Newsletter

ISSUE NO. 2 MARCH 1996

IN THIS ISSUE

From the Editor's Desk:

The Acting Committee for the International Group for Genetic Improvement of Cocoa (INGENIC) wishes to thank its readership for the enthusiastic response to the first issue (July 1995) of its biannual Newsletter. We hope that your interest will be translated into contributory notes for future issues.

This issue focuses on preparations for *INGENIC's Second International Workshop* on the **Role of Disease Resistance in Cocoa Varietal Improvement**, which will be held in November, 1996 and will coincide with the *12th International Cocoa Research Conference* in Bahia, Brazil. Consequently, the Newsletter will be sent to pathologists as well as breeders in preparation for the Workshop. The announcements for both scientific meetings have already been circulated by ICCO.

On pages 2-4 of this issue, The Chairman of INGENIC has outlined the objectives and format for reviews to be undertaken prior to the INGENIC Workshop. One of the major concerns of the international cocoa community is finding effective methods to address the problems of diseases and pests. Consequently, we look forward to your support in making the November Workshop a success.

This year's INGENIC activities (described in *INGENIC NEWS*) coincide with those of international organizations seeking to improve the conservation and use of some of the world's genetic resources. In June, the *Fourth International Technical Conference on Plant Genetic Resources*, organized by the UN Food and Agriculture Organization in close cooperation with IPGRI and other partners, will be held in Leipzig, Germany. A "Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture" will be considered for formal adoption.

In this issue of INGENIC Newsletter, the Acting INGENIC Committee has commented on a proposal for international action to promote **Conservation and Utilization of Cacao Germplasm**. This initiative seems timely, and should be encouraging to all those charged with the responsibility of protecting, characterizing and utilizing cacao genetic resources.

An objective of this newsletter is to promote an ongoing dialogue amongst the readership, in a relaxed and informal manner. As stated in *Issue* **No. 1**, this Newsletter will feature brief communications on matters related to cocoa breeding strategies and methodologies and novel results on breeding and genetic studies, germplasm evaluation, ideas for collaborative research and news on upcoming events and on supportive institutions. We also welcome responses or reactions to articles featured in previous issues.

The contributions made by various cocoa scientists, institutes and organisations to this issue are appreciated. It must be agreed that these articles help to foster global links in the international community, which may be difficult to achieve otherwise. We look forward to future submissions from these and many other sources.

The Acting INGENIC Committee would also like to thank various organizations for their generous financial support. We are grateful to ACRI for assistance with running costs, BCCCA and CAOBISCO for financing the publication and distribution of the *Proceedings* of the first INGENIC Workshop and for their contributions towards those of the second Workshop, and the Dutch Ministry of Foreign Affairs, CTA and FAO for their support for the upcoming Workshop and the Review project.

Frances Bekele

INGENIC News

We are pleased to report that we are making good progress in raising support for INGENIC and in getting a number of our planned projects off the ground. We would like to thank all those of you who have expressed your support for INGENIC and its planned activities, many of which are discussed in more detail later in this Newsletter. We are grateful to the American Cocoa Research Institute (ACRI) for making a contribution towards our running costs, including the production of the first and second issues of the INGENIC Newsletter. Our mailing list now contains over 220 addresses and we hope that our efforts to keep this list up to date ensure that the INGENIC Newsletter is sent to all those interested in the genetic improvement of cocoa.

The *Proceedings* of INGENIC's First International Workshop on Cocoa Breeding Strategies, Kuala Lumpur, 1994 have now been published and distributed to 134 organizations, thanks to the financial support of the Biscuit, Cake, Chocolate and Confectionery Alliance of the U.K. (BCCCA) and CAOBISCO. If you are interested in this publication and have not yet received a copy, please apply to the INGENIC secretariat (see address below). Due to a printing error, the front page containing the publishers information was accidentally omitted from the Proceedings. If you have already received a copy of the *Proceedings*, please affix the enclosed sticky label to the inside of the front cover.

INGENIC's Second International Workshop on the **Role of Disease Resistance in Cocoa Varietal Improvement** will be held in November, 1996 to coincide with the *12th International Cocoa Research Conference* in Bahia, Brazil. Last year, we contacted cocoa breeders and pathologists to see if they supported the idea of an independent review of the subject which could form a keynote paper for the Workshop. Following a strong positive response, we have drawn up a project proposal and have been seeking financial support from a number of organizations. We are pleased to announce that we have been offered financial support from FAO and from the Dutch Ministry of Foreign Affairs which has allowed us to commission the review. Full details of this project are given later in this Newsletter.

We are making progress with the INGENIC initiative to produce colour photographs as an aid to the identification of mislabelled germplasm, thanks to BCCCA funding for a pilot project. The work, which is described in detail later in this Newsletter, is currently focused on establishing the methodology for producing photographs which will allow breeders and genebank managers to pick out gross mislabelling errors within their germplasm collections. If the photographs prove useful, we hope to be able to distribute them to germplasm users, either as prints or as part of the ICGD. We look forward to hearing from anyone who has experience in this area.

The other initiative mentioned in the first issue of the INGENIC Newsletter was the establishment of an international clone trial to evaluate the performance of a number of genotypes under contrasting environmental conditions. Such a trial forms a central part of the project proposal being developed for submission to the Common Fund for Commodities (see below). We have received a number of replies expressing interest in taking part in such a trial and asking for further details, such as where it will be held, whether they can participate and how they can get the clones. As the answers are of general interest, here they are:

> the locations will be at the participants choice,
> anyone who wishes to can contribute sites,
> the clones can be obtained from The University of Reading Intermediate Cocoa Quarantine Facility(see article later in this Newsletter).

The International Plant Genetic Resources Institute (IPGRI), in conjunction with a number of collaborating institutions, has been developing a project proposal entitled "Cacao Germplasm Conservation and Utilization" to be submitted by the International Cocoa Organization (ICCO) to the UN Common Fund for Commodities. INGENIC contacted a number of cocoa breeders to find out their views on this project proposal. You will find an update on the status of this project and a note on some of the aspects of the proposal that INGENIC's members consider especially important later in this Newsletter. INGENIC fully supports the idea of an international effort toward more efficient conservation and utilization of cacao germplasm and we hope that the project proposal will be regarded favourably.

Please continue to send your suggestions for these and any other initiatives that you consider would benefit the cacao genetic resources and breeding effort to:

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Review on the Role of Disease Resistance in Cocoa Varietal Improvement

As part of the preparations for its second workshop, the INGENIC Acting Committee proposed that there should be an external review on the **Role of Disease Resistance in Cocoa Varietal Improvement**. Early in 1995, a letter was sent to cocoa breeders and pathologists seeking their opinions on this idea. In total, 22 replies were received (curiously most of these were from cocoa pathologists). All of the replies strongly supported the idea of an external review.

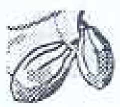
Some of the suggestions received regarding the review and organization of the workshop included:

- the expert should have extensive experience of quantitative disease resistance, preferably with some knowledge of cocoa;
- integrated disease management strategies and the physiology of disease resistance should be considered, as well as experimental designs to study disease resistance;

- the opportunity should be used to propose an international collaborative project on disease resistance;

- common criteria to be used in screening for disease resistance should be discussed.

The positive nature of the replies encouraged the INGENIC Committee to seek financing for this review from a number of potential funding agencies. We are pleased that FAO and the Dutch Ministry of Foreign Affairs (DGIS) have already offered financial support. Due to the broad nature of the review (see terms of reference hereafter) and to the financing arrangements, it was decided that the review should be separated into two parts, one dealing mainly with pathological aspects and the other mainly with breeding aspects. We are grateful to FAO for agreeing to finance the pathology review and this allowed us to commission Prof. J.C. Zadoks to undertake this work. Prof. Zadoks is an eminent specialist in plant disease resistance and epidemiology, recently retired from the Agricultural University of Wageningen, the Netherlands. Prof. Zadoks started his review by visiting CIRAD in France (28 November to 1 December 1995) and by holding discussions with several scientists in the United Kingdom (18 to 20 December). The review continued with visits to Ghana (11 to 17 January 1996) and to Trinidad and Ecuador (13 to 24 February). We would like to take this opportunity to thank everyone who participated in these discussions. Prof. Zadoks expects to produce an interim report of his findings by July 1996. INGENIC is about to organise the review on breeding aspects, and we hope that this will be initiated in April/May 1996. The external specialists (pathologist and breeder) will each present a keynote paper at the INGENIC workshop in November 1996. We hope that these papers, together with the other presentations made at the Workshop, will provide a sound basis for the discussions which will lead to recommendations as to the way forward for cocoa breeders, who are concerned with diseases.



Albertus B. ESKES
Chairman, Acting INGENIC Committee

External Review on the Role of Disease Resistance in Cocoa Breeding

Introduction

One or more diseases are considered to be limiting to cocoa cultivation in most producing countries, reducing yields or increasing costs or both. The principal among these are:

- Witches' Broom (*Crinipellis perniciosa*)
- Monilia (*Moniliophthora roreri*)
- Phytophthora pod rot and canker (*Phytophthora spp*)
- Vascular streak dieback (*Oncobasidium theobromae*)
- Cocoa swollen shoot virus.

Losses due to these diseases vary according to the environments, total losses may be estimated as 20 to 40% of the world cocoa crop, which represents roughly 500 million US dollars annually.

Over the last 50 years, efforts have been made to identify effective resistance to these diseases and to incorporate it into varieties for farmers' use. It is now generally considered that the effort has been largely ineffective, and that for most diseases sufficiently strong resistance still remains to be identified and incorporated. It has also been argued that the focus on disease resistance has been at the expense of the all-round performance of modern varieties.

A recent review of the literature on disease resistance in cacao suggested that there is no "immunity" to any disease, but that there is abundant variation for partial resistance to several of them, which could be built up in competent breeding programmes. There is improving understanding of how recurrent selection might be practised in cacao (for both the current seedling varieties and for the clones of the future). At the same time, more rapid early screening tests for resistance are being developed. This new knowledge prompts **re-assessment** of historic approaches to the search for and utilization of resistance.

As mentioned earlier, INGENIC is organizing a Workshop on breeding for disease resistance in cacao, to coincide with the **12th International Cocoa Research Conference.** The INGENIC committee requires an independent review of past resistance breeding and current approaches, and proposals for the future direction as a basis for the Workshop.

Scope of Work

The objective of the proposed review is to:

- analyse the role of resistance in the breeders' task of maximizing the profitability of cocoa production;
- analyse what is known about resistance and its inheritance, including resistance components;
- compare expected effectiveness of further surveys of genetic resources with strengthening of known resistance by adequate breeding methods;
- indicate long-term genetic strategies for utilization of resistance in variety improvement.

The focus will be on Witches' Broom, *Phytophthora* and *Monilia* as they are the most important diseases globally. The review may, however, show how the principles developed for these three diseases apply to the others, highlighting differences if and when they occur.

The review will entail:

- interpretation of published work;
- consultation with those having long-term knowledge of resistance to cacao diseases;
- discussion with currently active breeders and pathologists at the Workshop.

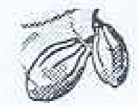
The reviewer(s) should be a breeder and/or pathologist with considerable experience in resistance to plant diseases. He should be able to analyse progress and constraints and to identify ways of more effective exploitation of resistance.

Terms of Reference

1. Analyse the expected contribution of disease resistance as a component of variety performance.
2. Review methods of evaluating resistance, taking into account the possible effects on yield and production costs, and its expression under field conditions.
3. Review the genetics and nature of resistance to cacao diseases, including host-pathogen interactions.
4. Describe the variation for resistance in cacao germplasm and make recommendations as to further searches for and distribution of germplasm with effective resistance. Recommend an appropriate division of effort between surveying the genepool for resistance and improving resistance by adequate breeding methods.
5. Make suggestions on the use of known resistance in practical cocoa breeding, with an indication of the time-frame, appropriate for each disease.
6. Discuss the role of networks in resistance breeding in cacao and make recommendations on collaborative efforts.
7. Indicate and prioritise other efforts required for support of resistance breeding, including biotechnology.

Reporting

1. A preliminary report, including a summary with cross references to the main report, should be submitted to the Chairman of INGENIC by August 1, 1996.
2. The report, or reports, will be presented at the Workshop as (a) main discussion paper(s).
3. The final reports will be revised in the light of discussion at the Workshop and submitted to the Chairman of INGENIC not later than February 1, 1997.



Common Fund for Commodities Project Proposal "Cacao Germplasm and Utilization" - Update

We are pleased to report that substantial progress is being made on the project proposal "Conservation and Utilization of Cacao germplasm" which is being developed by the International Plant Genetic Resources Institute (IPGRI) with the involvement of a number of collaborating institutions in cocoa producing and consuming countries for consideration by the UN Common Fund for Commodities (see INGENIC Newsletter **No. 1**, July 1995). After considerable debate, this project in outline (*i.e.* Part I) was cleared by ICCO acting as the International Commodity Body and forwarded to CFC for consideration. This project proposes increased international collaboration in the areas of germplasm conservation, evaluation and utilization (breeding) and would thus benefit many cocoa producing countries. Last November, Dr. Jan Engels of IPGRI circulated a copy of the Part I proposal, consisting of a general justification of the project, its objectives and an overall budget, to national and international cacao institutions and to organizations involved in cacao germplasm related activities, including INGENIC, and asked for their opinions on the proposal. We, in turn, have asked Dr. Basil Bartley, Dr. Tony Kennedy, Prof. Norman Simmonds, Dr. Jorge Soria and Dr. Hille Toxopeus for their views. Judging by the responses that Jan Engels and ourselves have received, there is very strong support for the proposed international project and it is clear that a large number of organizations are keen to participate in the initiative. IPGRI, in close collaboration with the participating countries and research institutes, is now preparing a more detailed Part II proposal, in line with the comments received from participating institutions and the Common Fund. This revision of the project will contain a detailed work plan and budget and will be submitted to ICCO for forwarding to the CFC ahead of the next Consultative Committee meeting later this year.

We would like to take this opportunity to highlight some aspects of the project proposal that INGENIC's members consider to be especially important:

General

An international effort toward more efficient conservation and utilization of germplasm is strongly supported.

Characterization and Evaluation

Characterization of germplasm for genetically stable traits is a significant step towards its efficient management and utilization. The ability to verify the identities of clones is important in any activity where information on their performance is to be exchanged, for example, results from multi-locational trials and evaluation studies.

Evaluation of germplasm is an integral part of any breeding programme and should be undertaken locally due to genotype x environment effects. International genebanks may play a role in characterization of germplasm as well as in assessing specific diversity in agronomic traits where these show little interaction with the environment.

Distribution of Germplasm

It is important that cacao germplasm can be distributed to breeders efficiently and in a way that minimizes the chances of introduction of foreign pests and diseases.

Training

There is a need for training in areas such as breeding techniques, genebank management and the development of technical skills such as vegetative propagation.

International Clone Trial

A multi-locational clone trial is strongly supported. Such trials might involve a comparision between international and local material and where possible, assess clonal performance at different planting densities.

International Hybrid Trials

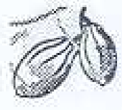
There is general support for some form of regionally coordinated hybrid trial since this would provide useful comparisons between the peformance of clones and their hybrids.

Breeding Activities

Coordinated activities aiming at population enhancement and breeding could give a much needed impetus to cocoa improvement worldwide. Due to the geographic specificity of major constraints to cocoa production, a regional approach would seem most appropriate.

We hope that the CFC will also respond positively towards the Part II proposal and that there will be an opportunity at the International Cocoa Research Conference in November for further discussions with all interested parties.

Readers are invited to send their comments to the Editor for inclusion in Newsletter **No. 3**. They are hereby advised that there will be room to publish at most the first 200 words of their letters!



The Acting Committee
INGENIC

Response to the note in the July 1995 Issue of the INGENIC Newsletter entitled *Cross-compatibility of self-incompatible Trinitarios* by Joe Pang Thau Yin and George Lockwood

Dalton Glendinning

Incompatibility alleles in cacao

I must correct two points in the letter from Joe Pang Thau Yin and George Lockwood in INGENIC Newsletter **No. 1** regarding the nomenclature for incompatibility alleles, which I put forward in the CRIG Report for 1963-1965. Firstly, I followed the Trinidad practice in using the letter 'I' for the Trinitario allele, and Knight & Rogers (1955) in using the number '1' for the dominant allele in Parinari 7 (PA 7). George Lockwood tells me that a typesetting error is involved here. Secondly, I did not use 'S' as a prefix for incompatibility alleles, but used letters for various alleles, including 'S' for one found in the T16 progeny.

That account was prepared hurriedly as I was about to leave Ghana and some misprints add to its obscurity. Glendinning (1967) is a simplified summary, though with one slip-up; for 'the incompatibility allele I found —' please read 'the incompatibility allele I, which is found —'.

Next, as regards 'unexpected' results :

1) I see no difficulty in accepting that additional incompatibility alleles may occur in the Trinitario population. As Trinitario seems to have its origin in hybridisation between wild cacao and introduced Criollo in the Orinoco Valley, such alleles could be of South American origin.

2) In Ghana, selfed progenies of a local Trinitario selection had been included in two major trials before an isolated 5-acre plot of the clone itself, apparently intended as a seed garden, came into flower and set very little crop. It was then found to be strongly self-incompatible, e.g. in one test only four of 300 self pollinations persisted for ten days, three of these falling off soon afterwards, and the last wilting after two months (see Glendinning, 1972). How, then, had those progenies been obtained? George Lockwood, in personal correspondence, tells of a finding that is virtually the opposite. Very good yields are being obtained in a large block of an Amazon clone which is known to bear an incompatibility allele. While Amazon alleles are not always fully effective (Glendinning, 1967), especially if mixed pollen is received (Lanaud *et al.*, 1988), I feel that there is something worthy of investigation here.

The E1 progenies were probably obtained on budded trees, and George's highly productive planting is budded, but the E1 clonal plot was planted with cuttings on their own roots. Although the Amazon clones in which Posnette (1945) detected incompatibility alleles were also probably budded, the possibility of there being rootstock-scion interactions seems worthy of consideration.

One may also note that Frank Cope (1962) found anomalies in some Trinitarios and Criollos which led him to suggest that further loci were involved. One of these selections was ICS 45 which, though classed as self-compatible, he suggested to be homozygous for the incompatibility allele, being rendered compatible by an allele at another locus. A progeny from open-pollination of ICS 45 was the only one found in Ghana to be entirely self- and cross-incompatible, all others segregating or being fully self-compatible. One wonders whether the ICS 45 anomaly may be due to some cause similar to the above, rather than to the operation of another locus. (I do not have Frank's paper at hand.)

References

Cope, F.W. (1962). *Heredity* **17** 157-182.

Glendinning, D.R. (1967). Incompatibility alleles of cocoa. *Nature* **213** 306.

Glendinning, D.R. (1972). Natural pollination of cocoa. *New Phytologist* **71** 719-729.

Knight, R. and Rogers, H.H. (1955). Incompatibility in *Theobroma cacao*. *Heredity* **9** 69.

Lanaud, C., Sounigo, O., Amefia, Y.K., Paulin, D., Lachenaud, Ph., and Clement, D. (1988). Nouvelles donnes sur le fonctionnement du systeme d'incompatibilité du cacaoyer et ses consequences pour la selection. *Proceedings* of the Tenth International Cocoa Research Conference, 573-580.

Posnette, A.F. (1945). *Tropical Agriculture* (Trinidad) **22** 184.

Please note: 1) The Project Proposal on pg. 4 is entitled "Cacao Germplasm Conservation and Utilization"
2) pg. 4 last paragraph, "performance of clones..."

UNIVERSITY OF READING/
LONDON COMMODITY EXCHANGE

ICGD

INTERNATIONAL COCOA GERMPLASM DATABASE

Information on germplasm is vital for its efficient management and utilization!

Please make sure that your institution does its best to help the international cacao germplasm effort by contributing your most recent information on clone characterization, evaluation and distribution to the ICGD so that everyone can make use of it.

A new printed version of the ICGD is now being produced so please send any new/updated data that you would like to appear in this book as soon as possible to:

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Networks for Germplasm Evaluation and Utilization

A Photographic Approach to recognising Mis-identifications

Rob Lockwood, Frances Bekele, Michelle End and Stephen Yow

Network approaches to the utilization of cacao germplasm depend on correct identification of the clones which the breeders receive. Errors abound, for example C.J.J. Van Hall described in his book on cocoa how, in 1888, an estate in Indonesia received from Venezuela seedlings which turned out to be Forastero and not the intended Criollo. The first clonal transfer of F.J. Pound's Upper Amazon material through The Royal Botanic Gardens at Kew in the early fifties was mixed (see the note on Don Edwards in this Newsletter) and even now we do not know what all the clones are. In the collection of about 210 imported clones at BAL Plantations Sdn. Bhd. in Sabah, more than 10% are known to be mis-identified.

Breeders already share information on the characterization of germplasm which is distributed as clones - for example the CATIE catalogues and the data on bean weights and cocoa butter content from BAL which are included in the International Cocoa Germplasm Database (ICGD). Similarly, evaluation data in the form of combining ability estimates can be shared when breeders publish their results. Obviously, sharing is useful only if the labelling of the clones is correct or at least agreed.

So far, errors in identification have been recognised by people like Basil Bartley, who have unique knowledge of cacao germplasm and a strong visual memory, and by reference to clone catalogues such as the CATIE one, which includes both descriptions and drawings of distinct morphological features like pods. However, Basil cannot inspect every collection in the world, nor can he be expected to recognise every clone from memory, and the CATIE catalogue covers only some of the clones at Turrialba. Breeders need a quick way of deciding whether they should be suspicious about identifications.

All the known errors at BAL are gross - the pod is the wrong colour or shape, or the flowers are pigmented when they should not be. From time to time, molecular profiles have been used to check identifications which were thought to be correct, and so far they have all been confirmed (within the limitations of the technique). Using a set of photographs from Papua New Guinea, we were able to see that one of BAL's nine Kerevat clones is wrongly identified, and we were able to sort out another which was mixed (our suspicions were aroused by deviations from parent - offspring regression!). The photographs had been prepared to help extension officers to identify the Trinitario clones which were issued to farmers as commercial planting material. We asked ourselves whether something similar would be useful for the clones in the International Cocoa Germplasm Collections.

BCCCA agreed to fund a pilot phase of a project to see if colour photographs of ripe and unripe pods and of flush and hardened leaves would be useful in identifying germplasm. Scale bars are included in the pictures to allow "sizing" and Kodak colour reference cards allow correction of the errors in colour printing. A few clones were selected which we were confident were correctly identified at BAL and which were fruiting in the International Cocoa Genebank in Trinidad, so that comparisons could be made. The pictures were taken at BAL in December and forwarded to Trinidad, where the clones were seen to be quite clearly recognisable. A little more work has to be done on the technicalities of the photography and the layout of the pods and leaves, but we are now confident that the photographs would be useful in identifying gross errors. The next step is to secure BCCCA's agreement to photograph the rest of BAL's germplasm collection. The timing of this is uncertain because an exciting possibility is to use a digital camera and to distribute the pictures on CD-ROM as part of the ICGD, as well as hard copy. If this technology is imminently available, we will wait for it.

Errors in labelling are most liable to occur when clones are propagated repeatedly, and the genebanks, the quarantine centres and the receiving countries should make every effort to prevent this happening. Many, including the University of Reading Intermediate Quarantine Facility, use accession numbers to keep track of the clones in their collections and it is in the long-term interest of breeders receiving new material to keep a note of these donor/quarantine accession numbers as part of their own clone documentation. Hopefully, the rate of the appearance of mislabelled clones in collections will decrease with the adoption of improved genebank management practices. In the meantime, photographs will help breeders to recognise mistakes, and where identifications are critical, molecular profiles can be used to confirm them with a high degree of certainty, but at some cost.

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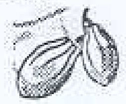


Adaptability Breeding Programme at Cocoa Research Institute of Nigeria - 1

J.A. Williams and S.A. Akinwale

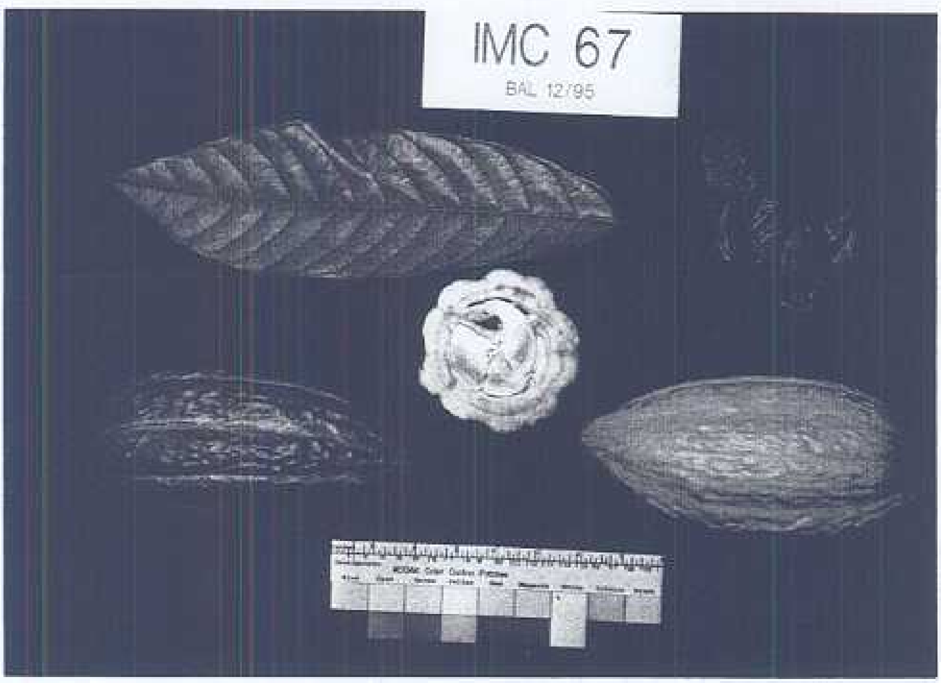
At the Cocoa Research Institute of Nigeria, the cocoa breeding programme involves two approaches. Firstly, there is breeding for genetic improvement through the introduction of exotic germplasm, and secondly, the improvement of the introduced material by introducing genes from the local selections or vice-versa. This article focuses on the combination of "old" and "new" genes.

Serious efforts were geared towards crosses involving local selections (West African Amelonado Varieties), which are known to maintain their peak production for much longer periods (over 10 years), and Amazon varieties with production periods of about six years. The impetus to pursue this hybridisation scheme was strengthened by the fact that the West African Amelonado has a higher pod value than material from the Amazon. A hybridisation scheme involving the WACRI series II (hybrid cacao) was embarked upon so that the bulk F_3 Amazon cacao could be replaced. The progenies of these crosses, which involve parents of Amelonado ancestry, were found to perform better than the parents. Subsequently, emphasis has shifted from intra and inter-Amazon bred cacao to a more vigorous, broad-based hybridisation complex.

The recent experiments along this line involve material such as the Amelonado, T 38 (which is Amelonado, but a cross *per se*), CF 126, and CF 62 with the later introductions from Trinidad. The local accessions, especially T 38, have heavy dried beans and breed true to type. The crosses involved are listed below.

Some of the CRIN Hybrid Adaptability Crosses

Amelonado local x (NA 737 x 332)
Amelonado local x (NA 737 x 137)
Amelonado local x (NA 342 x 387)
Amelonado local x (NA 222 x 387)
Amelonado local x (NA 202 x 310)
(NA 739 x 113) x Amelonado local
(NA 342 x 387) x Amelonado local
N 38 x N 38
N 38 x PA 35
N 38 x T 9/15
N 38 x SCA 12 x SM 2)
N 38 x NA 32
N 38 x T 19/9
N 38 x (SCA 6 x (DR 1 x DR 38)
N 38 x T 85/5



Photograph taken at BAL Plantation for the purpose of recognising mis-identifications

The focus on simulation of the "local" gene is to increase the adaptive value or fitness of introduced material. Results so far obtained revealed the positive effect of the local gene on the introduced material. This clearly shows that the cocoa breeders should not forget to conserve the old genes in their custody and to educate farmers to exercise caution in their effort to eliminate the old productive material. This approach will build up the "general purpose" genes to cater for the demands of a wider ecological range. The data are being subjected to stability tests and will be presented in part II of this series.

There are another four sets of crosses in addition to those listed above. The advantage of these crosses is not only the assimilation of desirable genes from earlier selections, but the broadness of the genetic base to cater for the demands of various ecological zones in Nigeria. It is a rewarding effort because the production base in Nigeria is being shifted and widened towards previously non-cocoa growing areas with different ecological demands.

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Cocoa Breeding at the Farmer's Plot in Nigeria (On Farm Breeding - 1)

The abundance of cacao collections in farmers' plots is a constant source of interest to cocoa breeders. There is often an array of cacao genetic material with desirable characters. The National Agricultural Research Programme (Project 3) of the Cocoa Research Institute of Nigeria, assisted by the World Bank, has as part of its mandate to make selections in farmers' plots. This has been decided so as to offset the threat of erosion of cacao genetic resources. A survey of selected farmers' plots in all of the ecological zones in Nigeria revealed the findings stated below.

1) The history of cocoa in Nigeria is known by some farmers. The on-going documentation of cacao germplasm in Nigeria can only be successful if farmers' records are included. The usefulness of this exercise is demonstrated by the example of a farmer, who designated his cacao germplasm as pre-independence, post-independence, pre-war and post-war.

2) Farmers have their own "finger-printing" techniques, which though crude, could be refined to make them scientifically sound.

3) Farmers have some knowledge about farming systems such as inter-cropping and these systems are widely used. Crops planted with cocoa include kola, oil palm, plantain, banana, citrus etc. The farmers know when to include these crops. Other maintenance practices are well known by farmers.

4) Farmers have some knowledge of the stability of their material. They can predict performance based on climatic trends.

The study revealed that where farmers alleged that their material is homogeneous, there is evidence of heterogeneity. It will be a worthwhile exercise to help the farmers to sort out this situation.

The next stage of this work is to select novel material from the farmers' plots and include it in our research programme for evaluation. Documentation of farmers' contributions to conservation, characterization and evaluation will be undertaken.

Against the foregoing findings, breeders are being advised to include farmers' plots in their breeding programmes. Further progress in this study will be reported in the near future.

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Characterization and Potential Utilization of Wild Cacao from French Guiana

Philippe Lachenaud and Michel Ducamp, CIRAD-CP

CIRAD-CP (formerly IRCC) has undertaken collections of wild cacao material, and of cacao cultivated in ancient times in French Guiana (Clement, 1986; Lachenaud and Sallée, 1993). Initially, it was believed that the latter category of cacao (Amelonado type) could have been derived from the indigenous wild cacao. However, isoenzyme analyses showed that the wild cacao is genetically very distinct (Lanaud *et al.*, 1993). This has recently been confirmed by RFLP and RAPD studies, which showed that this wild cacao is distinct from classical "Lower or Upper-Amazon" genotypes (Laurent, 1993; N'Goran, 1994). The RFLP analyses revealed another interesting feature of this material; the four accessions tested appeared to be homozygous for all the markers used.

The first collection of French Guiana wild cacao consists of about 150 accessions collected at 12 sites. This collection was planted at the COMBI Research Station of CIRAD, in 1988. This germplasm is being studied for vigour, incompatibility and 20 different characteristics of the fruit, bean and flower. One feature of these accessions is the relative variation in pod size and rugosity of the pod wall. The pods are generally bigger than those of Amelonado (up to 1.3 kg). The number of ovules per ovary varies between 37 and 50. The 34 genotypes tested so far appear to be self-incompatible. The high level of homozygosity could be explained by genetic drift, which may have occurred over the period of evolution of this material. For the plant breeder, this feature is of importance, as hybrids made with these accessions are expected to be more uniform.

In 1990, 22 accessions from the French Guiana expedition were transferred from the COMBI Research Station to Trinidad. The material was kept on the St. Augustine Campus of the University of the West Indies for post-quarantine observation. In 1994, it was introduced into the International Cocoa Genebank, Trinidad (ICG,T). Although this material is surrounded by clones infected with Witches' broom disease such as ICS 1 and SCA 12, the accessions have produced not a single broom since being established in the genebank! In the wild, this material is not affected by Witches' broom disease. The first artificial inoculations, carried out recently at CRU, seem to confirm the potential of this material for Witches' broom resistance. Studies are underway to confirm this resistance. Breeding with other clones resistant to Witches' broom is also underway.

In conclusion, the genetic uniqueness of French Guiana wild cacao, as well as the high level of homozygosity and possible resistance to Witches' broom, make these accessions of great interest. The evaluation of the breeding value of this material, as well as the mounting of new expeditions and collection missions in order to obtain wider representativity of this material are justified.

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St. Augustine
TRINIDAD

References

Clement, D., (1986). Cacaoyers de Guyane. Prospections. *Café, Cacao, Thé* **30**(1) 11-36.

Lachenaud, P. and Sallée, B. (1993). Les cacaoyers spontanés de Guyane. Localisation, écologie et morphologie. *Café, Cacao, Thé* **37** (2) avril-juin 1993, 101-114.

Lanaud, C., V. Laurent, J. N'Goran, A.M. Risterucci, A. Bouet and O. Sounigo (1993). Assessment of the genetic diversity of cocoa using biochemical and molecular markers at CIRAD. *Proceedings* of the International Workshop on Conservation, Characterisation and Utilisation of Cocoa Genetic Resources in the 21st Century, Port-of-Spain, Trinidad, 13-17 September, 1992, pp. 163-175.

Laurent, V. (1993). Etude de la diversité génétique du cacaoyer (*Theobroma cacao* L.) basée sur le polymorphisme de la longueur des fragments de restriction (RFLP). Doctorat, Université de Paris XI Orsay, 58 p.

N'Goran, J.A. (1994). Contribution à l'étude génétique du cacaoyer par les marqueurs moléculaires: diversité génétique et recherche de QTLs. Doctorat, Université de Montpellier II, 91 p.

Please note that the dates for the second INGENIC Workshop have been changed to November 25-26. This was unavoidable due to a public holiday on November 15.

Cocoa Breeding in Papua New Guinea

Yoel Efron

Cacao was introduced into Papua New Guinea (PNG) by the Germans from Samoa about 1900. Most of the material was Trinitario originating in Trinidad and Venezuela, and came via Java, Ceylon, and Cameroon to Samoa. It was a very mixed cacao with a very wide range of genetic diversity. There was a subsequent introduction of similar cacao to PNG from Java in 1932.

An additional introduction of significant value to the breeding programme was of the Upper Amazonian germplasm in the early 1960s.

Initially, prior to World War II, virtually all cacao was grown on plantations. From the early 1950s, it developed also as a small holder crop, and small holders now produce about two-thirds of the country's annual crop.

The major constraints for cocoa production in PNG are Vascular Streak Dieback (VSD) disease caused by *Oncobasidum theobromae*, and black pod and canker caused by *Phytophthora palmivora*. Termites, pantorhytes (*Pantorhytes* sp.), longicorns (*Glenea* sp. and *Oxymagis* sp.) and mirids are the most damaging insects.

Cocoa breeding was initiated after World War II by the Lowlands Agricultural Experiment Station (LAES) at Keravat, East New Britain. Later, in 1986, cocoa research was mandated to the Cocoa and Coconut Research Institute (CCRI). The first step was to collect open-pollinated seed from promising surviving trees and to plant them in progeny trials. This material provided the source of Trinitario genetic material for further selection and breeding work. Thirteen Trinitario clones were developed and officially released by LAES.

A severe outbreak of the previously unknown disease called Vascular Streak Dieback or VSD in many parts of PNG during the 1960s created havoc with cocoa research. This was investigated and found to be caused by *Oncobasidium theobromae*. Its effect was such that most of the trials were terminated. A full-scale breeding programme was resumed in 1972. The major efforts went into the development of Trinitario x Upper Amazonian hybrids. Naturally, emphasis was given to yield potential and resistance/tolerance to VSD using Trinitario and Amazonian clones that survived the VSD epidemics as parents. The first progeny trial was planted in 1973 and based on the results obtained, the first poly-cross hybrid SG1 was released in 1982. The hybrid was based on three Amazonian and three Trinitario clones crossed in all possible combinations.

Unfortunately, the SG1 Hybrids were not resistant to *Phytophthora palmivora*, which became more abundant in PNG. This was partially overcome by the release of the second hybrid group SG2, in 1988. This showed a higher level of resistance to black pod. The SG2 hybrids were based on 13 different crosses between six Amazonian and three Trinitario clones.

Though promising results were obtained at the experimental stage of the progeny trials, several problems (listed below) were identified with the SG2 hybrids in farmers' fields and plantations.

1) Yields were lower than expected.
2) Significant tree to tree variability in yield potential between and within crosses was found.

3) Yield reduction after the 4th - 5th year of production with increased tree to tree variability (C.V.s higher than 100% were found within crosses at the 10th year of production) was observed.
4) Very vigorous trees that require frequent pruning are produced.
5) The level of resistance to pod rot was insufficient, particularly when pruning was not carried out properly.
6) Between-cross variability in plant vigour caused interplant competition in the field.

Attempts are currently being made to minimize some of the problems encountered as follows:

1) Elimination of the crosses that are most susceptible to black pod.
2) Division of the SG2 hybrids into two sub-hybrid groups based on relative plant vigour.
3) Assigning higher proportions of the best crosses to the mixture of the two sub-hybrids.

It is assumed that with the above modifications along with better management of the seed garden some improvement in the performance of the SG2 hybrid can be achieved. However, it is not expected that the problem of tree to tree variability and yield reduction can be solved. Therefore, the present strategy of the cocoa breeding programme is to emphasize the development of poly-clonal varieties derived from progenies of Amazonian x Trinitario crosses. The potential of Amelonado x Amazonian and Amelonado x Trinitario derived clones will also be explored.

The present major screening criteria for the clones are yield potential, production stability, resistance to *Phytophthora* and VSD, butter fat content, and shell percentage. Successful budding, growth habit, vigour, compatibility, yield distribution, flavour parameters and pod and bean characteristics are also considered.

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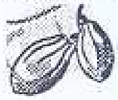
PAPUA NEW GUINEA



News from Pichilingue Station, Ecuador - Disease Research Programme

Freddy Amores

The main thrust of the research programme for cacao diseases in Ecuador is identifying resistance to the two major diseases of cacao, viz., *Monilia* pod rot and Witches' broom. Screening of 200 trees of Nacional origin through artificial inoculations of 80 day-old pods has resulted in the identification of some six trees with levels of *Monilia* resistance. These trees are now being propagated for future studies.

A semi-automatic screening method for Witches' Broom, developed as a result of collaboration between Florida University and Pichilingue, has been practised for the last three years. It involves the systematic inoculation of cacao seedlings of about 21 days old. From among the 200 Nacional trees tested, about 20 have shown some resistance. These parent trees are being used to investigate the stability of response and heritability of resistance against Witches' Broom disease.

Following the results from the International Witches' Broom Project, demonstration plots were set up at Pichilingue in 1992, and two farms have been established near the Station (1994). In both cases, the integrated management of cacao diseases involved the pruning of trees, reducing their heights to manageable levels (about 4 m). The first plot was an old hybrid orchard planted in late 1943. Three years after coppicing, yield increased four-fold over the original 400kg/year of dry cocoa. These results are prompting farmers to rehabilitate plots within their farms with guidance and support from the Station.

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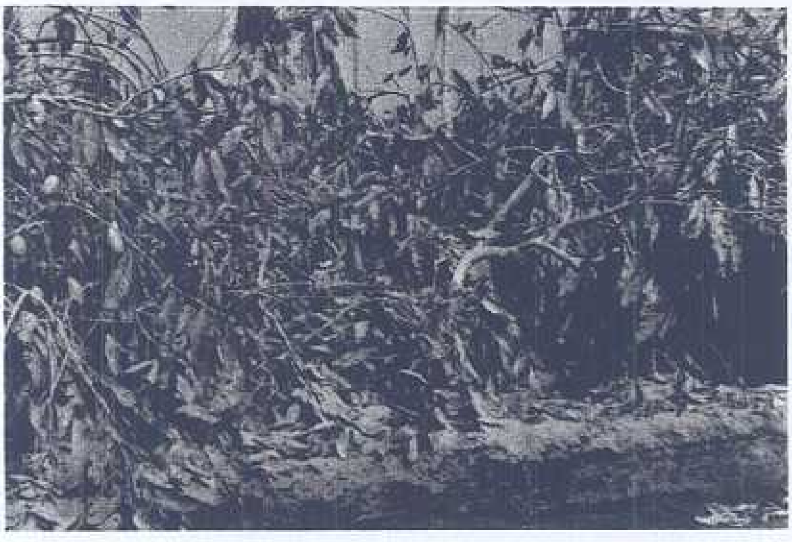

Cacao trees damaged by the 1995 volcanic eruption at Rabaul, PNG

UNIVERSITY OF READING/
BISCUIT, CAKE, CHOCOLATE &
CONFECTIONERY ALLIANCE

INTERMEDIATE COCOA QUARANTINE

The University of Reading/ BCCCA Intermediate Cocoa Quarantine Facility

The University of Reading Intermediate Cocoa Quarantine Facility is funded by the Biscuit, Cake, Chocolate and Confectionery Alliance of the U.K. (BCCCA) to enable the safe transfer of cacao germplasm between interested genebanks and organizations. The facility was established in 1983 when the Royal Botanic Gardens at Kew ceased to provide a quarantine service for cacao. At this time, approximately 90 clones were transferred from Kew to the newly established cocoa growing facility at Reading. For the next five years, budwood from these plants was distributed under the umbrella of the Royal Botanic Gardens although no new clones were added to the collection. The facility initiated quarantine operations in its own right in 1987 with the establishment of a purpose built quarantine facility and has since imported material from the International Cocoa Genebanks (ICG,T and CATIE), cacao quarantine facilities of USDA, Miami and CIRAD, Montpellier, and from the CIRAD genebank in French Guiana. All material received is virus indexed by examining Amelonado plants budded with the test material for visual symptoms over a two year period. Anyone who is interested in obtaining or exchanging germplasm should contact:

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Codes used for Donor Genebanks:

CRICATI - CATIE, Turrialba, Apdo 25, Costa Rica

GBRKEW - Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB, UK

GUFCIRA - CIRAD, Kourou, French Guiana

TTOICGT - International Cocoa Genebank, Trinidad, Cocoa Research Unit, University of the West Indies, St. Augustine, Trinidad & Tobago.

USASHRS - USDA Sub-Tropical Horticulture Research Station, 13601 Old Cutler Road, Miami, Florida, 33158, U.S.A.

Clone Name	Reading Accession Number	Availability	Donor Genebank	Origin
AM 1.8 [POU]	RUQ 469	1997	TTOICGT	Hacienda
AM 1.95 [POU]	RUQ 472	1997	TTOICGT	Amalia,
AM 2.43 [POU]	RUQ 454	1997	TTOICGT	Ecuador.
AM 3-9	RUQ 521	1997	TTOICGT	Pound,
AM 5-7	RUQ 522	1997	TTOICGT	1938
AMAZ 3-2 [CHA]	RUQ 91	Available	TTOICGT	R. Amazon,
AMAZ 5-2 [CHA]	RUQ 93	Available	TTOICGT	Iquitos
AMAZ 6 [CHA]	RUQ 94	Available	TTOICGT	Island, Peru.
AMAZ 6-3 [CHA]	RUQ 95	Available	TTOICGT	Chalmers,
AMAZ 10-1 [CHA]	RUQ 96	Available	TTOICGT	1973
AMAZ 10-3 [CHA]	RUQ 97	Available	TTOICGT	
AMAZ 12 [CHA]	RUQ 334	Dec.1996	TTOICGT	
AMAZ 12-4 [CHA]	RUQ 79	Available	TTOICGT	
AMAZ 15 [CHA]	RUQ 99	Available	TTOICGT	
AMAZ 15-15 [CHA]	RUQ 1	Available	GBRKEW	
B 12-2 [POU]	RUQ 436	1997	TTOICGT	Hacienda B
B 68 [POU]	RUQ 524	1997	TTOICGT	Bolivar,
B 131 [POU]	RUQ 348	Available	TTOICGT	Ecuador.
B 137 [POU]	RUQ 349	Available	TTOICGT	Pound, 1937.
BE 2	RUQ 117	Available	USATARS	Belem,
BE 3	RUQ 2	Available	GBRKEW	Brazil. Vello,
BE 10	RUQ 3	Available	GBRKEW	1965.
BORNE 7 A2 [GUF]	RUQ 397	1997	GUFCIRA	Borne 7,
BORNE 7 A6 [GUF]	RUQ 398	1997	GUFCIRA	Haut Oyapock,
BORNE 7 B2 [GUF]	RUQ 399	1997	GUFCIRA	Fr. Guiana Lachenaud,
BORNE 7 B4 [GUF]	RUQ 401	1997	GUFCIRA	1990
BORNE 7 B5 [GUF]	RUQ 402	1997	GUFCIRA	
CC 11	RUQ 4	Available	GBRKEW	Cacao Centre, Costa Rica
CC 38	RUQ 5	Available	GBRKEW	UF 676 x MATINA, Costa Rica
CL 19.21	RUQ 527	1997	TTOICGT	Hacienda
CL 103	RUQ 528	1997	TTOICGT	Clementina,
CLM 19	RUQ 438	1997	TTOICGT	Ecuador
CLM 90	RUQ 531	1997	TTOICGT	
COCA 3370-5 [CHA]	RUQ 137	Available	TTOICGT	R. Coca, Ecuador. Chalmers, 1973
CRU 47	RUQ 540	1997	TTOICGT	Cocoa Research Unit, Trinidad
CRUZ 7-11	RUQ 315	Dec.1996	TTOICGT	Open-pollinated seedling from C.Sul, Brazil.

Clone Name	Reading Accession Number	Availability	Donor Genebank	Origin
DOM 3	RUQ 543	1997	TTOICGT	Dominica
DOM 4	RUQ 544	1997	TTOICGT	Cassie,
DOM 5	RUQ 545	1997	TTOICGT	1991
DOM 10	RUQ 546	1997	TTOICGT	
DOM 14	RUQ 542	1997	TTOICGT	
DOM 30	RUQ 549	1997	TTOICGT	
EET 58 [ECU]	RUQ 383	1997	TTOICGT	Estacion
EET 95 [ECU]	RUQ 414	1997	CRICATI	Experimen-
EET 162 [ECU]	RUQ 350	Dec. 1996	TTOICGT	tal Tropical,
EET 272 [ECU]	RUQ 6	Available	GBRKEW	Ecuador.
EQX O [CHA]	RUQ 138	Available	TTOICGT	San Miguel,
EQX Z [CHA]	RUQ 109	Available	TTOICGT	Ecuador.
EQX J5 [CHA]	RUQ 107	Available	TTOICGT	Chalmers,
				1970.
EQX 69 [EQX]	RUQ 100	Available	TTOICGT	Selections
EQX 78 [EQX]	RUQ 83	Available	TTOICGT	from
				Ecuador.
				Ecuador.
				Chalmers.
EQX 3161 [CHA	RUQ 139	Available	TTOICGT	San Miguel
EQX 3308-1 [CHA]	RUQ 102	Available	TTOICGT	Coca
EQX 3348-44 [CHA]	RUQ 140	Available	TTOICGT	Coca
EQX 3348-52 [CHA]	RUQ 141	Available	TTOICGT	Coca
EQX 3360-3 [CHA]	RUQ 142	Available	TTOICGT	San Miguel.
GDL 3	RUQ 553	1997	TTOICGT	Guadeloupe
GDL 11	RUQ 555	1997	TTOICGT	Cassie,
				1991.
GU 123C	RUQ 187	Available	FRACIRA	R. Camopi,
GU 125C	RUQ 188	Available	FRACIRA	Fr. Guiana.
GU 133C	RUQ 190	Available	FRACIRA	Sallée,
GU 136H	RUQ 221	Available	FRACIRA	1987.
GU 144C	RUQ 191	Available	FRACIRA	
GU 147H	RUQ 222	Available	FRACIRA	
GU 154C	RUQ 192	Available	FRACIRA	
GU 168H	RUQ 223	Available	FRACIRA	
GU 171C	RUQ 195	Available	FRACIRA	
GU 183H	RUQ 224	Available	FRACIRA	
GU 207H	RUQ 225	Available	FRACIRA	
GU 221C	RUQ 200	Available	FRACIRA	
GU 221H	RUQ 226	Available	FRACIRA	
GU 239H	RUQ 227	Available	FRACIRA	
GU 249H	RUQ 228	Available	FRACIRA	
GU 259C	RUQ 203	Available	FRACIRA	
GU 290H	RUQ 229	Available	FRACIRA	
GU 296H	RUQ 230	Available	FRACIRA	
GU 341H	RUQ 231	Available	FRACIRA	
ICS 16	RUQ 110	Available	TTOICGT	Imperial
ICS 27	RUQ 143	Available	TTOICGT	College
ICS 43	RUQ 144	Available	TTOICGT	Selections,
ICS 44	RUQ 416	1997	CRICATI	Trinidad.
ICS 47	RUQ 145	Available	TTOICGT	
ICS 48	RUQ 146	Available	TTOICGT	
ICS 70	RUQ 321	Dec. 1996	TTOICGT	
ICS 100	RUQ 111	Available	TTOICGT	

Clone Name	Reading Accession Number	Availability	Donor Genebank	Origin
IMC 11	RUQ 8	Available	GBRKEW	Iquitos
IMC 14	RUQ 9	Available	GBRKEW	Mixed
IMC 20	RUQ 10	Available	GBRKEW	Calabacillo,
IMC 54	RUQ 11	Available	GBRKEW	Peru.
IMC 61	RUQ 12	Available	GBRKEW	Pound,
IMC 67	RUQ 13	Available	TTOICGT	1937
IMC 83	RUQ 15	Available	GBRKEW	
IMC 96	RUQ 16	Available	GBRKEW	
JA 10.12	RUQ 456	1997	TTOICGT	Hacienda
JA 19	RUQ 457	1997	TTOICGT	Javilla,
JA 119	RUQ 352	Dec. 1996	TTOICGT	Ecuador.
				Pound
KER 2-E	RUQ 405	1997	GUFCIRA	R. Kerin-
KER 3	RUQ 406	1997	GUFCIRA	dioutou (R.
KER 6	RUQ 408	1997	GUFCIRA	Oyapock),
KER 7	RUQ 409	1997	GUFCIRA	Fr. Guiana.
KER 9	RUQ 410	1997	GUFCIRA	Lachenaud,
				1990.
LAF 1	RUQ 17	Available	GBRKEW	Costa Rica.
LCT EEN 28S1	RUQ 67	Available	TTOICGT	R. Napo, R.
LCT EEN 31	RUQ 441	1997	TTOICGT	Yacuambi,
LCT EEN 37A	RUQ 148	Available	USASTHS	R. Villano,
LCT EEN 37F	RUQ 153	Available	USASTHS	Ecuador.
LCT EEN 37G	RUQ 154	Available	USASTHS	Allen, 1980
LCT EEN 37I	RUQ 156	Available	USASTHS	-1985
LCT EEN 46	RUQ 19	Available	GBRKEW	
LCT EEN 68	RUQ 442	1997	TTOICGT	
LCT EEN 85	RUQ 147	?	TTOICGT	
LCT EEN 86	RUQ 443	1997	TTOICGT	
LCT EEN 127	RUQ 69	Available	TTOICGT	
LCT EEN 162/ S1010	RUQ 70	Available	TTOICGT	
LCT EEN 163A	RUQ 178	Available	USASTHS	
LCT EEN 163D	RUQ 180	Available	USASTHS	
LCT EEN 241	RUQ 185	Available	USASTHS	
LP 141 [POU]	RUQ 353	Dec. 1996	TTOICGT	Hacienda La
LP 340 [POU]	RUQ 460	1997	TTOICGT	Paz,
LP 519 [POU]	RUQ 461	1997	TTOICGT	Ecuador
				Pound
LV 20 [POU]	RUQ 354	Dec. 1996	TTOICGT	Limoncillo
LV 28 [POU]	RUQ 462	1997	TTOICGT	Selections,
LX 6	RUQ 463	1997	TTOICGT	Ecuador.
LX 28	RUQ 355	1997	TTOICGT	Pound
MA 12 [BRA]	RUQ 124	Available	USATARS	Manaus,
				Brazil. Vello,
				1965
MAN 15-2 [BRA]	RUQ 86	Available	TTOICGT	Open-polli-
MAN 15-60 [BRA]	RUQ 87	Available	TTOICGT	nated seed-
				ling from MA
				15
MAR 9	RUQ 557	1997	TTOICGT	Martinique.
MAR 13	RUQ 559	1997	TTOICGT	Cassie,
				1991.

Clone Name	Reading Accession Number	Availability	Donor Genebank	Origin
MO 20	RUQ 233	Available	TTOICGT	R. Morona, Peru. Pound, 1937.
MO 83	RUQ 449	1997	TTOICGT	
MOCORONGO	RUQ 21	Available	GBRKEW	Santarem, Para, Brazil.
MOQ 222	RUQ 453	1997	TTOICGT	Hacienda Moquique, Ecuador. Pound, 1937.
MXC 67	RUQ 104	?	TTOICGT	Chiapas, Mexico.
NA 33	RUQ 114	Available	TTOICGT	R. Nanay, Peru. Pound, 1937.
NA 756	RUQ 468	1997	TTOICGT	
NA 776	RUQ 215	Available	TTOICGT	
NA 824	RUQ 218	Available	TTOICGT	
P 4A [POU]	RUQ 22	Available	GBRKEW	R. Nanay, Peru. Pound, 1942.
P 4B [POU]	RUQ 23	Available	GBRKEW	
P 7B [POU]	RUQ 24	Available	GBRKEW	
P 10 [MEX] = 10P	RUQ 29	Available	GBRKEW	Tabasco, Mexico
P 14B [POU]	RUQ 25	Available	GBRKEW	R. Nanay, Peru. Pound, 1942.
P 16A [POU]	RUQ 26	Available	GBRKEW	
P 19A [POU]	RUQ 27	Available	GBRKEW	
P 19B [POU]	RUQ 28	Available	GBRKEW	
PA 7	RUQ 113	Available	MYSBAL	Parinari, Peru. Pound, 1937.
PA 56	RUQ 32	Available	GBRKEW	
PA 70	RUQ 33	Available	GBRKEW	
PA 88	RUQ 34	Available	GBRKEW	
PA 107	RUQ 35	Available	GBRKEW	
PA 137	RUQ 36	Available	GBRKEW	
PA 175	RUQ 37	Available	GBRKEW	
PINA	RUQ 411	1997	GUFCIRA	Pina, Oyapock, Fr. Guiana. Lachenaud, 1990.
PLAYA ALTA 2 [VEN]	RUQ 232	1997	TTOICGT	Rio Orinoco Delta, Venezuela.
PUCALA 1	RUQ 39	Available	GBRKEW	Brazil.
R 10 [MEX] = 10R	RUQ 484	1997	TTOICGT	E.E. Rosario Izapa, Mexico.
R 21 [MEX] = 21R	RUQ 486	1997	TTOICGT	
R 39 [MEX] = 39R	RUQ 487	1997	TTOICGT	
RB 29 [BRA]	RUQ 129	?	CRICATIE	R. Branco, Brazil. Vello, 1965.
RB 29 [BRA]	RUQ 419	1997	USATARS	
RB 33/3 [BRA]	RUQ 40	Available	GBRKEW	
RB 39 [BRA]	RUQ 131	?	USATARS	
RB 41 [BRA]	RUQ 132	?	USATARS	
RB 46 [BRA]	RUQ 134	?	USATARS	
RB 47 [BRA]	RUQ 135	?	USATARS	
RB 49 [BRA]	RUQ 136	?	USATARS	
RED 127	RUQ 339	Dec. 1996	TTOICGT	Red Amelonado from the Amazon Valley.

Clone Name	Reading Accession Number	Availability	Donor Genebank	Origin
RIM 189 [MEX] = 189R	RUQ 310	1997	CRICATI	Chiapas, Mexico
SC 1 [?]	RUQ 41	Available	GBRKEW	Seleccion Colombia.
SC 3 [COL]	RUQ 42	Available	GBRKEW	
SC 4 [?]	RUQ 43	Available	GBRKEW	
SC 9 [COL]	RUQ 44	Available	GBRKEW	
SC 10 [COL]	RUQ 45	Available	GBRKEW	
SCA 6	RUQ 234	Available	TTOICGT	Scavina. Pound, 1937.
SCA 11	RUQ 374	1997	TTOICGT	
SCA 19	RUQ 46	Available	GBRKEW	
SCA 23	RUQ 390	1997	TTOICGT	
SCA 24	RUQ 357	Dec.1996	TTOICGT	
SIAL 93	RUQ 47	Available	GBRKEW	Brazil.
SIAL 339	RUQ 48	Available	GBRKEW	
SIC 5	RUQ 49	1997	GBRKEW	Brazil.
SJ 119	RUQ 358	Dec.1996	TTOICGT	Hacienda San Juan, Ecuador. Pound.
SLC 12	RUQ 539	1997	TTOICGT	Hacienda Santa Lucia, Ecuador.
SPA 4 [COL]	RUQ 341	Dec.1996	TTOICGT	Progeny of a fruit donated to Colombia by Pound
SPA 9 [COL]	RUQ 235	Available	TTOICGT	
SPEC 54-1	RUQ 50	Available	GBRKEW	R. Papuri, R. Cauca, Colombia. 1952
SPEC 160-9	RUQ 51	Available	GBRKEW	
SPEC 184-2	RUQ 323	1997	TTOICGT	
SPEC 194-75	RUQ 325	Dec.1996	TTOICGT	
TJ 1	RUQ 52	Available	GBRKEW	Criollo, Honduras
UF 221	RUQ 54	Available	GBRKEW	United Fruit Company selections from the Atlantic Coast, Costa Rica.
UF 667	RUQ 55	Available	GBRKEW	
UF 676	RUQ 56	Available	GBRKEW	
UF 677	RUQ 346	1997	TTOICGT	
UF 705	RUQ 57	Available	GBRKEW	
UF 705	RUQ 481	Available	TTOICGT	
B 5.7 [POU]	RUQ 522	1998	TTOICGT	
CRIOLLO 54	RUQ 643	1998	CRICATIE	
DOM 25	RUQ 571	1988	TTOICGT	
ECNR	RUQ 573	1988	TTOICGT	
GDL 7	RUQ 554	1988	TTOICGT	
GF 32	RUQ 648	1988	GUFCIRA	
IMC 27	RUQ 515	1988	TTOICGT	
JA 92	RUQ 586	1988	TTOICGT	
MO 121	RUQ 476	1988	TTOICGT	
PA 34	RUQ 588	1988	TTOICGT	
PA 67	RUQ 590	1988	TTOICGT	
PA 90	RUQ 594	1988	TTOICGT	

Obituary

Don Edwards

Sadly our 1995 Christmas card to Don Edwards was returned with a note to say that he had died. We do not know when, but we did not receive a card from him in 1994.

Don was involved with cocoa, its seed production and breeding for much of his career, although he began quite differently. As a school leaver he joined the Fleet Air Arm as a pilot, and as someone who could be described as vertically disadvantaged, described with amusement his difficulty in the U.S.A when he first got into the pilot's seat of a training aircraft which had been set up for the average Texan! He completed his training successfully, and to his relief, only got as far as Trincomalee before the Pacific war ended.

On demobilisation, Don did a degree in Agriculture at Reading, and then the two year diploma in tropical agriculture, divided between Cambridge and Trinidad, where he enjoyed the teaching and social life of the Imperial College of Tropical Agriculture. His first posting was to the Department of Agriculture in Ghana (then the Gold Coast) where he did extension work and trials with maize, before joining the cocoa division. Eventually he became deputy Chief Cocoa Officer and, among other things, was responsible for establishment of the first generation of seed gardens. He left Ghana in 1962.

Don's next posting was to Sabah, Malaysia, where his responsibilities included establishment of the now very successful Sabah oil palm breeding programme as well as the cocoa programme. He used his knowledge of the Trinidad introductions at Tafo and of seed gardens to create the Sabah hybrids, based on Peter Posnette's 1944 compatibility tests with the fortuitous mis-identification of the UIT clones, and he established the seed gardens to produce them. This work allowed the cocoa boom there. His belief that the production potential in Sabah is limited by the extent of the volcanic soils has been borne out.

Don returned to Ghana in 1969 as the Head of Plant Breeding Division and senior breeder in the British Research Team working on cocoa swollen shoot virus. His lasting contributions were the scaling up of the introduction of cacao germplasm and the establishment of techniques for large-scale seed production by manual pollination. Don remarked to me that some of the Upper Amazon clones could be very high yielding if managed correctly, as has been shown in Sabah over the last few years. However, he was frustrated by what he saw as inappropriate emphasis of the breeding programme, over-reliance on science and insufficient understanding of agronomy.

From Ghana, Don went to Ecuador in 1972 as specialist cocoa advisor, based at Pichilingue. This was a challenging interlude for a man used to being in charge, but a key observation was of the field resistance to witches' broom disease of some of the "refractario" type material. He saw that the combination of a slow flushing cycle, open canopy and out of season cropping allowed the trees to yield, if modestly, in a situation where the "hybrids" performed very poorly indeed. He realised that manual pollination could be used to force out of season cropping, avoiding pod infection with monilia disease and witches' broom, even stem girdling trees to encourage flowering. With Don's encouragement, smallholders around Pichilingue were able to produce large crops with the children doing the pollinations. Don also maintained his interest in germplasm, accompanying Dan Chalmers on one of his collecting expeditions, and establishing much of Dan's material in a nursery area, where it survived for many years.

Don's last cocoa period was back where he had begun at the Imperial College, which had grown into the University in Trinidad. He was cocoa breeder in 1978/79 and Head of the Cocoa Research Unit for about 18 months. He thoroughly enjoyed having access to the cocoa populations such as the Upper Amazons, which he had known around the world, less so the financial and administrative aspects of his role.

After Trinidad, Don undertook consultancy assignments on cocoa in West Africa and in Sri Lanka. The years of tropical sun had taken their toll and after removal of what he described as non-essential parts, he retired to Scotland.

A confirmed bachelor, Don hinted darkly of a past and unrequited liaison with the fair sex, which others have confirmed. He was an excellent tennis player, and in Sabah learned to play badminton very well. He was a fine snooker player when in practice, but reluctantly as he said a show of skill is a sign of a mis-spent youth. His greatest interest was fishing, preferably with a fly for trout on remote Scottish waters, and elsewhere by any sporting means for whatever had scales and swam. Don was a shy and private man of old fashioned values who did not suffer fools or deceit gladly, leading many to (wrongly) dismiss him as an obsolete colonial with nothing useful to offer. On the contrary, as I got to know Don better over the years, I grew to respect his keen perceptions of cocoa and agree with his conviction that husbandry skills are as important in research as they are in commercial cultivation. I shall think of him sipping a brandy and ginger after a game of tennis and remember him for his awful pipe, his dry humour and above all for his deep understanding of cocoa.

Rob Lockwood

ANNOUNCEMENT

BOOK RELEASE

Fritz, P.J., Phillips-Mora, W. and Rodriquez, R.H. (1995). New Tools for 21st *Century Plant Breeding. DNA Markers: Theory and Applications with examples from research on the Chocolate Tree, Theobroma cacao,* 122p; 27cm. Tech. Bulletin/CATIE **No. 251**, CATIE Turrialba, Costa Rica. ISBN 9977-57-204-6. SB633.74 F919.

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(Available in English and Spanish)

Errata for Issue No. 1

Article on *Cross-compatibility of self-incompatible Trinitarios*

page 7, paragraph 1, line 4. Replace "incompatibility allele S1 (Dalton Glendinning's nomenclature)" by "incompatibility allele, I".

page 7, paragraph 4, line 2. Replace "S1" by "I".

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Explanation of acronyms

ACRI	-	American Cocoa Research Institute
BCCCA	-	Biscuit, Cake, Chocolate and Confectionery Alliance (United Kingdom)
CAOBISCO	-	The European Employer's Federation for the Chocolate and Biscuit Industry
CATIE	-	Centro Agronómico Tropical de Investigación & Enseñanza
CIRAD	-	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CRU	-	Cocoa Research Unit

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