82	3	7	0.03	19.23	57	33
300	S	82	9	1	0.00	-1.00	57	42
302	S	83	9	4	0.00	25.00	40	57
306	S	82	9	6	0.02	12.75	56	38
313	S	83	9	3	0.00	83.33	72	20
320	S	82	10	12	0.19	18.65	57	12
321	S	82	10	16	0.11	28.40	55	24
323	S	82	10	30	0.39	14.79	64	16
324	S	82	10	23	0.25	19.68	56	22
325	S	82	8	84	0.19	15.52	43	52
326	S	82	8	16	0.01	15.15	22	76
328	S	83	8	3	0.11	16.44	29	22
329	S	83	4	0	0.02	10.86	33	33
331	S	83	3	5	0.09	13.88	53	20
332	S	83	10	0	0.00	-1.00	50	50
333	I	83	5	5	0.03	12.82	68	24
335	S	83	9	3	0.13	15.43	20	13
336	S	83	9	0	0.00	14.70	50	0
337	S	83	9	0	0.00	23.58	25	0
340	S	83	10	0	0.00	13.88	66	0
341	S	83	10	0	0.00	-1.00	100	0

APPENDIX 6 (continued)

LCT-EEN (1)	PROP METH (2)	PLANT YEAR (3)	NUM.OF TREES (4)	PODS/ TREE (5)	YIELD/ TREE (6)	POD INDEX (7)	% PODS INFECTED WB (8)	MON (9)
342	S	83	8	6	0.06	13.08	55	31
344	S	83	10	0	0.01	10.00	66	16
345	S	83	8	0	0.00	-1.00	100	0
346	S	83	9	0	0.00	-1.00	75	25
347	S	83	9	1	0.00	22.12	38	15
349	S	83	9	2	0.06	15.62	52	0
350	S	83	6	0	0.01	16.66	60	20
351	S	83	8	2	0.00	55.55	45	45
356	S	83	9	0	0.00	-1.00	100	0
357	S	83	8	0	0.00	-1.00	100	0
359	S	83	7	0	0.01	10.00	50	0
360	S	83	9	0	0.01	19.84	50	0
361	S	83	7	1	0.02	19.84	62	0
362	I	83	1	8	0.23	26.04	25	0
364	I	83	3	6	0.14	30.12	15	15
367	I	83	5	7	0.12	25.00	48	10
369	I	83	5	4	0.02	40.98	72	0
371	I	83	5	1	0.02	19.23	66	11
373	I	83	2	9	0.00	-1.00	33	66

NOTES:

i) column headings (see Section 7.1 for full explanation):
- (1) Collection number (all with prefix LCT-EEN)
- (2) Propogation method: S = seed I = budwood
- (3) Planting year: 1981, 1982 or 1983
- (4) Number of trees (excluding non-producing replacement trees)
- (5) Pods/tree: total healthy + diseased pods divided by (4)
- (6) Yield/tree: estimated yield of dry beans per tree
- (7) Pod index: estimated number of pods for 1 kg of dry beans
- (8),(9) Percentage of pods with witches' broom and Moniliophthora

ii) data from period January 1984 - June 1986

iii) missing values coded as -1

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