

Overview of Research Effort at Reading

Areas of activities

- International Cocoa Quarantine Centre, Reading.
 - International Cocoa Germplasm Database.
 - Physiological research
 - Plant response to environmental variation.
-
- Cocoa Swollen Shoot Virus
 - Cryopreservation

ICQC, R

International Cocoa Quarantine Centre



- Provides intermediate quarantine for safe international movement of cocoa germplasm (2 year quarantine period)
- Germplasm has been provided from Trinidad, Costa Rica, Ecuador, Malaysia, USA and France
- Institutes in around 20 countries have received plant material from ICQC, R
- Currently over three hundred accessions available for distribution; another 100 are passing through the quarantine process



Improving the quarantine progress



- Receipt of material as micro-grafted plants: to improve establishment
- Cryo-preservation of somatic embryos: to back-up key clones
- Genetic identification of new material entering the collection (confirm identity).

Physiological Characterisation of Germplasm

- Assessing heat stress tolerance in different genotypes
- Genetic variation in photosynthetic rates

International Cocoa Germplasm Database

The ICGD

- Began in 1988, becoming the International Cocoa Germplasm Database in 1990.
- Supported by Euronext.liffe and BCCCA.
- 28,239 clone names, of which 14,127 are true names and 14,112 are synonyms.
- Meaning and origin of most of those clone names.
- Accession lists for 48 of the major cocoa genebanks, including quarantine stations.
- Details of collecting expeditions from 1919 to the present day.
- 740 colour photographs and drawings of cocoa germplasm in collections around the world.
- Genetic fingerprinting data of the accessions in the ICQC,R collection.



The ICGD Website

- Information about the ICGD project.
- Access to the online database.
- Details on the quarantine facility and germplasm collection.



The screenshot shows the ICGD Online website interface. The header includes the title "ICGD Online" and the subtitle "International Cocoa Germplasm Database". Navigation links include "Home", "Search ICGD", "Project Background", "ICQC,R", and "Help?". The main content area is divided into several sections: "Welcome to ICGD" with a photograph of cocoa pods and text describing the database's purpose and funding; "Guide to Site Navigation" with sub-sections for "Search ICGD (under development)", "Project Background", and "International Cocoa Quarantine Centre, Reading (ICQC,R)". The left sidebar contains a "Navigation" menu, logos for "Euronext.liffe" and "University of Reading", and a "Partners" section listing "CocoaGenDB" and "USDA". The footer contains "Contact Us" and "Disclaimer" links, along with design and copyright information.

ICGD Online International Cocoa Germplasm Database

Home | Search ICGD | Project Background | ICQC,R Help?

Navigation

- » Home
- > Links
- > Acknowledgements

 Euronext.liffe

Biscuit Cake Chocolate & Confectionery Association 

 University of Reading

Partners

- > CocoaGenDB
- > USDA

Welcome to ICGD



The International Cocoa Germplasm Database (ICGD) is an information service for the cocoa research community. Based at the University of Reading, the project aims to collate information on the origins, characteristics and availability of cocoa germplasm and to make this available to researchers.

The project is funded by [Euronext.liffe](#) and administered by the [BCCCA](#), full details of which can be found in the [Project Background](#) section of this site.

Guide to Site Navigation

Search ICGD (under development)

[Search the database](#) for information on synonyms, origins and locations, and a wide range of morphological and agronomic characters of cocoa clones. Photographs and genetic fingerprints (SSR profiles) can also be accessed.

These search routines are still under construction, so not all the information is available yet. However, all data can still be accessed through the original [character searches](#) or the [microsatellite profile search](#).

Project Background

Details on the [ICGD project](#) and other work on Cocoa at the University of Reading, including information on previous versions of the database.

International Cocoa Quarantine Centre, Reading (ICQC,R)

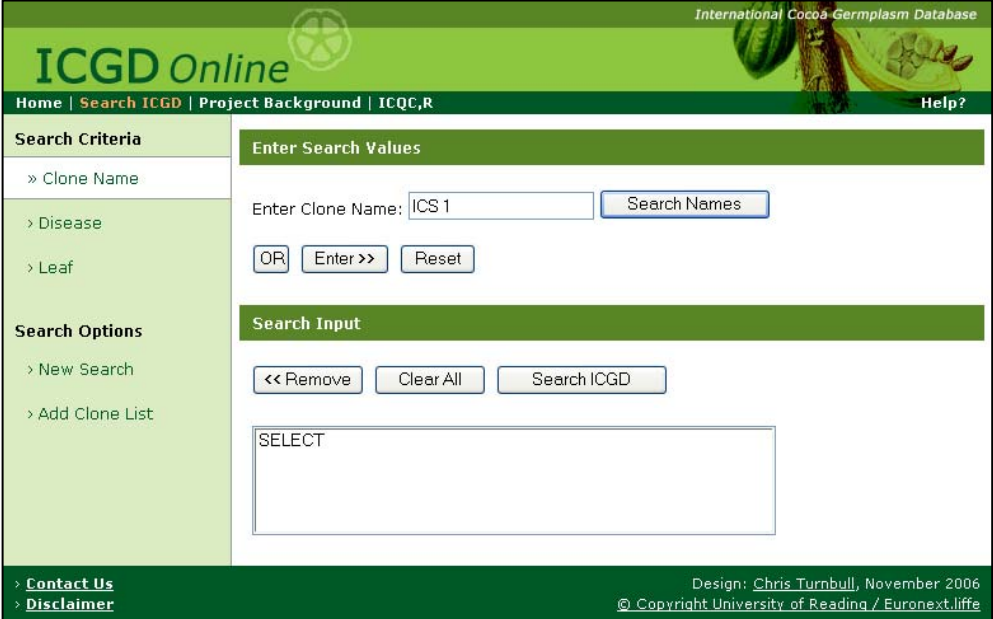
Information about the [intermediate cocoa quarantine facility](#) maintained at the University of Reading, including the current list of disease-free (post-quarantine) accessions maintained in the collection and any material undergoing quarantine procedures.

> [Contact Us](#)
> [Disclaimer](#)

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ICGD Online

- Web-based MySQL database.
- Free public access.



The screenshot shows the ICGD Online web interface. The header includes the ICGD Online logo and the text "International Cocoa Germplasm Database". Navigation links include Home, Search ICGD, Project Background, ICQC,R, and Help?. The main content area is divided into two columns. The left column contains "Search Criteria" with expandable sections for Clone Name, Disease, and Leaf, and "Search Options" with expandable sections for New Search and Add Clone List. The right column contains "Enter Search Values" with a text input field for "Enter Clone Name" (containing "ICS 1") and a "Search Names" button, along with "OR", "Enter >>", and "Reset" buttons. Below this is the "Search Input" section with "<< Remove", "Clear All", and "Search ICGD" buttons, and a large text area containing the word "SELECT". The footer includes "Contact Us" and "Disclaimer" links, and design information: "Design: Chris Turnbull, November 2006" and "© Copyright University of Reading / Euronext.liffe".

Information can be accessed for any accession name or using the full range of characters recorded in the database.

ICGD Online

International Cocoa Germplasm Database

ICGD Online

Home | Search ICGD | Project Background | ICQC,R Help?

Search Options

- > New Search
- > Back

ICS 1 [Images]

DISEASE

Phytophthora:

- Tolerant** (Pod), sp. PA (Enriquez, G. & Soria, V.J., 1977).
- Moderate Resistance** (Pod), sp. PA. **Notes:** Unripe, Attached and not wounded (Morera, J., 1993).
- Resistant**, 54.00 % infection (Pod), sp. PA. **Notes:** Unripe, Attached and not wounded (Blaha, G. & Lotode, R., 1976).
- Susceptible** (Leaf (abaxial surface)), sp. PA. **Notes:** Interflush 2, Unattached and not wounded (Iwaro, D. Sreenivasan, T.N. & Umaharan, P., 1997c).
- Resistant** (Pod), sp. PA (Sreenivasan, T.N., 1980).
- Susceptible** (Leaf (adaxial surface)), sp. PA. **Notes:** Interflush 2, Unattached and punch inoculated (Iwaro, D. Sreenivasan, T.N. & Umaharan, P., 1997c).
- Resistant** (Pod), sp. PA. **Notes:** Unripe, Unattached and not wounded (Iwaro, D. Sreenivasan, T.N. & Umaharan, P., 1997).
- Susceptible** (Pod), sp. PA. **Notes:** Unripe, Unattached and 3mm stab inoculated (Iwaro, D. Sreenivasan, T.N. & Umaharan, P., 1997).
- Susceptible** (Leaf (adaxial surface)), sp. PA. **Notes:** Interflush 2, Unattached and not wounded (Iwaro, D. Sreenivasan, T.N. & Umaharan, P., 1997c).
- Resistant**, 55.00 % infection (Pod), sp. PA. **Notes:** Unripe and not wounded (Lopez-Baez, O. Fraire, V.G. & Cueto, M.J., 1996).

Witches Broom:

- Tolerant** (Enriquez, G. & Soria, V.J., 1977).
- Resistant** (Field Reaction) (Luz, E.D.M.N. et al., 1997).
- Resistant** (Seedling) (Luz, E.D.M.N. et al., 1997).
- Tolerant** (Pod) (Trinidad - CRU, 1994b).
- Intermediate** (Morera, J. & Mora, A., 1990b).
- Intermediate** (Enriquez, G.A. & Soria, V.J., 1967c).
- Resistant** (Pods) (Trinidad - Dept of Agriculture, undated).
- Intermediate** (Leaves) (Trinidad - Dept of Agriculture, undated).

Ceratocystis:

- Resistant** (Iton, E.F., 1959).
- Susceptible** (Barros-Nieves, O., 1963).
- Susceptible** (Freeman, W.E., unknown).

International Cocoa Germplasm Database


ICGD Online

Home | Search ICGD | Project Background | ICQC,R Help?

Search Options

- > New Search
- > Back

ICS 1 - Mature pod.



Trinidad, ICGT (Trinidad - CRU, 2002).

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- All information is referenced to the original source.
- Also available as CD-ROM

Germplasm Management Tool

Germplasm Management Tool

- An online tool for the impartial and unambiguous ranking of accessions.
- All inputs are user-defined.
- Is not restricted to Cocoa.



The screenshot shows the homepage of the Germplasm Management Tool. The header includes the University of Reading / ICGD logo and the title 'Germplasm Management Tool'. The main content area features a welcome message and a detailed description of the tool's capabilities. Below the description, there are two sections: 'For data already converted to a 0 - 9 scale:' and 'For unedited (raw) data:'. Each section contains two blue hyperlinks. The footer includes 'HOME' and 'HELP' links.

University of Reading / ICGD
Germplasm Management Tool

Welcome to the Online Germplasm Management Tool

A flexible and dynamic web-based management tool that allows accessions to be impartially and unambiguously ranked, based on information on the traits the individual clones possess and the genetic diversity they represent. The program is flexible in the number of accessions and traits that can be input and weighting of individual traits is user defined (so that they can be targeted to specific requirements). Safeguards have been built-in to protect the ranking of accessions with rare and highly desirable characteristics.

For data already converted to a 0 - 9 scale:

- [Go to Basic version](#)
- [Go to Advanced version](#)

For unedited (raw) data:

- [Convert data and submit to Basic version](#)
- [Convert data and submit to Advanced version](#)

HOME HELP

Combine agronomic traits with genetic information with specific weighting for each trait and allowing interaction between genetic and agronomic data.

Germplasm Management Tool



- The accessions are ranked based on the scores and weightings of each trait.
- Rare traits are highlighted.

University of Reading / ICGD
Germplasm Management Tool

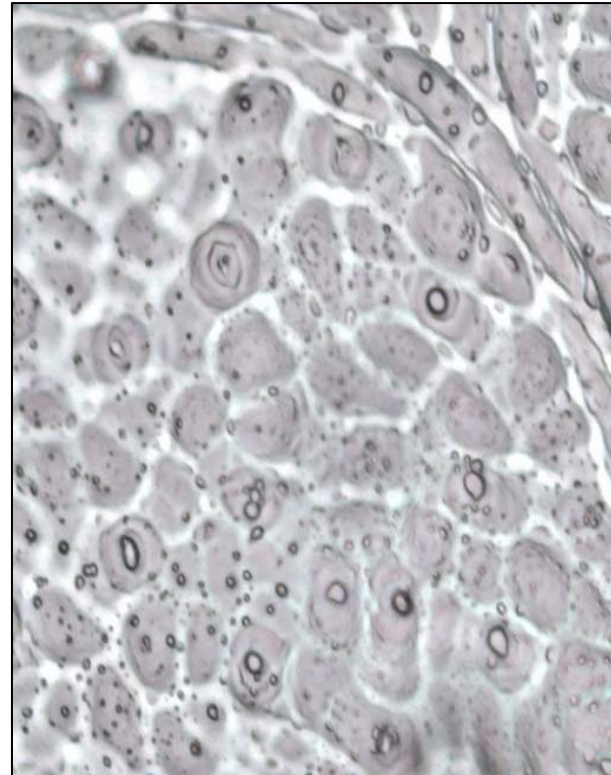
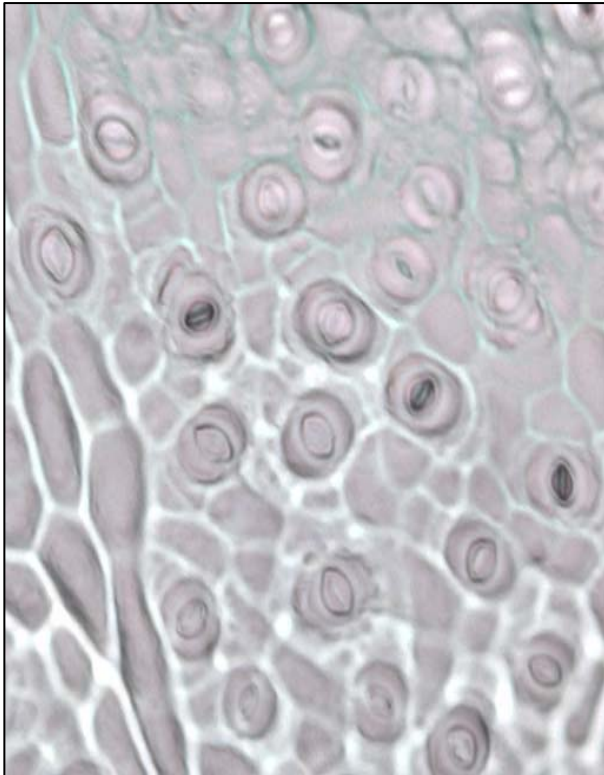
Weightings Used
Colour Key
Warning! Rare Characters: Bean size has only 2 high-scoring accessions
Mon has only 1 high-scoring accession

TABLE OF 31 RANKED ACCESSIONS: [Export Table](#)

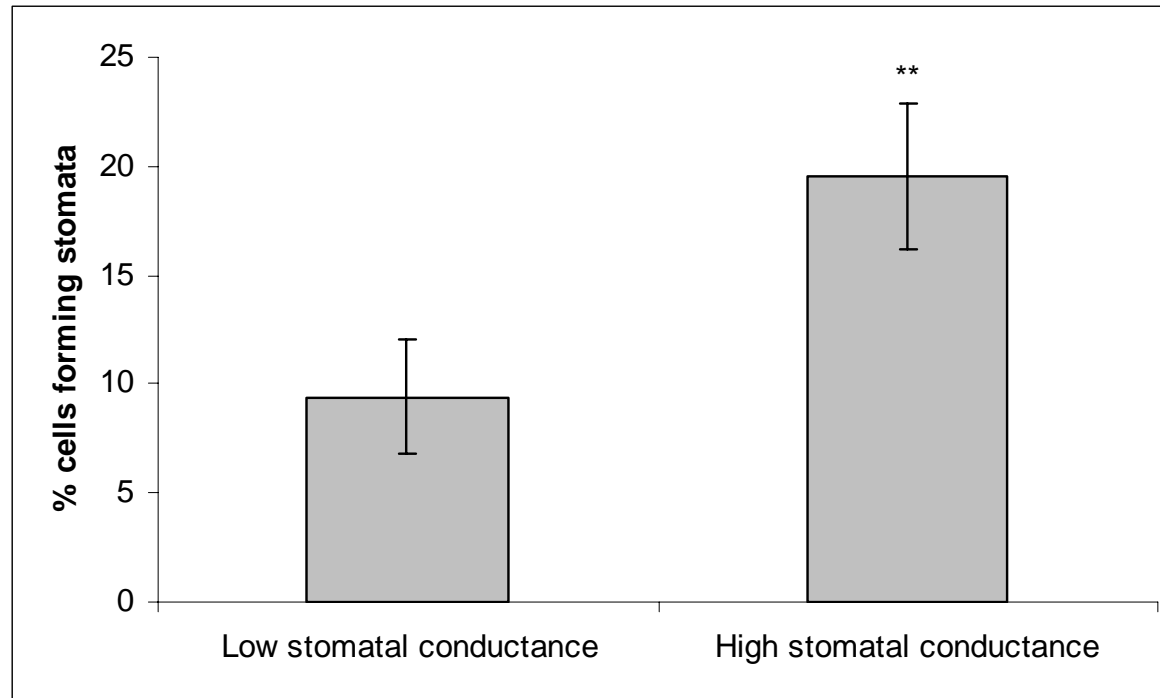
1	RUO 6	EET 272 [ECU]	372.3
Diversity: 9.00 Yield: 9 Pod: 2.63 Bean size: 1.18 Lipid: 7.39 Phyt: 10.20 WB: 10.20 Mon: _ VSD: 0 Mirids: _ (Unweighted - Requests: 0.47)			
2	RUO 1144	ICS 95	310.6
Diversity: 0.29 Yield: 9 Pod: 3.60 Bean size: 1.73 Lipid: 2.82 Phyt: 5.18 WB: 6.99 Mon: 6.75 VSD: 4.37 Mirids: 6.38 (Unweighted - Requests: 0.00)			
3	RUO 334	AMAZ 12 [CHA]	299.6
Diversity: 4.70 Yield: _ Pod: 7.02 Bean size: 1.95 Lipid: 4.43 Phyt: 9.27 WB: 9.20 Mon: _ VSD: _ Mirids: _ (Unweighted - Requests: 0.77)			
4	RUO 849	IMC 47	294.1
Diversity: 3.11 Yield: 9 Pod: 2.56 Bean size: 1.32 Lipid: 2.55 Phyt: 6.70 WB: 8.69 Mon: _ VSD: 0 Mirids: _ (Unweighted - Requests: 2.62)			
5	RUO 1089	ICS 39	278.6
Diversity: 3.52 Yield: 9 Pod: 6.39 Bean size: 3.32 Lipid: 3.63 Phyt: 3.55 WB: 6.62 Mon: _ VSD: 2.25 Mirids: 5.25 (Unweighted - Requests: 0.00)			
6	RUO 1058	PA 4 [PER]	275.5
Diversity: 4.66 Yield: 9 Pod: _ Bean size: 1.82 Lipid: 2.55 Phyt: 3.63 WB: 8.21 Mon: _ VSD: _ Mirids: _ (Unweighted - Requests: 0.00)			
7	RUO 55	UF 667	265.8
Diversity: 0.82 Yield: 8.40 Pod: 4.49 Bean size: 4.86 Lipid: _ Phyt: 1.12 WB: 8.52 Mon: 0 VSD: 8.62 Mirids: 4.35 (Unweighted - Requests: 0.26)			
8	RUO 862	IMC 103	249.8
Diversity: 2.82 Yield: _ Pod: 3.91 Bean size: 3.59 Lipid: 4.97 Phyt: 5.59 WB: 7.62 Mon: _ VSD: _ Mirids: _			

Regulation of physiological traits

Stomatal number change with genotype



Relationship between stomatal number and conductance

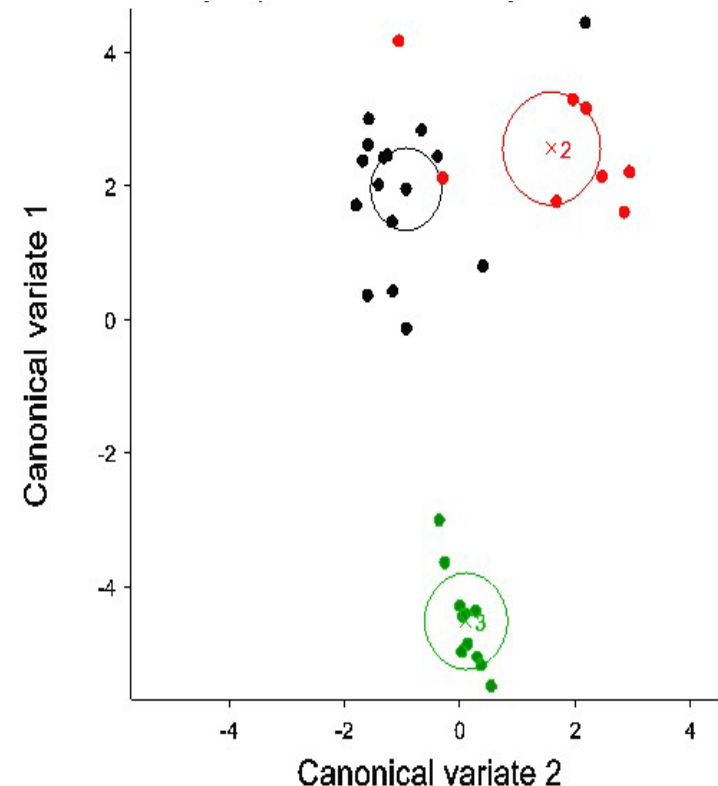


How does the plant respond to high temperatures and limited water supply.

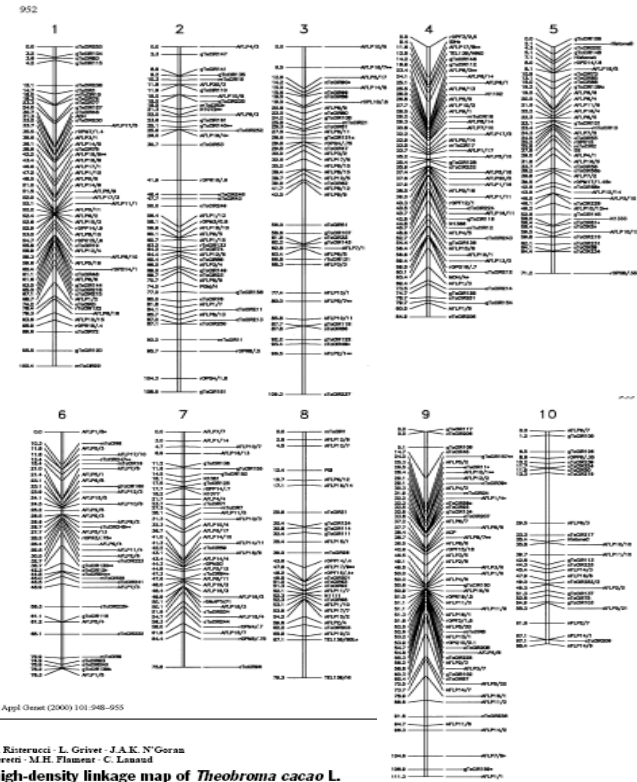
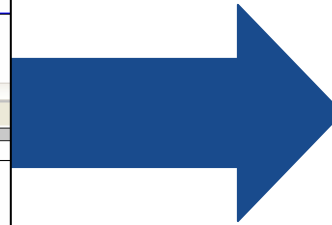
Plant plasticity and Genomic regulation

DNA methylation differences between tissue types

- Different tissues from the same plant show reproducible and predictable differences in methylation of patterns.
- Indiscriminate methylation increases with age.
- Similar response for temperature differences



Where are the changes



- By identifying areas of the genome that are heavily regulated in response to temperature we identify genes linked the plant response

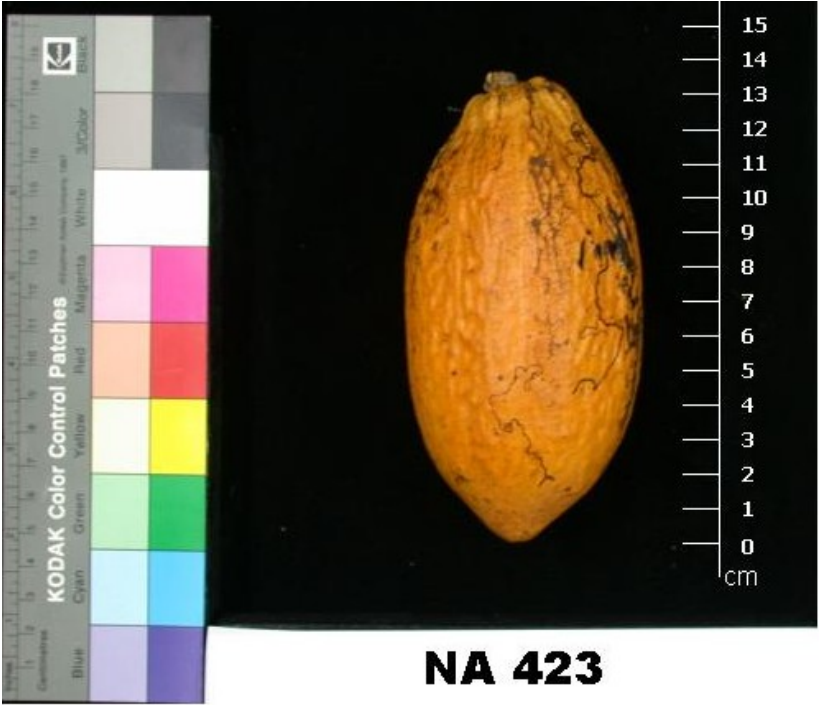


Cocoa population structure in the upper Amazon

Nicholas Cryer, David Butler

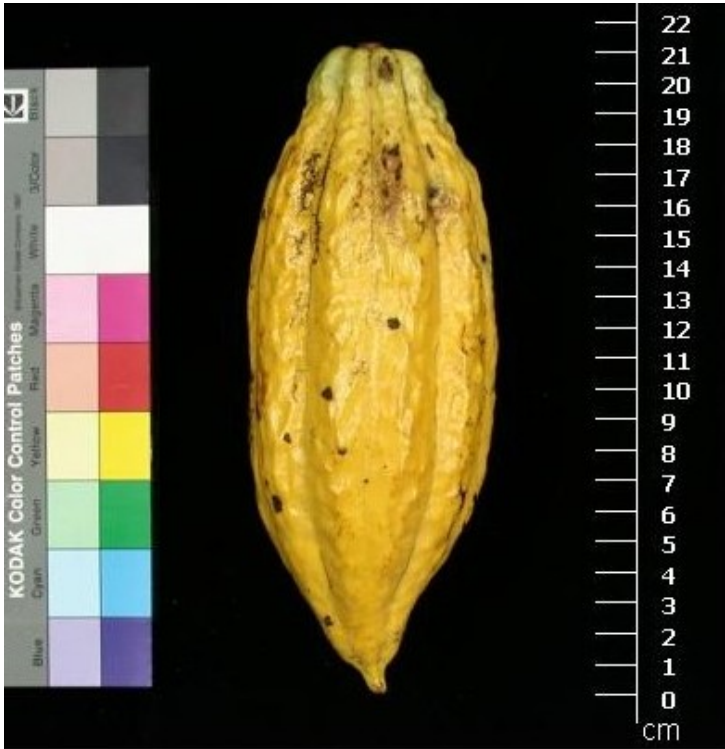


The upper Amazon region is rich in diversity



NA 423

MARPER D757



PA 218

D708 MARPER



Morphological classification

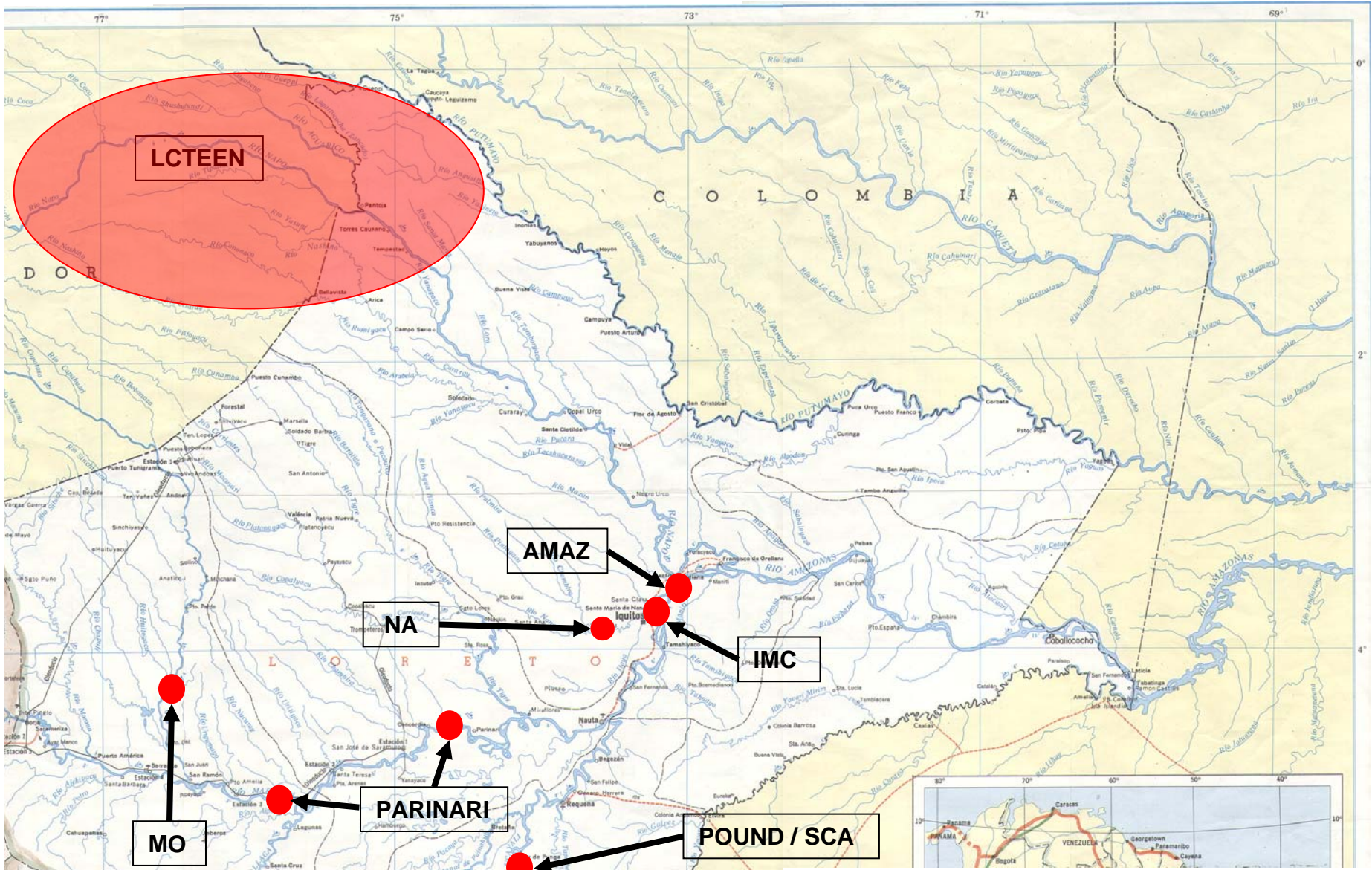
- **Morphological traits are complex.**

- It is difficult to describe relationships between populations based on morphological descriptions of individuals.



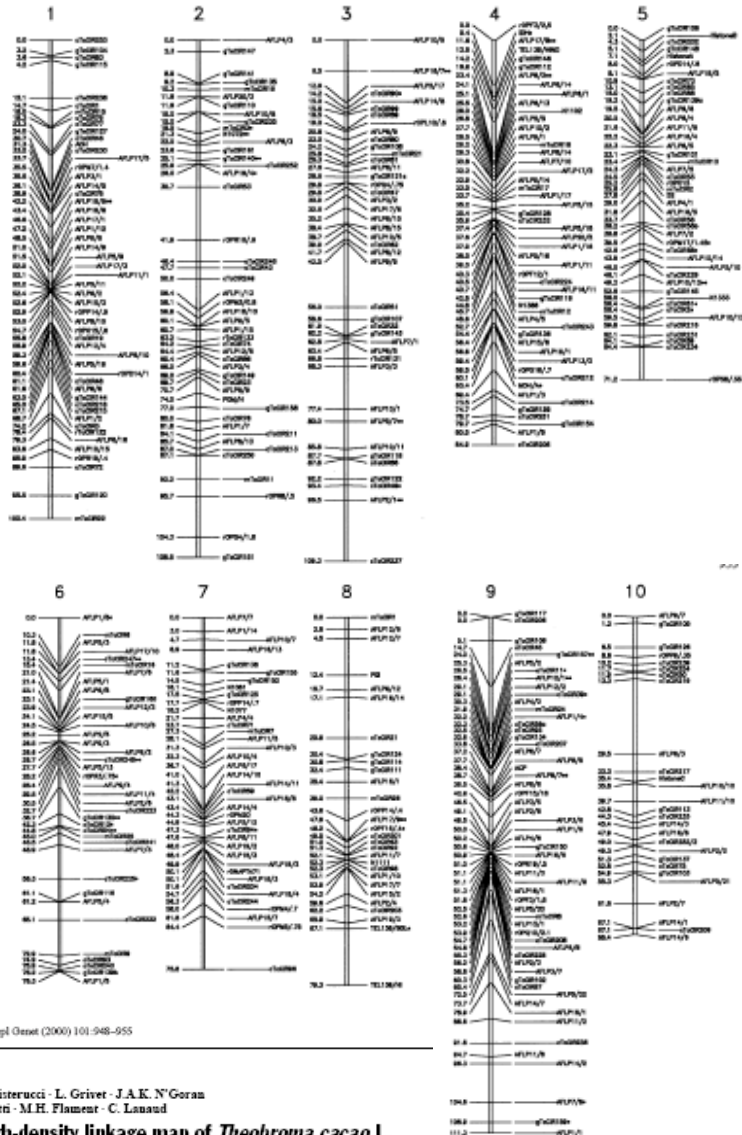
- **There are environmental effects on the morphological traits being measured.**

Collection Sites in Upper Amazon





What has been measured?



Theor Appl Genet (2000) 101:948–955

A.M. Rasterrucci · L. Grivet · J.A.K. N'Goran
I. Pierrat · M.H. Flamant · C. Linaud

A high-density linkage map of *Theobroma cacao* L.



Most typical specimens



LCTEEN10	0.978	0.004	0.001	0.000	0.001	0.003	0.002	0.002	0.001	0.003	0.002	0.003
LCTEEN16	0.944	0.000	0.001	0.006	0.009	0.009	0.000	0.003	0.002	0.022	0.001	0.002
ELCTEEN1	0.945	0.001	0.000	0.000	0.022	0.007	0.006	0.001	0.000	0.017	0.000	0.000
LCTEEN21	0.995	0.000	0.000	0.001	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
LCTEEN32	0.979	0.008	0.001	0.000	0.004	0.001	0.000	0.003	0.000	0.002	0.002	0.000
LCTEEN38	0.970	0.004	0.002	0.007	0.001	0.001	0.001	0.005	0.003	0.004	0.001	0.002
LCTEEN41	0.159	0.780	0.000	0.001	0.000	0.000	0.035	0.001	0.000	0.000	0.018	0.005
LCTEEN36	0.005	0.837	0.039	0.010	0.000	0.006	0.000	0.001	0.014	0.087	0.001	0.000
LCTEEN40	0.119	0.853	0.023	0.001	0.000	0.001	0.001	0.003	0.000	0.001	0.000	0.000
LCTEEN36	0.012	0.945	0.000	0.001	0.013	0.019	0.004	0.002	0.002	0.001	0.001	0.000
LCTEEN41	0.253	0.713	0.000	0.000	0.005	0.000	0.000	0.001	0.000	0.003	0.000	0.024
ELP16	0.000	0.001	0.990	0.000	0.001	0.001	0.000	0.001	0.004	0.000	0.000	0.002
GU300/P	0.000	0.000	0.992	0.000	0.001	0.000	0.000	0.000	0.002	0.002	0.001	0.001
GU351/P	0.001	0.001	0.990	0.000	0.002	0.000	0.000	0.000	0.000	0.001	0.000	0.003
GU175/P	0.001	0.000	0.989	0.001	0.000	0.001	0.001	0.001	0.004	0.002	0.001	0.000
GU151/F	0.000	0.002	0.988	0.002	0.002	0.001	0.000	0.000	0.000	0.000	0.002	0.002
GU335/P	0.003	0.001	0.985	0.001	0.000	0.001	0.000	0.001	0.005	0.001	0.001	0.001
GU305/P	0.001	0.002	0.992	0.001	0.001	0.000	0.001	0.000	0.001	0.000	0.002	0.000
PA184	0.001	0.002	0.005	0.936	0.021	0.010	0.000	0.002	0.001	0.001	0.015	0.006
NA534	0.002	0.000	0.002	0.983	0.001	0.002	0.003	0.001	0.001	0.001	0.004	0.000
PA12	0.003	0.000	0.023	0.960	0.005	0.000	0.001	0.003	0.002	0.000	0.003	0.001
PA27	0.000	0.000	0.001	0.944	0.000	0.000	0.000	0.007	0.005	0.029	0.000	0.014
PA186	0.005	0.002	0.002	0.952	0.008	0.006	0.008	0.009	0.001	0.002	0.001	0.005
PA95	0.004	0.002	0.005	0.962	0.004	0.004	0.001	0.001	0.010	0.002	0.004	0.001
PA139	0.003	0.002	0.001	0.956	0.002	0.023	0.000	0.009	0.004	0.000	0.000	0.001
PA41	0.002	0.004	0.006	0.973	0.004	0.001	0.002	0.003	0.001	0.002	0.002	0.001

- By inferring an ideal population individuals can be assigned based on how closely they meet this concept.



Morphological classification

- **Morphological traits are complex.**

- By using the most typical individuals defined from the molecular data it is possible to gain an insight into how the morphological variation follows population relationships .



- **There are environmental effects on the morphological traits being measured.**



Outcomes (1)

- We now have direct evidence that there are geographically separated populations in the upper Amazonian region.
- Distinct populations can also be collected from confined regions.
- Individuals can be assigned to populations and hybrids between populations have been identified.



Outcomes (2)

- The agronomic characterisation of accessions can be prioritised in order to most efficiently study a wide a range of significantly different germplasm.
- We can better recommend where to collect new accessions based on improved understanding of population groups.
- Provide information to aid rationalisation decisions in genebanks.



Reading University

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- Heather Lake

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- Mike Wilkinson

CRU, Trinidad

- David Butler

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- **CFC**