GENETIC RESOURCES OF COCOA

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INTERNATIONAL BOARD FOR PLANT GENETIC RESOURCES

IBPGR Working Group on Genetic Resources of Cocoa

co-hosted by the IOCC and ACRI
Arlington, Virginia, USA, 8-9 July 1980

REPORT

IBPGR SECRETARIAT
Rome, 1981

The International Board for Plant Genetic Resources (IBPGR) is an autonomous, international, scientific organization under the aegis of the Consultative Group on International Agricultural Research (CGIAR). The IBPGR, which was established by the CGIAR in 1974, is composed of its Chairman and 15 members; its Executive Secretariat is provided by the Food and Agriculture Organization of the United Nations. The basic function of the IBPGR, as defined by the Consultative Group, is to promote an international network of genetic resources centres to further the collection, conservation, documentation, evaluation and use of plant germplasm and thereby contribute to raising the standard of living and welfare of people throughout the world. The Consultative Group mobilizes financial support from its members to meet the budgetary requirements of the Board.

IBPGR Executive Secretariat
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INTRODUCTION

1. A Working Group on Genetic Resources of Cocoa was held at Arlington, Virginia, USA, 8-9 July 1980. This was organized by the IBPGR and co-hosted by the International Office of Cocoa and Chocolate (IOCC) and the American Cocoa Research Institute (ACRI). The meeting was chaired by Dr. Russell E. Larson, ACRI and Dr. J.T. Williams, Executive Secretary IBPGR acted as technical secretary.

2. Membership of the Working Group was purposely kept small in order to develop a feasible plan of action which would meet international requirements. Of the participants invited, the following attended: Dr. R.E. Larson (ACRI), G. Lockwood (UK), J.O. Sanwo (Nigeria), H. Toxopeus (IOCC) and J. Soria (Brazil). Dr. V.A. Martinson (Ghana) and Dr. P. Dublin (Ivory Coast) were unable to attend. Dr. Quentin Jones represented the IBPGR and the following attended as observers: Dr. E.P. Imle (USDA) and Messrs. R.T. O'Connell and Glen Trout of ACRI. The full addresses of the participants are shown in Appendix I.

3. Dr. Williams welcomed the participants on behalf of the IBPGR and expressed the hope that the meeting would reach definite conclusions on action required and that specific recommendations would be made to the Board and to those organizations involved with cocoa, particularly on collection requirements, sites for conservation and on the descriptors to be used to characterize material.

4. The provisional agenda was modified and adopted as shown in Appendix II.

REPORT[1/]

5. Recognizing that:

(a) the genetic base of parents used for the production of hybrid cocoa varieties is very limited;

(b) there is severe genetic erosion of cocoa germplasm resources in Latin America; Criollo types are particularly endangered in Central America;

(c) there have been hitherto uncoordinated collecting missions;

(d) some indigenous germplasm in the Amazon Basin has already been lost because of oil exploration and other developments;

(e) immediate attention should be given to collections of *Theobroma bicolor*, *T. gileri*, *T. mammosum*, *T. angustifolium* and *T. grandiflorum* as well as *Herrania* spp.;

(f) there is germplasm available in collections which is apparently not known to the cocoa community; a large proportion of existing material has never been evaluated or utilized; and moreover there are known major gaps in the collections;

1/ This report was endorsed by the IBPGR at its eighth meeting, Rome, 17-20 February 1981.

(g) cocoa is highly important as a cash crop in developing countries; there is a great demand for planting material, prompted in part by the role of cocoa in subsistence farming systems for the small farmer (e.g. it takes the place of bush fallow); and

(h) progress with control of major diseases is limited by the lack of diverse germplasm;

it was agreed unanimously by the Working Group that cocoa should receive priority global consideration.

Existing collections

6. The Working Group discussed the major existing collections on the basis of reports provided by participants and published reports. The major collections are as follows:

(i) Trinidad: the collections have the widest representation of cocoa populations obtained from expeditions to South America in the 1930s and later and are the most important sources of genetic variation for other countries. The collections at the University and the Cocoa Board include many unique accessions of species of *Theobroma* and *Herrania* (e.g. samples of the Anglo-Colombian material, Pound's material from the Upper Amazon, Ecuadorian refactarios, Freeman's TSH and TSA clones and Chalmer's Oriente seedlings). The collection includes the original ICS selections. The Working Group was informed that additional material is being incorporated from collections in Ecuador financed by the London Cocoa Trade. They were also advised that the European Economic Commission is to provide funds (under the Lomé Convention) for the Trinidad work on cocoa which will assist in expanding the collection, evaluating the material, and propagating for interregional distribution. The project is planned for three years with a possibility of expansion for a further period. The Working Group welcomed this information insofar as it ensures the short-term continuation of the unique Trinidad collection.

(ii) Brazil: CEPLAC-CPATU Experiment Station, Belém (primary station) and Centro de Pesquisos do Cacau, Itabuna (secondary station). Includes material from several missions to the Amazon and at least 10 species of *Theobroma*, but there have been no efforts to collect systematically the closely related wild species. Very little of the collection is duplicated elsewhere. It also includes many clonal introductions from Trinidad, UF clones selected by the United Fruit Company on the Atlantic coast of Costa Rica and CC clones from selections among local material at Turrialba, Costa Rica. Some restrictions have been experienced in the availability of this material.

(iii) Ecuador: Estación Experimental Tropical INIAP, Pichilingue. Over 500 samples are represented including clones selected on Ecuadorian farms as well as material from the eastern side of the Andes in the Amazon area, arising from collecting expeditions made in the late 1940s as well as more recent collaborative work with Trinidad. There are few samples of wild material. Material is not always readily exchanged and there is an urgent need for duplication of the material and to convince the Ecuadorian government to pay more attention to the maintenance of the important collection. Within Ecuador, *T. gileri*, a possible ancestor of cultivated cocoa, should be collected.

(iv) Costa Rica: Centro de Enseñanza y Investigacion de IICA, Turrialba. This collection includes a) United Fruit Company material, b) vegetatively propagated selected clones from most Latin American cocoa producing countries, and c) seedlings and budwood of interesting Criollos collected by Soria from Central America, the Dominican Republic, Venezuela and Colombia. In addition there are eight species of *Theobroma* and seven species of *Herrania*. The Criollo material is easily lost due to *Ceratocystis* attack and this, at present, represents a hazard.

(v) Venezuela: Estación Experimental Caucagua. The collection includes Criollo or near-Criollo types from northern Venezuela, especially the Orinoco valley Amazon types. It is not comprehensive and more Orinoco populations should be collected.

(vi) United States: Subtropical Horticulture Research Unit, Miami (transfer station) and Mayaguez Experiment Station, Puerto Rico. The collection presently includes 213 clones of known breeding work. Also included are four hybrid lines and 34 Amelonado seedlings.

7. The collections listed above in paragraph 6 were, with the exception of the USA collection, recognized by the Working Group as primary collections. In addition there are smaller primary collections in Colombia (Instituto Colombiano Agropecuario ICA, Palmira) which includes local selections made in the 1940s and 1950s and some new ones made in the oriental Amazon basin, and Mexico (Izapa Station) which has a small collection.

8. All other cocoa collections (i.e. those in Africa and Asia) are to be regarded as secondary collections. Each should be viewed as an isolated collection taking material from primary collections through an intermediate quarantine station. None of the secondary collections are comprehensive but some do contain unique material, e.g. the old Criollo introductions taken to Java, Indonesia via the Philippines, the pure Criollo material in cultivation near Madras, India and the interesting West African Amelonados and Trinitarios in several West African countries. Nevertheless, since the material of major importance is from the centre of diversity in the New World, the Working Group agreed that recommendations should relate to that part of the world and secondary collections should not confuse the picture.

9. The major collections are not representative of the genepool of cocoa and collecting is urgent in many regions (see paras. 10 - 13). Also, to date, cocoa breeders have been unable to transfer genetic material from wild species; hence the genetic base of the wild species is not part of the present base of *Theobroma cacao*. Nevertheless, the Working Group recognized that collections should be expanded to include more wild material in the expectation that difficult crossing barriers can be overcome. In addition, the interest currently being shown in the food oil-producing species will necessitate the screening and use of more wild species. Of the many *Theobroma* and *Herrania* species the following merit attention and should be better represented in collections:

Theombroma bicolor (used as a beverage in Central America)
T. speciosum
T. simiarum
T. mammosum
T. angustifolium
T. gileri
T. grandiflorum

Identification of priority areas for collecting

10. The Criollos of Central America represent the original material first cultivated, the Forasteros form a second large genetic complex which includes material derived from wild Amazon populations. Hybrids between the two are known as Trinitarios. The Working Group considered the priority areas i) specifically in relation to Criollos and ii) to the other parts of the genepool.

11. Criollos

(i)	Mexico:	Lancandona area (wild or semi-wild) Chontalpa and Tapachula districts (cvs.)
(ii)	Guatemala:	Suchitepéquez (relict cultivation) Border area between Guatemala and Belize
(iii)	Honduras:	Cuyamel and Bajo Aguán (Criollo types in the jungle)
(iv)	Nicaragua:	San Jorgé and Valle Menier (plantation material) Nandaime, Masatepe regions and river Chinandega (relict Criollos)
(v)	Costa Rica:	Plains of Los Guatusos
(vi)	Colombia:	Tuluá, Buga and Cartago in the Cauca valley Huila district Chinschiná (Caldas) Dibuya (Magdalena)
(v)	Venezuela:	Santa Bárbara Catatumbo river Chama valley North of the State of Aragua

It was not possible to rank the above areas into any descending order of priority because genetic erosion is severe in all the areas identified. Much material has already become extinct (e.g. in 1977 Imle reported Criollos in the western slopes of Guatemala but they have since disappeared). Many of the areas contain relict populations of pre-conquest cultivation and it is urgent that they are salvaged.

12. Other priority areas

(i)	Bolivia:	Mamoré and Alto Beni rivers
(ii)	Peru:	Ucayali, Huallaga, Marañon and Madre de Dios rivers
(iii)	Ecuador:	South, bordering Peru (Morona river)
(iv)	Colombia:	Lower and Putumayo rivers
(v)	Brazil:	Obidos area Jari area
(vi)	Venezuela:	Orinoco river system Guyana border area

13. The Working Group recognized that of the countries listed in paragraphs 11 and 12, only the national programmes of Costa Rica, Brazil, Ecuador and Venezuela are likely to have personnel available for collecting. Specific recommendations for a *modus operandi* are made in paragraph 24.

Methods of conservation and sampling techniques

14. Three approaches may be considered as alternatives to the maintenance of trees: seed storage, pollen storage and tissue culture. The first has no practical relevance except for temporary storage of moist cocoa seeds, the second has not proved practicable for long periods and the techniques have not been sufficiently researched for the third. The Working Group recognized that much more research is required to develop tissue culture techniques for cocoa and recommends that the work be continued and expanded. In the foreseeable future, however, trees offer the only secure procedure for maintenance of cocoa germplasm.

15. It was agreed that to maintain clonal material a minimum of three to four trees is necessary and that each clone must be so replicated over different locations. For large and variable populations up to 100 trees should be sampled by taking a few pods randomly per tree. The seed from these pods should be mixed thoroughly and not less than 100 progeny (preferably more) should be maintained. For small variable populations 100 pods should be taken at random, the seeds thoroughly mixed and 100 progency maintained. These rules may be modified by the collectors. When buuwood is collected, 50 trees should be sampled at random.

Proposed collections for designation as major repositories

16. Following the conclusion in paragraph 8, the Working Group agreed that there is no case for the designation of a cocoa genetic resources centre outside the New World, since the genepools for consideration are exclusively the primitive populations of Latin America. The Working Group recommends three types of designated centres:

(i) Primary collections, which are at centres actively associated with collecting part of the genepool and which will maintain, evaluate, document and exchange material.

(ii) Universal collection depositories which, between them, duplicate their own material and that of the primary collections. These depositories will be involved with all aspects of genetic resources work.

(iii) Quarantine transfer collections, which will act as centres for the transfer of material, and will serve as "safe haven" working collections for breeders.

17. The Working Group suggests that the IBPGR designate a number of centres, listed below, on condition that the following criteria are met:

(i) the host government guarantees free and full availability of material and information about the materials;

(ii) the host government recognizes the global importance of the collections and provides an assurance of its continued maintenance at least for the foreseeable future and that if, for some reason or other in the future, this commitment cannot be fulfilled it will alert the IBPGR; and

(iii) the funding for the collection is secure, either by means of the national budget or through bilateral aid.

The following centres should be designated:

(i) Brazil (Belém) and Ecuador (Pichilingue) as primary collections;

(ii) Trinidad and Costa Rica, as universal collection depositories (each duplicating their collection at the other); and

(iii) USA (USDA stations at Mayaguez and Miami) and UK (Royal Botanic Gardens, Kew) for quarantine transfer and Mayaguez as a secure working collection for breeders.

18. The IBPGR is requested to assist the primary collections to undertake systematic field collecting. In addition the IBPGR is asked to inform the goverments of the USA and UK of the tremendous importance of the intermediate quarantine service provided and for the secure working collection of cocoa clones. The Working Group recognized that other services have existed on a small scale in the Netherlands, France and Portugal for specific customers.

Quarantine

19. The Working Group recognized that there has been over the past two decades an increasing demand for the exchange of cocoa germplasm between the major producing countries but rigid quarantine control measures are essential.

20. With respect to the USA quarantine transfer, collection clones or seeds should be transmitted directly to Miami for quarantine; from there they may be distributed directly or they may be transferred to Mayaguez from whence distribution will be effected. Material should not be sent directly to Mayaguez for any reason. With respect to post-entry quarantine, this depends on the individual country regulations.

21. The Working Group recommends that curators use a courier system to ensure the safe and speedy transfer of material. The IBPGR might wish to draw the attention of IATA to the fact that valuable short-lived germplasm has all too frequently been killed in transit.

22. The participant from Nigeria suggested that a West African nursery station for West African producing countries should be established and asked the IBPGR to draw the attention of FAO to this possibility.

Descriptors

23. Several papers proved to be valuable in the discussions of the Working Group, particularly Soria's International Cocoa Cultivars Catalogue and a list of descriptors by Engels, Bartley and Enriquez. The Working Group, however, agreed to recommend the adoption of a list of descriptors based on collective experience. It should be used for a) collecting expeditions and b) by the curators of collections for characterizing samples and data should be provided when materials are exchanged. The agreed lists are shown in Appendix IV.

Proposed framework for action

24. In view of the statement in paragraph 1 and moreover the recognition that a) there is no commercial breeding of cocoa outside Southeast Asia, and b) intermediate quarantine

is substantially financed by the industry, the Working Group recommends that the IBPGR consider urgent action on cocoa genetic resources, and specifically:

(i) accepts responsibility for coordinating the collecting and the conservation centres by funding for a limited period a respected scientist to devise a detailed plan which will be reported back to IBPGR, IOCC and ICRI. This should include the degree of individual government involvement, estimation of costs for the collecting and maintenance, the timing of the collecting, statement of what collecting work has been done so far, listing the outlook for financial support for the maintenance of collections and promoting interest;

(ii) following the report the IBPGR should, in principle, support a two to three year collection programme; and

(iii) following endorsement of this report the IBPGR should make it widely available in particular to the members of the Cocoa Producers Alliance in the event that the CPA's Research Committee might consider supplemental funding.

25. The Working Group points out to the IBPGR that there may be a need for it to meet again at some future date but not before the proposed coordinated work has been carried out and reported.

APPENDIX I

PARTICIPANTS

Representing IBPGR

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Dr. J.T. Williams	Executive Secretary, IBPGR FAO, Rome Italy

Representing IOCC

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Representing ACRI

Dr. R.E. Larson	ACRI 608 Elmwood Street State College, PA 16801 USA

Other Participants

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Dr. J.O. Sanwo	Cocoa Research Institute of Nigeria PMB 5244 Ibadan Nigeria

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APPENDIX I
(Continued)

Participants invited but unable to attend

Dr. V.A. Martinson	Ghana Cocoa Research Institute P.O. Box 8 Tafo Ghana
Dr. P. Dublin	GERDAT B.P. 5035 34032 Montpellier Cedex France

Observers

Dr. E.P. Imle	USDA, SEA Hyattsville, MD 20782 USA
Mr. Glenn Trout	ACRI - HERCO Hershey, PA 17033 USA
Mr. R.T. O'Connell	ACRI 7900 Westpole Drive Suite 514 McLean, VA 22102 USA

APPENDIX II

AGENDA

1. Need and reasons for a report on cocoa genetic resources

2. Review of ongoing activities and major existing collections (by species and areas represented)

3. Consideration of form of maintenance to be proposed for collections

4. Site or sites to be designated (by the IBPGR) as major repositories

5. Quarantine problems affecting transfer of material

6. Consideration of descriptors to be used to characterize accessions

7. Identification of resources and expenditures required and summary recommendations to IBPGR

APPENDIX III

PAPERS CONSULTED BY THE WORKING GROUP

1. Cacao and its Allies - A Taxonomic Revision of the Genus *Theobroma* by José Cuatrecasas. Smithsonian Institute, Washington, D.C., 1964, 614 p.

2. Global Concepts for Genetic Resources and Breeding in Cacao by B.G.D. Bartley. VII International Research Conference, 4-12 November 1979, Douala, Cameroon, 24 p.

3. International Cocoa Cultivar Catalogue, edited by J. Soria, 1975.

4. Guidelines for Developing Descriptor Lists, IBPGR Secretariat, 1980.

5. Cocoa Descriptors, their states and *Modus operandi*, by J.M.M. Engels, CATIE, undated.

6. Data sheet for scoring descriptors of *Theobroma cacao* (mimeographed; in Spanish), CATIE, undated.

7. Descriptores de Cacao (*Theobroma cacao* L.) by J.M.M. Engels, CATIE, undated.

8. Preliminary list of Cocoa germplasm collections, IBPGR Secretariat, 1980.

9. Primitive Cultivars of Cacao in America by J. Soria, In; Frankel O.H. (ed.) Survey of Crop Genetic Resources in their Centres of Diversity, 1973: 119-125, FAO/IBP.

10. The CRIG Cocoa Germplasm Collections with Notes on Codes used in the Breeding Programme of Tafo and elsewhere by G. Lockwood and M.M.O. Gyamfi, 1979 Tech. Bull. 10, Cocoa Res. Inst. Ghana, 62 p.

11. Cocoa Genetic Resources in Nigeria - Current Status, Activities and Attending Problems by J.O. Sanwo, 1980, 8 p.

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APPENDIX IV

LIST OF DESCRIPTORS FOR COCOA

PASSPORT DATA

1. ACCESSION DATA

1.1 ACCESSION NUMBER

This number serves as a unique identifier for accessions and is assigned by the curator when an accession is entered into his collection. Once assigned, this number should never be reassigned to another accession in the collection. Even when an accession is lost, its assigned number is still not available for re-use. Letters occur before the number to identify the genebank

1.2 GENUS

1.3 SPECIES

1.4 CULTIVAR NAME

1.5 DONOR NAME

If received from another institute

1.6 DONOR NUMBER

Number assigned by donating institute

1.7 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH THE ACCESSION

Not collection number, see 2.2

2. COLLECTION DATA

2.1 COLLECTING INSTITUTE

2.2 ORIGINAL NUMBER ASSIGNED BY THE COLLECTOR OF THE SAMPLE

2.3 DATE OF COLLECTION OF ACCESSION

Expressed as day/month/year, e.g. 27 May 1981 as 270581

2.4 COUNTRY OF COLLECTION

Use the three letter abbreviations supported by the Statistical Office of the United Nations. Copies of these abbreviations are available from the IBPGR Secretariat

2.5 LATITUDE OF COLLECTION SITE

Degrees and minutes suffixed by N or S, e.g. 0530 N

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2.6 LONGITUDE OF COLLECTION SITE

Degrees and minutes suffixed by E or W

2.7 LOCATION OF COLLECTION SITE

Number of kilometres and direction from nearest town, village or map reference point

2.8 ALTITUDE OF COLLECTION SITE

Elevation above sea-level, in metres

2.9 TYPE OF SAMPLE

1 Population
2 Clone

2.10 STATUS OF SAMPLE

1 Wild
2 Weedy
3 Primitive cultivar
4 Advanced cultivar

CHARACTERIZATION AND PRELIMINARY EVALUATION

3. CHARACTERIZATION BY THE COLLECTOR

3.1 PLANT APPEARANCE

A score referring to the general appearance and based on observations of several trees

3 Small
5 Medium
7 Large

3.2 FLUSH COLOUR

Description of the absence or presence of anthocyanin in a young flush

0 Green
1 Pigmented

3.3 FLOWERING CHARACTERISTICS

3.3.1 Anthocyanin in petal ligule

0 Green
1 Red pigmented

3.3.2 Anthocyanin in petal filament

0 Absent
5 Intermediate
7 Intense

3.4 FRUIT CHARACTERISTICS

3.4.1 Fruit shape

1 Angolata
2 Cundeanor
3 Amelonado
4 Calabacillo
5 Other

(Reference: Van Hall, C.J.J. 1932, Cocoa. 2nd Edition, Macmillan, London, pp. 87-91)

3.4.2 Basal constriction

Score representing the constriction, or 'bottle neck' of the basal part of the fruit (see Figure 1)

0 Absent
1 Slight
2 Intermediate
3 Strong
4 Wide shoulder

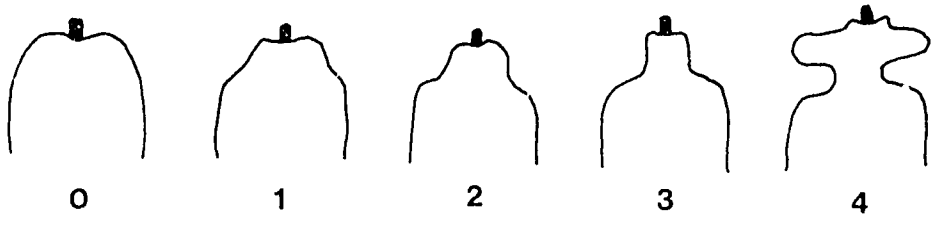

Figure 1. Basal constriction

3.4.3 Apex form

Score representing the form of the apical part of the fruit (see Figure 2)

1 Attenuate
2 Acute
3 Obtuse
4 Rounded
5 Mammelate
6 Indented

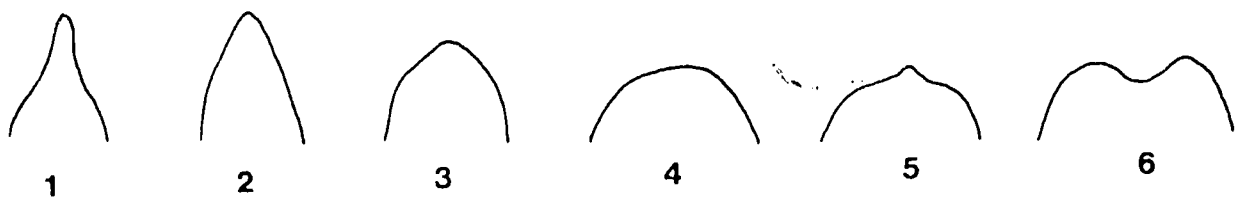

Figure 2. Apex form

3.4.4 Fruit surface rugosity

The description of the absence or presence of protuberances on the fruit surface

0 Smooth
5 Intermediate
7 Rough

3.4.5 Prominence of ridges

1 Slight
2 Distinct

3.4.6 Fruit ridge pair disposition

1 Equidistant
2 Paired

3.4.7 Husk hardness

3 Soft
5 Intermediate
7 Hard

3.4.8 Colour of immature fruit

1 Green
2 Reddish
3 Red

3.4.9 Size of fruit

3 Small
5 Medium
7 Large

3.5 SEED CHARACTERISTICS

3.5.1 Number of beans per pod

Record as the absolute number

3.5.2 Size of beans

3 Small
5 Medium
7 Large

3.5.3 Shape of beans

1 Flat (plate like)
2 Round (plump)

3.5.4 Percentage beans with white cotyledons

3.5.5 Percentage beans with purple cotyledons

3.5.6 Percentage beans with intermediate colour cotyledons

3.6 DEGREE OF PRESENCE OF DISEASES

3.6.1 *Crinipellis perniciosa* infection

0 Absent
5 Intermediate
7 High

3.6.2 *Phytophthora* sp. infection

0 Absent
5 Intermediate
7 High

3.6.3 *Monilia roreri* infection

0 Absent
5 Intermediate
7 High

3.7 COLLECTORS' REMARKS

APPENDIX IV
(Continued)

4. CHARACTERIZATION AND PRELIMINARY EVALUATION BY THE CURATOR

4.1 PLANT HABIT

A mean observation of several trees. The angles between two main branches or the angles between the main branches and the trunk should be recorded as absolute figures

4.2 LEAF CHARACTERS

Scored as a mean of 15 second leaves

4.2.1 Length/width ratio

Use absolute values

4.2.2 Length of leaf

Length from base to widest point, in cm.

4.2.3 Leaf base shape

Expressed as the angle which the margins form with the petiole at its point of insertion. Absolute values should be recorded

4.2.4 Leaf apex shape (see Figure 3)

1 Acute
2 Short acuminate
3 Long acuminate

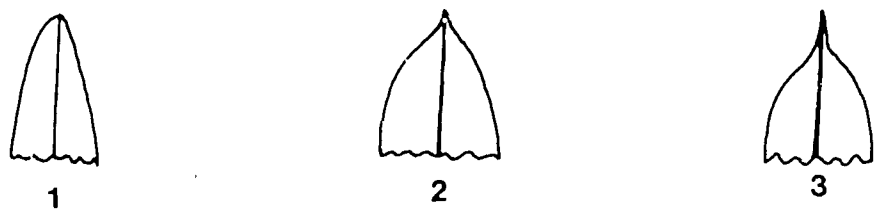

Figure 3. Leaf apex shape

4.2.5 Leaf petiole pulvini

Presence or absence of pulvini

0 Pulvini absent
+ Pulvini present

4.3 FLOWERING CHARACTERS

4.3.1 Flowering intensity

The number of flowers per cushion (sample size 300)

3 Low
5 Medium
7 High

4.3.2 Self-compatibility

0 No
+ Yes

4.4 FLOWER CHARACTERS

Data are taken from five feshly opened flowers

4.4.1 Peduncle colour

1 Green
2 Green with red
3 Red

4.4.2 Anthocyanin in outer sepal

0 Absent
3 Slight
5 Intermediate
7 Intense

4.4.3 Sepal length in millimetres (sample size 20)

4.4.4 Sepal width at widest point in millimetres (sample size 20)

4.4.5 Sepal length/width ratio

4.4.6 Sepal reflexion

0 Not reflexed (i.e. horizontal)
1 Reflexed (i.e. curved backwards)

4.4.7 Petal ligule length

Distance in millimetres between point of insertion of isthmus in hood and apex of ligule (sample size 15)

4.4.8 Petal ligule width at widest point in millimetres

4.4.9 Anthocyanin in stamen filament

0 Absent
3 Light
5 Intermediate
7 Intense

4.4.10 Staminode length in millimetres (sample size 10)

4.4.11 Ovary length in millimetres (sample size 15)

4.4.12 Ovary width at widest point in millimetres (sample size 10)

4.4.13 Number of ovules per ovary

The absolute numbers in 5 ovaries

4.4.14 Style length in millimetres (sample size 10)

4.5 FRUIT CHARACTERS

4.5.1 Fruit shape

The character recorded during collection[1/] can be amplified by more detailed description of mature fruits as below (see Figure 4)

1 Oblong
2 Elliptic
3 Obovate
4 Orbicular
5 Oblate

(lines represent greatest width)

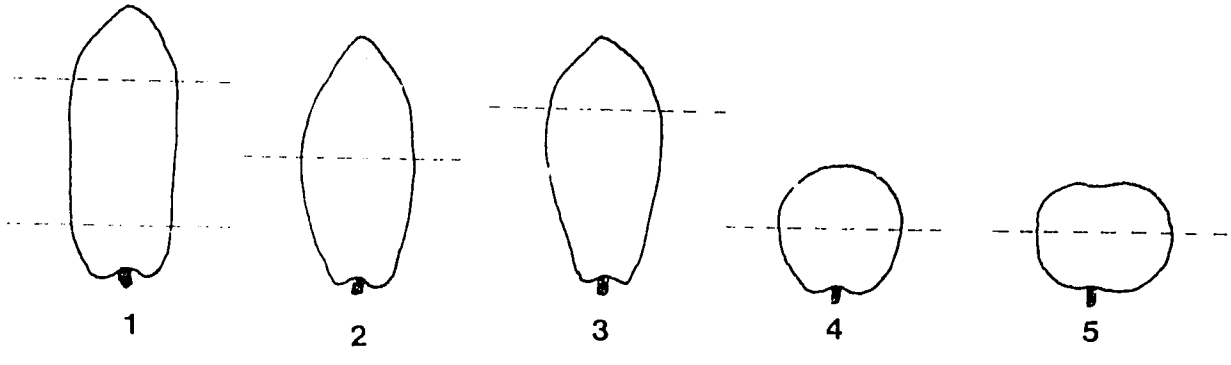

Figure 4. Fruit shape

4.5.2 Fruit length in centimetres (sample size 35)

4.5.3 Fruit width at widest point in centimetres (sample size 35)

4.5.4 Weight of whole pod in grammes (sample size 35)

1/ Curators should include in the data base the characters recorded during collection

APPENDIX IV
(Continued)

4.5.5 Fruit primary furrow depth

The depth of the furrow between a pair of ridges

3 Superficial
5 Intermediate
7 Deep

4.5.6 Fruit wall thickness

Measurements made after removal of endocarp. Sample size 35

4.5.6.1 Husk hardness

3 Soft
5 Intermediate
7 Hard

4.5.6.2 Ridge depth in millimetres

4.5.6.3 Primary furrow depth in millimetres

4.5.6.4 Secondary furrow depth in millimetres

4.5.6.5 Mesocarp stony layer

3 Thin
5 Intermediate
7 Thick

4.5.7 Anthocyanin intensity of ridges

Scored on unripe fruits

0 Absent
3 Light
5 Intermediate
7 Intense

4.5.8 Anthocyanin intensity of primary furrows

0 Absent
3 Light
5 Intermediate
7 Intense

4.5.9 Anthocyanin intensity of ripe fruits

0 Absent (yellow)
3 Light
5 Intermediate
7 Intense

4.5.10 Period of maturity

The days from pollination to maturity

3 Short (150 days)
5 Intermediate (151-170 days)
7 Long (171 days)

4.5.11 Weight of husk

In grammes oven dry weight. Sample size 20 pods

4.5.12 Wet weight of beans

Mean weight in grammes per pod. Sample size 20 pods

4.5.13 Minimum number of seeds in a ripe pod

Sample size 20 pods

4.5.14 Average number of seeds in a ripe pod

Sample size 20 pods

4.6 SEED CHARACTERS

4.6.1 Dry cleaned unpeeled seed weight

In grammes of 20 pods, 5 seeds from each are weighed

4.6.2 Dry peeled seed weight

In grammes of 20 pods, 5 seeds from each are weighed

4.6.3 Seed length

In millimetres 5 peeled seeds from each of 20 pods are measured

4.6.4 Seed width

In millimetres 5 peeled seeds from each of 20 pods are measured

4.6.5 Seed thickness

In millimetres 5 peeled seeds from each of 20 pods are measured

4.6.6 Seed shape in longitudinal section (see Figure 5)

1 Oblong
2 Elliptic
3 Ovate

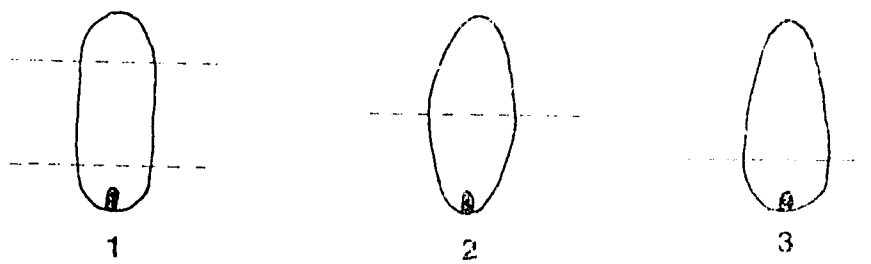

Figure 5. Seed shape in longitudinal section

PESTS AND DISEASES REACTION

It is not proposed that curators of collections carry out screening for pests and diseases, this being a task for the breeders as part of further evaluation. Nonetheless data should be fed back to the curators who maintain the primary material.