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GENETIC RESOURCES OF TOMATOES and wild relatives

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GENETIC RESOURCES OF TOMATOES AND WILD RELATIVES

- a global report -

by

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IBPGR SECRETARIAT
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Preface

Following the consultant report on vegetable germplasm (AGP:IBPGR/77/23), IBPGR held an expert consultation on this subject in January 1979. This consultation agreed on nine priority vegetables (see ACPE:IBPGR/79/3); tomato was considered of overriding importance. The IBPGR agreed with these proposed priorities and requested the Secretariat to carry out a special study on the genetic resources of Lycopersicon esculentum and related species.

The report presented here has relied heavily on information from Dr. C.M. Rick of the University of California at Davis, USA. In addition, Dr. W.H. Skrdla, Iowa State University, Ames, USA and Dr. R.L. Villareal, Asian Vegetable Research and Development Center (AVRDC), Taiwan, China have also provided significant contributions. Other important and valuable information has been obtained from Dr. M. Holle, Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica, Dr. Chr. Lehmann, Zentralinstitut für Genetik und Kulturplanzenforschung, Gatersleben, Democratic Republic of Germany, Dr. H.M. Munger, Cornell University, Ithaca, New York, Dr. R.W. Robinson, Northeastern Regional Plant Introduction Station, Geneva, New York and Dr. M.A. Stevens, University of California at Davis.

A draft of the report was circulated among a number of other world experts, then finalized and tabled for consideration by the IBPGR. At its eighth meeting, February 1981, the Board endorsed this report.

Acknowlegements

In addition to those cited on the previous page, the author acknowledges the assistance of the following in the preparation of this report:

Ir. D.H. van Sloten, IBPGR Secretariat, for discussions on technical aspects and presentation;

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Recommendations

On 17-20 February 1981 this report was discussed and approved by the IBPGR at its eighth meeting in Rome. The major recommendations endorsed by the Board during this meeting are outlined below:

1) Institutions dealing with genetic resources in the Andean zone should be contacted in order to motivate them to organize collecting missions in priority areas in this region. The cooperation of Dr. C.M. Rick would be very valuable in this respect.

2) Advice should be sought from the IBPGR Regional Committee for Southeast Asia with regard to collecting Asian cultivars in priority areas. The cooperation of Dr. R.L. Villareal would be very valuable in this area.

3) Tomato germplasm should be stored, evaluated and maintained in the following centres:

   i) A Genebank in the Andean zone

   A genebank in the Andean zone should be designated to hold a global base collection of *Lycopersicon* species, as soon as suitable long-term storage facilities are available;

   ii) Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica

   CATIE has agreed to hold a global base collection as part of the IBPGR global network. This agreement is a temporary solution until the genebank in the Andean zone is operational;

   iii) The National Seed Storage Laboratory (NSSL), Fort Collins, Colorado, USA

   The NSSL has agreed to hold a global base collection as part of the IBPGR network;

   iv) Zentralinstitut für Genetik und Kulturpflanzenforschung, Gatersleben, GDR

   This institute has been invited by the IBPGR to hold a global base collection as part of the IBPGR network;

   v) Institute for Plant Breeding (IPB), Los Baños, Philippines

   The IPB has agreed to hold a base collection of Asian *Lycopersicon* as part of the IBPGR network.

1. ECONOMIC AND NUTRITIONAL IMPORTANCE

The tomato is already the most important vegetable in many countries and its popularity is steadily increasing. This is a very recent phenomenon and is largely due to plant breeding. In 1581 the herbalist Matthias de l'Obel stated "these apples were eaten by some Italians like melons, but the strong stinking smell gives one sufficient notice how unhealthful and evil they are to eat". These prejudices have continued into this century. Until very recently it was believed to be poisonous because of its relationship with other toxic members of the Solanaceae family, such as Belladonna and Mandrake. Today, however, the crop has worldwide economic importance (see Table 1).

Table 1. World tomato production

	Average tomato production per year (1,000 MT)	
	1969-1971	1977-1979
World total	34 704	47 518
Developed countries	15 848	19 814
Centrally planned countries	9 238	13 021
Developing countries	9 617	14 683

Source: FAO Production Yearbook 1979 (vol. 33)

The nutritive value of the tomato is not very high (see Table 2). According to a survey carried out by Dr. Allen Stevens of the University of California, Davis, it ranks 16th in relative concentration of a group of 10 vitamins and minerals among the main fruit and vegetable crops in the United States. Nevertheless, its popularity as demonstrated by its high level of consumption (see Table 3), makes this crop one of the major sources of vitamins and minerals in many countries (Figure 1).

Table 2. Average nutritive value of tomatoes, per 100 grams edible product

Waste	6.0%	Carotene	0.5 mg
Dry matter	6.2 g	Thiamine	0.06 mg
Energy	20.0 Kcal	Riboflavin	0.04 mg
Protein	1.2 g	Niacin	0.6 mg
Fibre	0.7 g	Vitamin C	23.00 mg
Calcium	7.0 mg	Average nutritive value (ANV)	2.39
Iron	0.6 mg	ANV per 100 g dry matter	38.5

Source: Tropical Vegetables and their Genetic Resources (AGPE:IBPGR/77/23)

Table 3. Estimated average daily tomato consumption (grams per caput)

	Average daily tomato consumption (g/caput)	
	1969-1971	1977-1979
World	26	31
Developed countries	60	70
Centrally planned countries	20	26
Developing countries	15	19

Source: Production and population figures, FAO Production Yearbook 1979 (vol. 33)

Figure 1. Typical Central American market where local cultivars of tomatoes are sold or exchanged

2. ORIGIN AND DOMESTICATION OF CULTIVATED TOMATOES

There are still many unclear aspects with regard to the origin and domestication of the cultivated tomato. However, Rick believes that some aspects are reasonably certain:

a) The most likely ancestor of the cultivated tomato is the wild cherry tomato (Lycopersicon esculentum var. cerasiforme) which grows spontaneously in tropical and sub-tropical areas of the world.

b) The cultivated tomato originated in the New World.

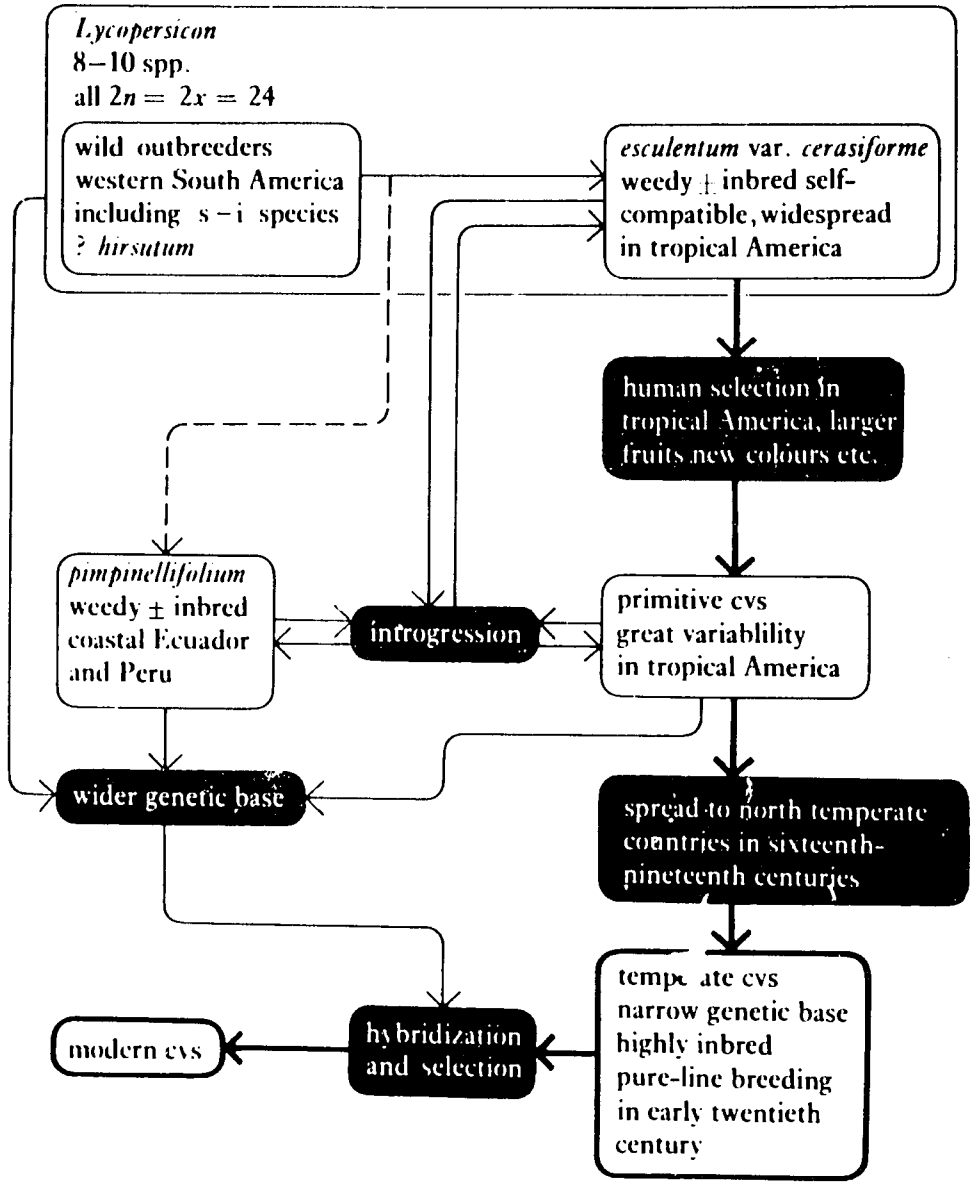
c) The tomato had reached a fairly advanced stage of domestication before being taken to Europe and Asia.

It is difficult to be more specific on the time and place of domestication. Although the centre of origin of the genus Lycopersicon is the Andean zone, there are reasons to believe that Mexico is the origin of domestication of tomatoes. Electrophoretic studies of alloenzyme variance show much greater similarities between cultivars (both European and primitive) and the cherry tomatoes of Mexico and Central America than between the European cultivars and the primitive plants of the Andean zone. Another argument is that no representation of tomato, or parts of the plant, have been encountered in the archaeological remains of the Andean zone. Furthermore, tomatoes have no known name in Quechua, Aymara or any of the other Andean languages, whereas the name Tamath

Figure 2. Farmworkers harvesting cultivated tomatoes in Mexico

in the Nahua tongue of Mexico is probably the origin of the modern name. Comparisons among genetic variability of tomatoes found in Mexico, Central America and Peru and studies on genetic distances between primitive cultivars from these areas and modern varieties have neither substantiated nor disproved the hypothesis that Mexico was the centre of domestication.

Figure 3 shows the evolutionary relationships of tomatoes (Lycopersicon esculentum) and Figure 4 presents the history of domestication of this crop (from discussions with Drs. R.L. Villareal and M. Holle.)



Source: Rick, C.M. Tomato, in Simmonds, N.W. Evolution of Crop Plants, Longman, London and New York, 268-273.

Figure 3. Evolutionary relationships of the tomato, Lycopersicon esculentum

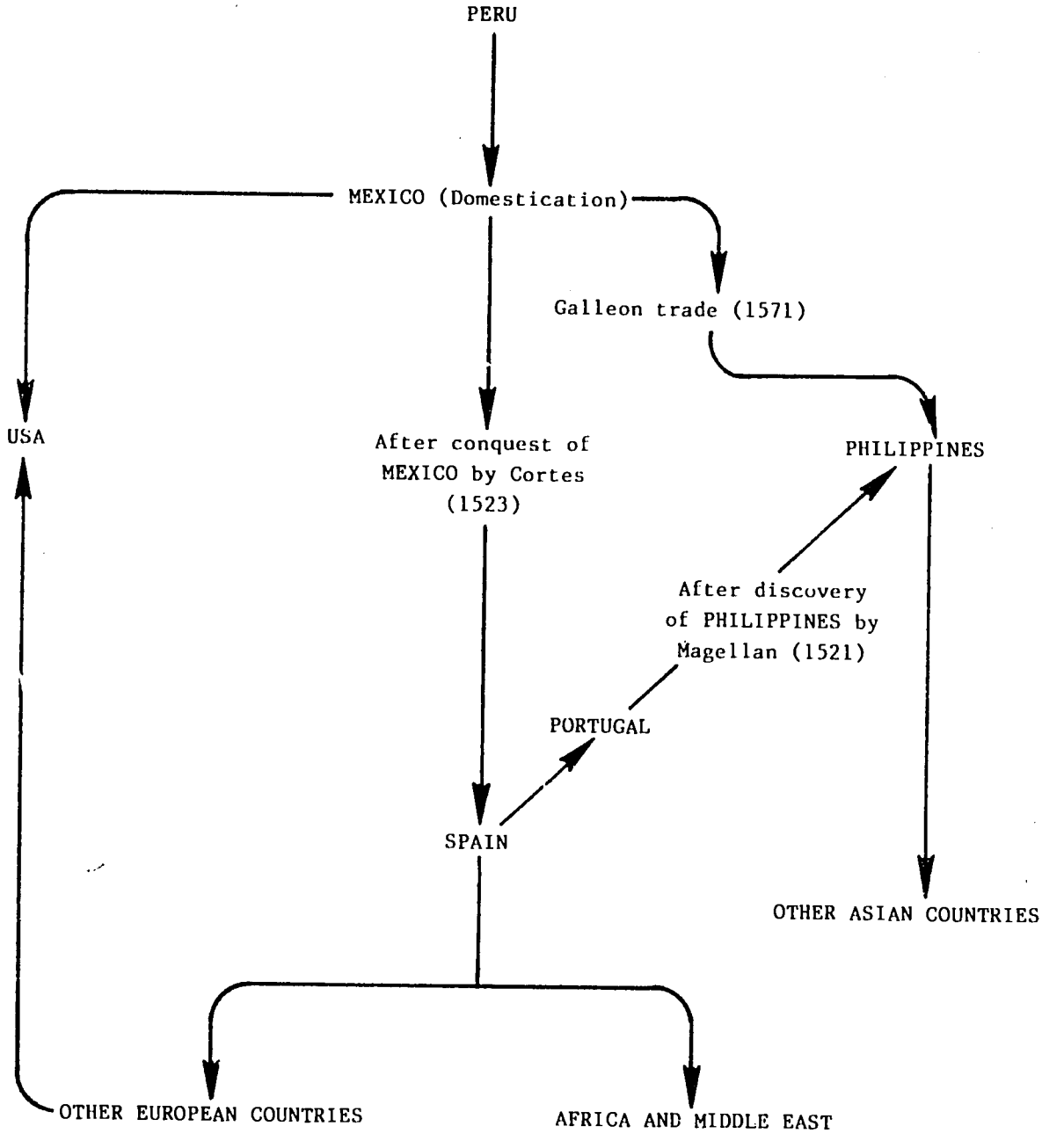


Figure 4. Possible pathways of tomatoes spread since the sixteenth century

Figure 5. Lycopersicon pimpinellifolium found in the Inter-Andean valleys of Peru

3. WILD SPECIES, DISTRIBUTION AND IMPORTANT FEATURES

The natural distribution of the genus Lycopersicon extends from northern Chile to southern Colombia and from the Pacific coast (including the Galapagos islands) to the lower eastern foothills of the Andes. Many species overlap but no evidence of natural introgression has been found, with the exception of L. pimpinellifolium and L. esculentum. All the species have well-defined ranges of distribution, except L. esculentum var. cerasiforme, which is the only wild and weedy Lycopersicon found outside the area of distribution of the genus. It is also present in the Old World where it might have escaped cultivation. Table 4 provides a synthesis of some important data of wild species. Illustrations are shown in Figures 5, 6, 7 and 8 as well as 9, 10, 13, 15 and 16.

Figure 6. L. esculentum var. cerasiforme grows voluntarily in the first year of cultivation in this typical land clearing of the Peruvian jungle in Alto Mayo, San Martin, Peru

Table 4. Distribution and important features of wild Lycopersicon spp.

Species	Distribution	Mating System	Genetic variability	Ecological preferences
L. esculentum var. cerasiforme (Figure 6)	Tropical regions; Native area: Ecuador/Peru	Wide range self-pollination	Eastern Peru variable; other regions monomorphic	Wide range wet conditions. Weed in new open ground
L. pimpinellifolium (Jusl.) Mill. (Figure 5)	Coastal Peru, inter-Andean, northern Peru, Ecuador	Regional differences in self-pollination	Regional differences; correlation with self-pollination	Weed in cultivated fields of Peruvian coastal valleys Dry inter-Andean washes
L. cheesmanii Riley (Figure 9)	Endemic to Galapagos archipelago	Highly autogamous	Uniformity within populations; differences between populations	Sub-species minor prefers low elevations; extends into saline littoral zone
L. chmielewskii	Central Peru; inter-Andean region	Self-compatible	Moderately variable	Moist habitats, although well-drained, rocky environments
L. parviflorum (Figure 8)	Northern and central Peru; southern Ecuador; inter-Andean region	Highly autogamous	Relatively uniform	Well-drained, rocky environments
L. hirsutum Humb. and Bonpl. (Figure 10)	From central Peru to northern Ecuador, 500-3,300 m	Regional differences of self-pollination	Regional differences	Prefers moist, well-drained areas; ascends to high altitudes
L. peruvianum (L.) Mill. (Figure 15)	Distributed widely in Peru, extending into northern Chile	Strict self-incompatibility	The most variable of Lycopersicon spp; many "races"	
L. chilense Dun. (Figure 7)	Southern Peru and northernmost Chile	Entirely self-incompatible	Relatively variable	Prefers very dry environments
Solanum pennillii Corr. (Figure 13)	Mid-elevations in western drainage central Peru	Self-incompatible; few exceptions	Highly variable	Adapted to xeric areas; subject to dew and fog

Table 4. Continued

Species	Interesting features	Ability to cross with tomatoes	Other observations
L. esculentum var. cerasiforme (Figure 6)	Moisture-tolerance, resistance to wilt, root-rotting and leaf-spotting fungi	Very good	Possible origin of cultivated forms; introgression of genes from L. pimpinellifolium
L. pimpinellifolium (Jusl.) Mill. (Figure 5)	Contributed to improved colour, fruit quality and disease-resistance in cultivated tomatoes	Good	Most closely related species to L. esculentum
L. cheesmanii Riley (Figure 9)	Salt-tolerance; genes for retention of fruit and thick pericarp	Possible	Several sub-specific taxa
L. chmielewskii	High sugar content	Possible	Together with L. parviflorum this was formally classified as L. minutum complex
L. parviflorum (Figure 8)		Possible	Together with L. chmielewski this was formally classified as L. minutum complex
L. hirsutum Humb. and Bonpl. (Figure 10)	May be cold and frost-tolerant; resistant to noxious insects	Only when used as male	Strong odour
L. peruvianum (L.) Mill. (Figure 15)	Not well studied; nematode resistant	Only by sterile culture	Sub-generic complex with L. chilense
L. chilense Dun. (Figure 7)	Water economy system based on deep root system	Better than L. peruvianum	Sub-generic complex with L. peruvianum
Solanum pennillii Corr. (Figure 13)	Withstands drought; absorbs atmospheric moisture through leaves	Possible	Poorly developed root system. Hybridizes with Lycopersicon spp.

Figure 7. This xeric habitat along the Sama river, Tacna, Peru, is typical of Lycopersicon chilense

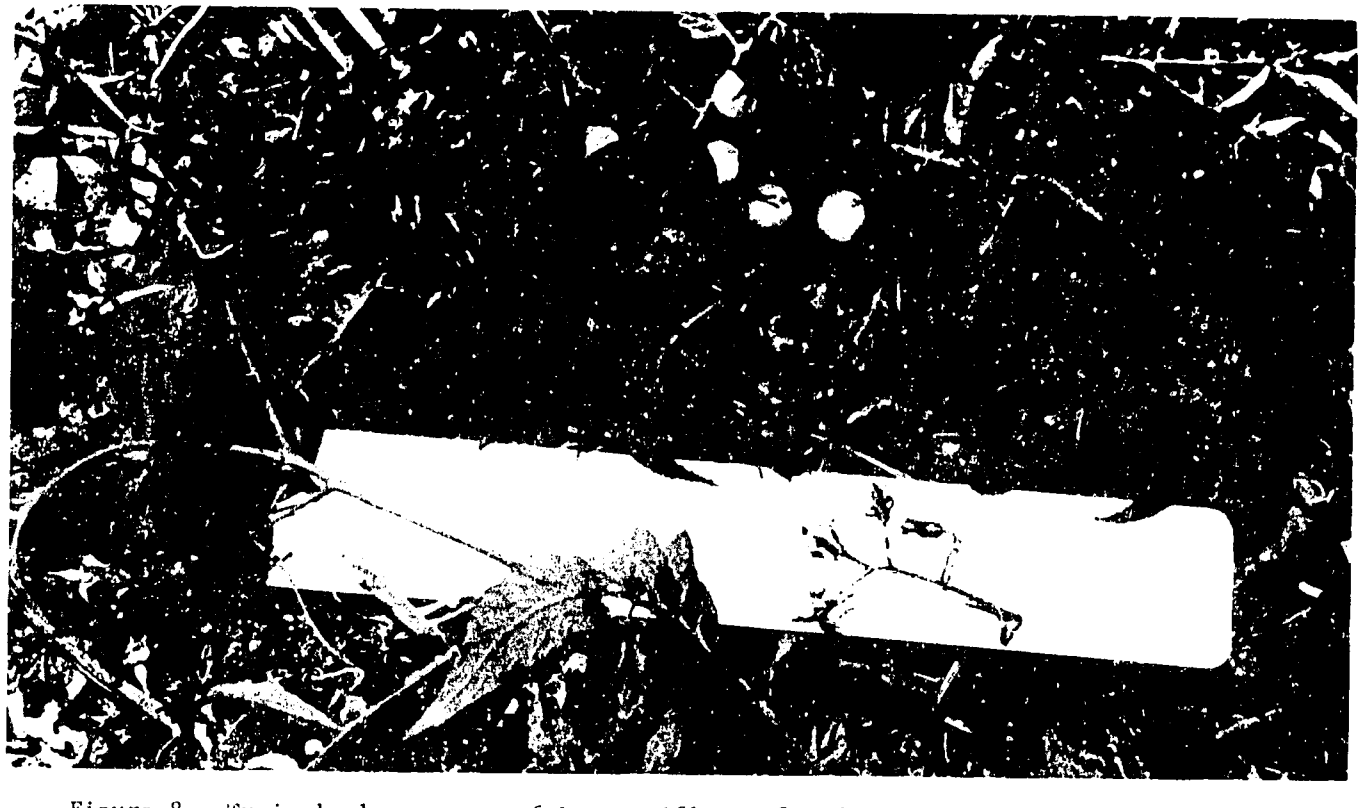


Figure 8. Typical plant parts of L. parviflorum found in Tialango, Amazonas, Peru.

4. GENETICS AND GENETIC IMPROVEMENT

4.1 GENETICS

All Lycopersicon species have 12 pairs of nearly homologous chromosomes; most of these species can inter-cross. The cultivated tomato (Lycopersicon esculentum) can produce fertile hybrids with all other species of the genus, with varying degrees of difficulty (see Table 4).

The cytogenetics of tomatoes have been thoroughly studied and more than 250 genes have been allocated and mapped in their respective chromosomes; also centromere positions have been identified. A large part of this work has been carried out by Rick at the University of California, Davis.

The ability of tomatoes to produce inter-specific crosses, together with such a thorough knowledge of their cytogenetics, provides the breeders with powerful tools to use the genetic resources of Lycopersicon sp. efficiently by transferring beneficial genes to cultivated tomatoes.

4.2 GENETIC IMPROVEMENT

4.2.1 Achievements

Some outstanding examples in cultivated tomatoes are:

a) Resistance to fungi

- Alternaria solani (early blight) from L. esculentum var. cerasiforme.
- Botrytis cinerea (Botrytis mould) from L. hirsutum.
- Cladosporium fulvum (leaf mould) from L. pimpinellifolium.
- Colletotrichum phomoides (Anthracnose) from L. esculentum var. cerasiforme.
- Fusarium oxysporum f. lycopersici (Fusarium wilt) by L. pimpinellifolium.
- Pyrenochaeta terrestris (Corky root) from L. peruvianum.
- Septoria lycopersici (Septoria leaf spot) from L. hirsutum.
- Stemphylium solani (grey leaf spot) from L. pimpinellifolium.
- Verticillium albo-atrum (Verticillium wilt) from L. esculentum var. cerasiforme.

b) Resistance to viruses

- Curly top virus from L. chilense.
- Tobacco mosaic virus from L. peruvianum.

c) Resistance to nematodes

- Root-knot nematode (Meloidogyne sp.) from L. peruvianum.

d) Incorporation of the genes that prevent easy abscission of fruit and retention of undesirable pedicel stubs, from L. cheesmanii.

e) Increment of soluble solids from L. chmielewskii.

Transfer and combination of other genetic traits, some of them bred from wild species into cultivated forms, are largely responsible for increasing yield (fruit concentration, fruit size, fruit setting ability, etc.) and quality (colour, flavour, shape, soluble solids, texture, uniformity, etc.) and for the improvement of handling and storage (both sometimes to the detriment of quality) in modern tomato varieties.

4.2.2 Prospects

In spite of these great achievements, most of the existing genetic variability among and within Lycopersicon spp. is still under-exploited by tomato breeders and its more intensive utilization may allow new objectives to reached in the future. Some prominent examples of this reported by Rick are as follows:

a) High tolerance to salt from certain types of Lycopersicon cheesmanii (Figure 9). Some populations of this species are found on the shores of the Galapagos islands, a few metres from the high tide line. D. Rush and E. Epstein of the University of California, Davis have demonstrated that these forms survive in sea water while cultivated tomatoes die when the sea water concentration exceeds 50 percent. They also discovered that this ability reflects sodium tolerance of the cells and is not due to any barrier on uptake or translocation of sodium.

b) Ability to withstand drought from Solanum pennellii (Figure 13). This species requires much longer dehydration to wilt than other Lycopersicon species. This is largely due to the foliage resistance to water loss, while its root system is astonishingly poorly developed. Tests carried out by Rick have indicated that this trait could be bred into horticultural tomatoes.

c) Insect resistance from Lycopersicon hirsutum (Figures 10 and 11). The strong odour of this species could be part of the reason for this unusual resistance to insects. It has been demonstrated for spider mite, leaf miner, tobacco fleabeetle, greenhouse whitefly and Colorado potato beetle.

d) Certain variants of L. esculentum var. cerasiforme growing in tropical conditions exhibit moisture tolerance. Some of these tropical areas receive 4-5 metres of annual rainfall and most of the land surface is often covered by water, the water table always being close to the surface. Adaptation to this environment implies resistance to wilt and root-rotting fungi and to leaf-spotting fungi that are

usually present under these conditions. In eastern Ecuador and Peru, Rick has observed planting of modern large-fruited cultivars of L. esculentum to succumb completely to Pseudomonas solanacearum, Cladosporium and other fungi within two weeks of the advent of the rainy season, while some wild cerasiforme continue to grow and fruit throughout the year.

Figure 9. Ability of Lycopersicon cheesmanii f. minor to tolerate high salinity, as suggested by this habitat along the western coast of Isabela island, Galapagos, has been verified by repeated laboratory tests

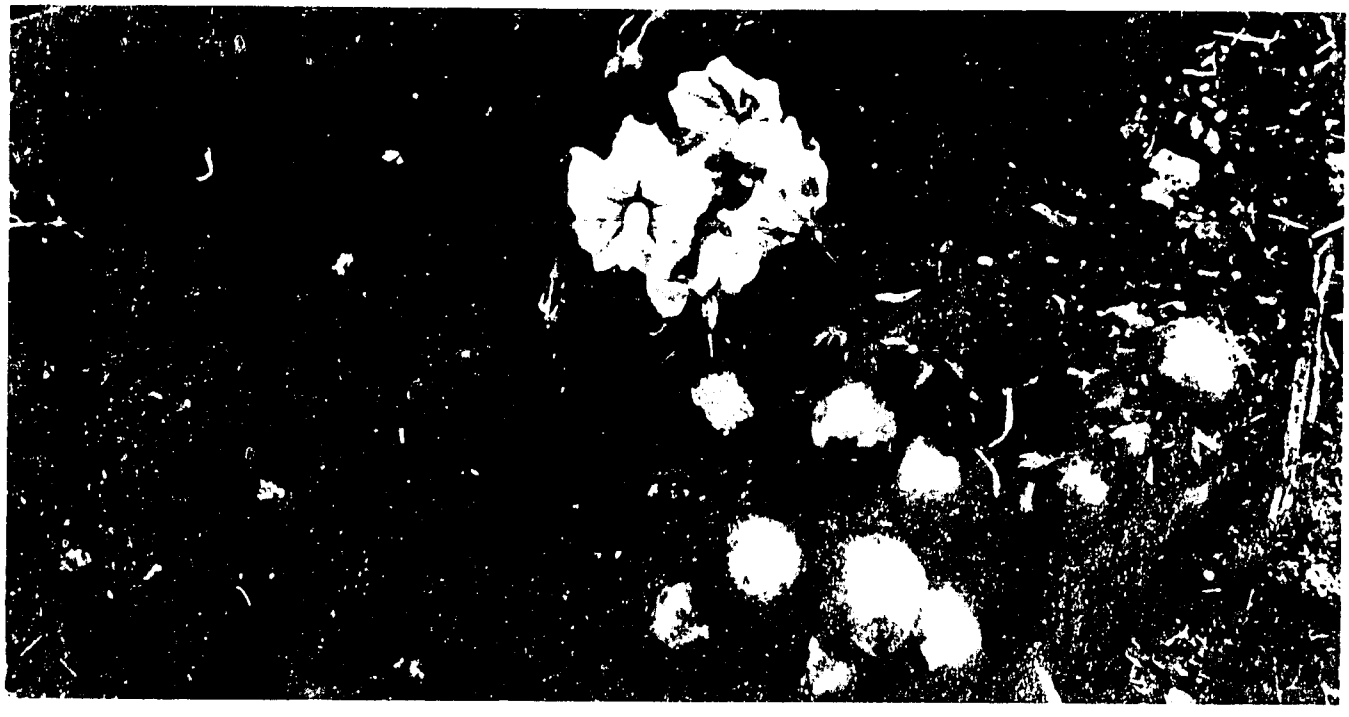


Figure 10. Closeup of Lycopersicon hirsutum f. glabratum showing typical features of plant parts, Saraguro (Loja), Ecuador. Note absence of insect predation, characteristic of many collections of this species

Figure 11. Test for resistance to lepidopterous leaf miner conducted by INTA in Yuto, Salta, Argentina

Left: L. hirsutum f. glabratum, completely resistant
Center: cv. of L. esculentum, completely defoliated
Right: F_1 between the two species, moderately resistant

5. GERMPLASM VARIATION AND EROSION

5.1 GERMPLASM VARIATION (Figure 12)

New techniques in the separation and identification of isoenzymes (the direct product of genes), have provided the most precise way of measuring germplasm variation to date. This method has been successfully applied by Rick and his colleagues within and between the Lycopersicon species, and the results are extremely useful in determining and comparing the potential value of their genetic resources.

Primitive cultivars from many parts of the world tested by this method have proven to be very uniform. Accessions from Hawaii, the Southeast Pacific, Thailand, India and Central America have shown the same zymotype in 95 percent of the cases. From this it cannot be concluded that primitive cultivars are sterile resources since some interesting variants can be found for specific traits. Genes responsible for fruit setting at high temperature, for example, were only found in some Philippine cultivars. 1/

Although there are grounds to believe that tomatoes have been domesticated in Mexico, it is surprising to find that Andean cultivars show more variability than those from Mexico. This has been explained as a consequence of introgression of Andean cultivars with wild Lycopersicon pimpinellifolium.

Wild material of most Lycopersicon spp., unlike the cultivars, has shown a high degree of genetic variation when tested by the method mentioned above.

To account for the poor variability of cultivated material in comparison to the other species of the genus, Rick has suggested that the migration of the ancestors of the cultivated forms from their native Andean zone to Mexico was probably accompanied by frequent restrictions in population size. Similar restrictions are also likely to have occurred during the domestication process and, again, during the transfer of tomatoes to Europe. Passage through such bottle-necks, undoubtedly under selection pressure (Founder principle), would have tended to reduce genetic variability. The autogamy enforced by lack of appropriate pollination in the non-native regions would have led to the rapid fixation of genes, further depletion of genetic variability and, consequently, extreme uniformity.

It is, therefore, important to stress that the world genetic resources of Lycopersicon come mainly from the Andean zone and very little diversification has occurred outside this area, except for spontaneous and induced mutants.

5.2 GENETIC EROSION

No publications have been found on genetic erosion of Lycopersicon spp., but discussions held with experts and collectors have been very useful in the preparation of this section. Primitive cultivars and wild material will be treated individually.

1/ This discovery is interpreted as an example of mutation followed by strong selection. The cultivars are in the Campbell collection.

Figure 12. Some variability of Lycopersicon spp.

5.2.1 Wild material

The native region for Lycopersicon extends from northern Chile to Ecuador, including a small part of Colombia. The centre of this area is Peru, with more than 50 percent of the wild Lycopersicon in the world. No wild Lycopersicon can be found outside Latin America, except for the very uniform Lycopersicon esculentum var. cerasiforme. The situation is critical in the coastal zone of these countries due to agricultural and industrial development and the expansion of urban areas. In the mountains the situation is better, the major danger being the increasing number of grazing goats.

The degree of genetic erosion varies according to the species. Solanum pennellii (see Figure 13) and L. chilense, for example, tend to grow in more remote places, hence their germplasm is less endangered. But even in these species some old populations described in the literature have not been found in recent expeditions.

5.2.2 Primitive cultivars

Primitive cultivars are being rapidly replaced everywhere by modern commercial varieties and hybrids which are more adapted to new agricultural techniques and market demands.

Reduced variability of primitive tomato cultivars has already been discussed in this report. There are, however, a few interesting gene codings (mainly for adaptation and resistance) that deserve to be preserved. Some of these genes have already been incorporated into the new varieties, but others still need to be collected, tested and/or utilized.

Information gathered on the current erosion of primitive cultivars may be summarized as follows:

a) In the countries of origin (Andean zone)

The variability of primitive cultivars used to be larger in these countries than in any other place. As of lately they are being substituted by US varieties and new varieties introduced by the Universidad Nacional Agraria, La Molina, Peru. The following information refers to local markets and fields:

Figure 13. Typical habitat for the entire Solanum pennellii species: plant in foreground, near Lima, Peru, is the only living vegetation except for cacti and bromeliads

i) Peru

In the coastal area the old cultivars are practically extinct. In the interior, eastern Andean range from 50 to 75 percent of the traditional cultivars and populations of L. esculentum var. cerasiforme can still be found. Although this material is very scattered and scarce, it is at the same time very interesting and unique. Introgression with Lycopersicon pimpinellifolium has probably occurred.

ii) Ecuador

In the coastal areas most local cultivars have disappeared during the last few years although some material still remains. A similar, but less extreme, situation prevails in the interior.

iii) Northern Chile

Existing material was found to be variable. Unfortunately, no recent information on genetic erosion is available.

iv) Colombia

In the central region practically nothing remains. In the Buenaventura area some local cultivars can still be found.

b) Other Latin American countries

Cultivars from other Latin American countries are very uniform and, with the exception of Mexico and Guatemala, also very recent. Many of them have already been replaced by new US cultivars. Nevertheless, native cultivars are still grown to a large extent in countries like Argentina and Brazil.

c) Europe

Almost nothing remains. Perhaps some local cultivars could still be found in the Mediterranean countries.

d) Asia

In general, not much genetic erosion seems to be taking place. The old cultivars are in the markets together with some new ones. In the Philippines genetic erosion is becoming serious in certain areas.

d) People's Republic of China

No sufficient information on genetic erosion is available. The Vegetable Research Institute in Beijing is collecting seeds of cultivars with local adaptation. About 400 samples have been sent to the United States. Recent tests carried out in the US suggest that these are mostly introductions from Europe and the United States.

6. MAJOR WORLD COLLECTIONS

Compared with other vegetable crops, the status of tomato germplasm may be considered relatively satisfactory. Following are data on some of the major world collections; others have not been included due to a lack of information. Tables 5 and 6 show important features of these major collections.

The AVRDC Collection

Curator: Dr. R.L. Villareal
Address: Asian Vegetable Research and Development Center
P.O. Box 42,
Shanhua, Tainan 741
Taiwan, China

The AVRDC collection is the largest and most comprehensive active collection of tomato germplasm in the world. Most samples are duplicates of other collections and comprise almost the total USDA collections held at Ames and Fort Collins. It also contains unique Asian cultivars from Guam, India, Indonesia, Korea, Malaysia, Papua New Guinea, the Philippines, Thailand, etc., as well as some wild or weedy Asian accessions of *L. esculentum* var. *cerasiforme*.

Campbell Collection

Address: Campbell Institute for Agricultural Research
Campbell Soup Company
Camden, New Jersey 08101, USA

This company has a well-documented collection for breeding purposes. During the 1960s Campbell sent missions to the Andean zone to collect wild material. They also have interesting landraces from many other countries. The collection is systematically evaluated for a number of characters.

DHUNA Collection

Curator: Dr. F. Delgado de la Flor
Address: Departamento de Horticultura de la Universidad Nacional Agraria (DHUNA)
La Molina, Lima, Peru

This is an active collection, noteworthy for wild material. Poor storage conditions exist. It is duplicated in Rick's TGSC collection.

INIFAT Collection

Curator: Dr. R. Martinez Viera
Address: Academia de Ciencias de Cuba
Instituto de Investigaciones Fundamental en Agricultura Tropical "Alejandro de Humboldt"
Calle 1^{a} esq. 2^{a}, Santiago de las Vegas
Ciudad Habana, Cuba

This is a large active collection with about 2,500 samples. Most of the material represents Cuban cultivars.

IVT Collection

Curator: Ms. H.J. Roelofsen
Address: Institute for Horticultural Plant Breeding (IVT)
P.O. Box 16
6700 AA Wageningen, Netherlands

This is an active collection unique for many Dutch cultivars. It also holds a large number of wild populations which are mainly duplicates from other collections. It is also responsible for the maintenance of the mutant collection that resulted from the work of Dr. K. Verkerk of the Agricultural University, Wageningen.

NIAS Collection — Curator: Dr. K. Kumagai
Address: National Institute of Agricultural Sciences
Division of Genetics, Seed Storage Laboratory
Kannondai 3-1-1, Yatabe-machi
Tsukuba-gun, Ibaraki-ken, 300-21 Japan

This is a base collection unique for Japanese and Asian landraces.

NIAVT Collection — Curator: Dr. J. Unk
Address: Research Centre for Agrobotany (NIAVT)
H-2766 Tápiószele, Hungary

This is a base collection which holds unique landraces from Hungary and other eastern European countries.

ROBINSON'S Collection — Curator: Dr. R.W. Robinson
Address: Northeast Regional Plant Introduction Station
Geneva, New York 14456, USA

This is also a breeders' collection. Its importance is due to the large number of mutants most, but not all, of which have been duplicated in either the USDA or Rick's collection.

The TGSC Collection — Curator: Dr. C.M. Rick
Address: Tomatoes Genetics Stock Center (TGSC)
Department of Vegetable Crops
University of California,
Davis, California 95616, USA

The TGSC is a breeders' collection. It is a unique collection of wild accessions and genetic and chromosomal stock (mutants and markers). These are systematically evaluated and scrupulously rejuvenated. Rick's collection can be considered the most reliable one (Figure 14).

The USDA Collection

For active collection at Ames: — Curator: Dr. W.H. Skrdla
Address: North Central Regional Plant Introduction Station, Iowa State University
Ames, Iowa 50010, USA

For base collection at Fort Collins: — Curator: Dr. L.N. Bass
Address: National Seed Storage Laboratory
Colorado State University, Fort Collins
Colorado 80523, USA

The USDA collection is the second largest collection in the world. It is kept as a base collection at Fort Collins and as an active collection at Ames. Ames multiplies and partially evaluates the material for Fort Collins. Most of this material is duplicated in AVRDC.

The USDA collection is very well documented, it has been tested for 13 horticultural characters and a number of resistances, and the results are published together with the passport descriptors.

Figure 14. Some of the Lycopersicon esculentum collected in the Dept. of San Martin, Peru and maintained in the TGSC collection

VIR Collection

Curator: Dr. V.F. Dorofeev
Address: N.I. Vavilov All-Union Institute of Plant Industry (VIR)
44 Herzen St., 190000 Leningrad, USSR

This is a very large base collection, unique for many landraces and wild material. The total number of samples held here is approximately 4,100.

ZIGUK Collection

Curator: Dr. Chr. Lehmann
Address: Zentralinstitut für Genetik und Kulturpflanzenforschung (ZIGUK), Corrensstrasse 3
Gatersleben 4325, GDR

This is a base collection. It is unique for its landraces, most of which were collected in El Salvador, the Honduras, Guatemala and Costa Rica by F. Schwanitz in 1958. The collection also includes a large number of mutants.

Some local cultivars are kept in Argentina: Ing. Agr. O. Costamagna, INTA, Estación Experimental de Rio Negro, Casilla de Correo 52, 8332 General Roca; Ghana: Dr. F. Agble, Crops Research Irstitute (Horticulture Section), P.O. Box 3785, Kumasi; and Japan: Dr. S. Nishi, Vegetable and Ornamental Crops Research Station, Ishinden-Ogoso, Tsu-City. Interesting genetic stocks are kept in Australia: Dr. D.R. Marshall, CSIRO Division of Plant Industry, P.O. Box 1600, Canberra City, A.C.T. 2601 and Canada: Dr. R. Loiselle, Ottawa Research Station, Building 75, Ottawa, Ontario K1A 0C6.

Information collected from other institutions refers mainly to breeding material and/or commercial varieties.

Table 5. Major world collections 1/
(Information as provided by respective curators)

Collections	Wild 2/ relatives	Genetic stocks 3/	Landraces & old cultivars	Commercial cultivars	Geographical distribution	Storage	Containers
AVRDC Taiwan China	528		4 277	282	Entire world (87 countries)	6°C R.H.50%	Various
Campbell Camden NJ, USA			22	550	Many countries	20°C R.H.60%	Envelopes
DHUNA La Molina Lima, Peru	315		30		Peru	20°C R.H.90%	Paperbags
IVT Wageningen Netherlands	500			2 500	Entire world	Room temp. R.H.30%	
NIAS Japan	336			300	Many countries	-10°C R.H.30%	Cans
NIAVT Tápiószele Hungary	47			1 097	Mainly European	-20°C m.c. 3%	Sealed glass jars
Robinson's Geneva NY, USA	50	500	50	250	Mainly Mexico & Andean region	7°C R.H.20%	Paper envelopes
TGSC (Rick's) Davis, CA, USA	546	600 5/	80	60	Mainly Andean region 6/	8°C R.H.30%	Various
USDA, Ames, Iowa (active) Fort Collins, CO (base)	535	150	2 804	830	Entire world 4/	6°C R.H.45% -14°C m.c. 7%	Glass jars Sealed packages
ZIGUK, Gatersleben, GDR	110	250	750	1 000	Entire world	0°C	Sealed glass jars

1/ Two major world collections are not included in this table due to lack of detailed information, i.e. the VIR collection in Leningrad, USSR and the INIFAT collection in Cuba. Some information is, however, provided in the text (pages 15 and 16). This table does not include recent collections noted in Appendix II.

2/ Detailed information in Table 6.

3/ Includes mutants, linkage screening testers, chromosome markers, alloenzyme variants, reciprocal translocations, autotetraploids, triploids, etc.

Table 5. Continued

Collections	Evaluation	Free availability	Duplicates	Computer System	Observations
AVRDC Taiwan China	Heat tolerance and disease resistance	When justified	Most in USDA (Ames & Fort Collins)	No	Mainly duplicates from other collections and some unique Asian material. Active
Campbell Camden NJ, USA	Fruit quality. Agronomical characters and disease resistance	Up to 10 samples per request			Active
DHUNA La Molina Lima, Peru	Agronomical and morphological (partial)		In TGSC	No	Active
IVT Wageningen Netherlands	Agronomical and morphological (partial)	If enough seeds	Yes, except for Dutch material	Yes	Many Dutch varieties. Active
NIAS Japan			Many in USDA	Yes	Unique for some Japanese and Asian material. Base
NIAVT Tápiószele Hungary	Morphological and agricultural characters	If enough seeds	No		Unique for Hungarian landraces. Base
Robinson's Geneva NY, USA	Cold tolerance and disease resistance	If enough seeds	Some in Ames, Fort Collins and TGSC	No	Very good for mutants. Active
TGSC (Rick's) Davis, CA, USA	Only for genetic stocks	When justified	Some in Fort Collins	No	Unique for many wild accessions and genetic stocks. Active
USDA, Ames, Iowa (active) Fort Collins, CO (base)	Systematic for horticultural characters and resistances 4/	If enough seeds	In AVRDC	Yes (SAS)	Very well documented. Active (Ames) & base (Fort Collins)
ZIGUK, Gatersleben, GDR	Disease resistances	Yes	Wild & genetic stocks in TGSC		Unique for landraces and many mutants

4/ Detailed information in: North Central Regional Research Publication 172, April 1968, Regional Plant Introduction Station, Ames, Iowa. List of seeds available from the North Central Regional Plant Introduction Station Ames, Iowa 50010, 1977. A summary of reports on the resistance of plant introduction to diseases, nematodes, insects, mites and chemicals, Lycopersicon sp., Regional Plant Introduction Station, Ames, Iowa.

5/ Detailed information in TGC Reports 28 and 29, Tomato Genetic Stock Center, Department of Vegetable Crops, University of California, Davis, CA 95616.

6/ Detailed information in TGC Report 27 (wild material) and 29 (cultivars), Tomato Genetic Stock Center, Department of Vegetable Crops, University of California, Davis, CA 95616.

Table 6. Species of wild Lycopersicon stored in major collections[1/]

Species	AVRDC Taiwan	NIAS Japan	NIAVT Hungary	TGSC, California USA [2/]	USDA, Iowa USA	ZIGUK GDR
L. cheesmanii	4			67	12	
L. chilense		94		22		
L. chmielewskii				8		
L. esculentum var. cerasiforme				92		85
L. glandulosum	10	10	2		14	
L. hirsutum	25	5	5	50	53	
L. parviflorum				11		
L. peruvianum	85	33	14	92	114	10
L. pimpinellifolium	246	18	15	166	186	15
Solanum pennelli				28		
Others		92	17			
Unclassified		84				
Suspected natural crosses of L. esculentum with other Lycopersicon spp., mainly with L. pimpinellifolium	158				156	
Total:	528	336	47	546	535	110

1/ Some of these collections are duplicates (see Table 5).

2/ These figures do not include the material collected during a recent IBPGR-supported mission to Ecuador and Peru (August-October 1980, see Appendix II).

7. COLLECTING ACTIVITIES

7.1 SUMMARY OF COLLECTING MISSIONS CARRIED OUT SINCE 1778

Documents record that exploration and collection of tomato germplasm is to have taken place since at least 1778. The first major exploration specifically for Lycopersicon was carried out by Blood and Tremelling in 1936-38, covering almost all territories where native species could be found, except the Galapagos islands. Since 1950 a number of US and USSR missions have taken place.

Recently M. Holle, C.M. Rick and D.G. Hunt have expended considerable energy to compile a catalogue of seed collection of the green-fruited species of Lycopersicon and the related Solanum penellii. This work shows to what extent the available seeds represent the geographic distribution of the different species, thereby helping to identify gaps and to pin-point which areas should be explored in future expeditions. Summaries of this collection data for Lycopersicon hirsutum, L. chilense, L. peruvianum and S. penneliii from 1778 to 1976 are shown in Appendix I.

7.2 PRIORITIES FOR COLLECTING

The following conclusions have taken into consideration the genetic value and variability of Lycopersicon species in different areas, the gaps in the existing collections and the rate of genetic erosion taking place at present.

7.2.1 Wild material

a) Emergency situations

Although there may be some urgency to collect in certain areas, in no case is there an emergency.

b) Areas where collections should be carried out, in order of urgency.

i) The Marañon River valleys (Figure 15) and surrounding areas[1/], for Lycopersicon peruvianum, L. hirsutum, L. chmielewskii and L. parviflorum.

ii) Southeast Ecuador[1/], for L. esculentum, L. peruvianum, L. hirsutum, L. chmielewskii, L. parviflorum and related Solanum species (Figure 16), and

iii) Northern Chile and southern Peru for L. peruvianum, L. chilense and related Solanum species. Frost-resistant material may be found here. These areas are extremely dry and significant quantities of rain fall, on the average, once every 25 years. The collection should be carried out during the October-February period of a year in which rain has fallen from January to April.

c) Areas where exploration and collection should be carried out, in order of urgency.

This refers to areas in the centre of diversity of this species which are not represented, or very poorly represented, in existing collections and about which very little, or even contradictory information has been obtained.

1/ In order to speed up action to implement the recommendations in this report, even before it was published, the IBPGR has already supported collecting missions in these areas of Peru and Ecuador (see Appendix II). As a result of these expeditions most areas included in 7.2.1b)i) and 7.2.1b)ii) have been adequately collected. However, more intensive collecting in the Marañon drainage is still needed.

Figure 15. Lycopersicon peruvianum found in the Marañon river valleys, Peru, during the collecting expedition outlined in Appendix II

Figure 16. Solanum ochrantum found in Tuntún, Loja, Ecuador during the collection mission described in Appendix II. This huge trunk situated close to the stream in the lower left, ascends to a height of 15 m with branches cascading to the base

i) Eastern slopes of the Andes between 500-1,000 m for L. esculentum var. cerasiforme, primitive cultivars and other Lycopersicon spp. to be found there. This material may show resistance to high humidity and high temperature. The area includes: San Juan del Oro and Tambopata (Puno); Quincemil (Madre de Dios); La Convención (Cusco); San Francisco (Ayacucho); Satipo; Pachitea; Tingo María; Yurimaguas; Mayobamba; "marginal" highway; and a few locations in Ecuador; and

ii) The inter-Andean valleys from Cusco north to Ecuador for L. minutum complex and other Lycopersicon spp. to be found there.

d) Areas where collections have already been carried out and where further collections should now be made. I.e. areas where samples previously collected have deteriorated.

New collections are necessary in coastal valley areas of the Andean region from 1,500-3,000 m, mainly for L. peruvianum and L. hirsutum.

7.2.2 Primitive cultivars

a) Urgent collections should be carried out in southeast Ecuador;

b) Collections of primitive cultivars are also needed in:

i) Southeast Asia, mainly the Philippines, India, Thailand and Burma;

ii) Mediterranean area; and

iii) Mexico.

c) There is insufficient information on Turkey and China.

7.3 SAMPLING TECHNIQUES (Figure 17)

Sampling techniques for Lycopersicon populations need to be different for each species, depending on the amount of genetic variability, degree of autogamy, distance between populations and other factors.

For most wild species collection should be carried out from a large number of plants per population. However, in autogamous species such as Lycopersicon parviflora, a single plant may be sufficient. A few plants per cultivar are also enough for cultivated tomatoes since they are self-pollinated.

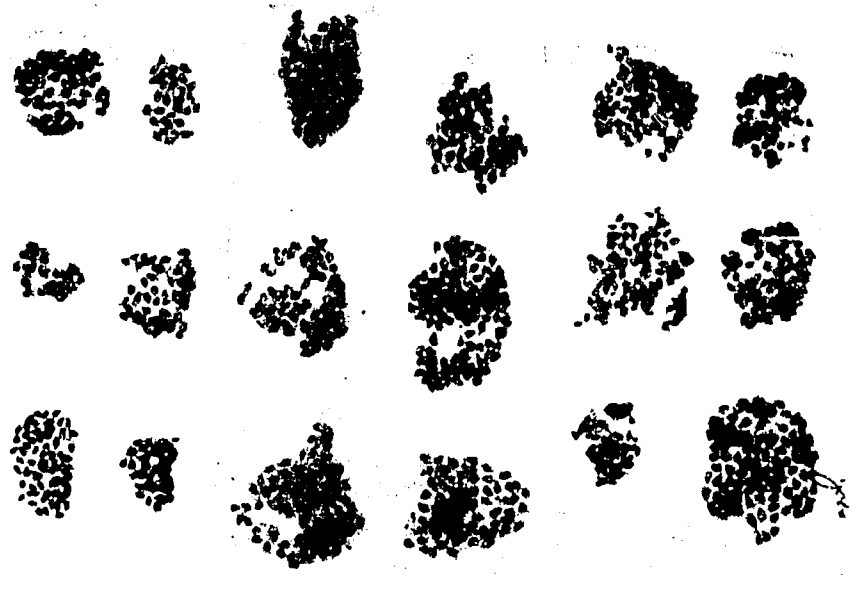


Figure 17. The use of absorbing paper in collecting expeditions provides a rapid and economic method to dry and keep separate tomato seeds from single fruits

8. CONSERVATION

Conservation entails the multiplication and storage of germplasm.

8.1 MULTIPLICATION

Problems and requirements for the multiplication of Lycopersicon germplasm vary greatly from cultivated species to wild material.

i) Cultivated species are self-pollinated and, in most cases, are pure breeds (monomorphics). Multiplication is, therefore, a very easy task for these species as it only requires the sowing of the accessions side by side, followed by their separate harvesting. This can not be applied to tropical areas where cross pollination may be as much as 25 percent.

ii) Most wild species are open-pollinated. Some sophistication is therefore needed to multiply them. This must be done by controlled pollination. To reduce genetic drift and undesired selection, the plants may be crossed at random and the same amount of seeds harvested from each plant. Multiplication of wild material is not carried out correctly in most active collections.

8.2 STORAGE

Most of the existing collections are active (Table 5), maintained at $0^{o}C$ or more, and are handled by breeders. A few countries also have national base collections (Figure 18).

The world base collection for Lycopersicon species should be established in their native Andean zone where the ecological conditions for multiplication of this genus are optimal. The physical facility for this could be the new genebank for base collections in the Andean region, expected to be established with IBPGR assistance. Until then the seeds may be stored temporarily at CATIE, Costa Rica.

Duplicates of this collection should be deposited in other genebanks which should fulfil the following requirements:

a) Long-term storage facilities;

b) Interest in Lycopersicon germplasm;

c) Geographically distant from each other, for safety purposes, if possible in different continents;

d) Located in countries with different economic, social and political structures, for both safety reasons and to guarantee better availability of seeds to everyone.

On this basis the following genebanks are recommended to store, evaluate and maintain Lycopersicon germplasm:

i) A Genebank in the Andean zone

A genebank in the Andean zone should be designated to hold a global base collection of Lycopersicon species, as soon as suitable long-term storage facilities are available;

ii) Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica

CATIE has agreed to hold a global base collection as part of the IBPGR global network. This agreement is a temporary solution until the genebank in the Andean zone is operational;

iii) The National Seed Storage Laboratory (NSSL), Fort Collins, Colorado, USA

The NSSL has agreed to hold a global base collection as part of the IBPGR network;

iv) Zentralinstitut für Genetik und Kulturpflanzenforschung, Gatersleben, GDR

This institute has been invited by the IBPGR to hold a global base collection as part of the IBPGR network;

v) Institute for Plant Breeding (IPB), Los Baños, Philippines

The IPB has agreed to hold a base collection of Asian *Lycopersicon* as part of the IBPGR network.

Figure 18. Genebank long-term storage facilities

9. EVALUATION

Evaluation of the major collections is presently at various stages (see Table 5). The USDA tomato collections, for example, have already been evaluated for many characters and it is difficult to judge how much still remains to be done. A major gap does, however, exist in the evaluation of wild species of Lycopersicon, especially for useful agricultural characters.

Systematic evaluation according to an internationally accepted minimum list of descriptors is still to be carried out. Breeders have mixed feelings regarding such evaluation, but in general they recognize the necessity for it.

In properly evaluating tomato germplasm, the following recommendations should be taken into consideration:

a) If the tests are conducted at one station only, there should be at least two replications, but it is preferable to conduct the tests at two different ecological stations with two replications being made at each station.

b) Tests should be carried out under conditions ensuring normal growth. The size of the plots should be such that plants, or parts of plants, may be removed for measuring and counting without prejudice to the observations which must be made up to the end of the growing period. For each plot the sample size should, if possible, be at least 20 plants (more for wild material). It would be wise to use more plants in the cases of wild material since resistance to certain diseases and other very old valuable genes in wild populations may not be present in more than 1% of the genotypes. Separate plots for observation and for measuring can only be used if they have been subject to the same environmental conditions.

c) The minimum testing time should be two growing periods.

d) Where resistance to pests or diseases is used for assessing distinctness, homogeneity and stability, records must be taken under conditions of controlled infection.

10. DESCRIPTOR LIST

It is an impossible task to produce a standard list of descriptors that satisfies both breeders and curators, or even breeders alone. The list in Appendix III is an attempt to reach a compromise. The basic documents used for the preparation of this list are:

Report of the first meeting of the Genetic Resources Information Program (GRIP) Tomato Technical Advisory Committee; Boulder, Colorado, 16-17 March 1978;

Report of the second meeting of GRIP Tomato Technical Advisory Committee; Ames, Iowa, 15-19 March 1979;

Official Canadian list of descriptors for Lycopersicon;

Table of descriptors for tomato, recommended by the International Union for the Protection of New Varieties of Plants (UPOV); and

A number of descriptor lists used by breeders and seed companies.

This list has been mainly conceived for Lycopersicon esculentum, although most of the descriptors are also suitable for other species of Lycopersicon. However, the best characteristics to assess distinctness of accessions within a species are extremely dependent on the species. Lycopersicon pimpinellifolium populations, for example, show almost no morphological differences and they have always been considered very uniform, but they have shown a great amount of alloenzyme variation when tested by electrophoresis. Solanum pennellii is another similar case.

Figure 19. Tomatoes to be tested for yield and quality at the Yalova Horticultural Research and Training Centre, Turkey

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APPENDIX I

SUMMARY OF COLLECTION DATA FROM 1778 TO 1976 FOR LYCOPERSICON HIRSUTUM, L. CHILENSE, L. PERUVIANUM AND S. PENELLII[1/]

Species/Watersheds	Range of years collected	Altitude range (m)	Month seed collected	Collection sites	Sites with seed	Sources of seed[2/]
L. hirsutum						
INTERIOR						
Marañon	1937-1974	1800-3400	My,Jl,Sp,Dc	15	6	PI,LA
Eastern tributaries	1962-1974	1850-3400	-	5	-	-
Western tributaries	1938-1966	1800-2900	My,Mr	4	1	LA
Cajamarca	1937-1956	2700-3000	Sp,Dc	2	2	PI,LA
Huancabamba	1964-1974	2300-2460	Jl	3	3	PI
COASTAL						
Ecuador	1818-1974	200-2700	Mr,Jl,Ag,Sp	17	12	PI,LA
Peru						
Tumbes	-	-	-	-	-	-
Chira	1952	1800	-	1	-	-
Piura	1948-1974	500-1500	Mr,Jl	2	2	PI, DHUNA
Olmos	1953-1964	600-2000	Sp	1	1	LA
Reque-Chancay	1952-1956	500-1000	-	2	-	-
Zaña	1874	2000±	-	1	-	-
Jequetepeque	1956-1970	2100-2700	Ag,Sp,Dc	3	3	PI,LA
Chicama	1868-1970	1200-2580	Ag,Dc	5	3	LA
"Lomas"	1949-1953	450- 720	-	2	-	-
Moche	1937-1970	1625-2800	Fb,Dc	6	3	PI,LA
Virú	-	-	-	-	-	-
Chao	-	-	-	-	-	-
Santa	1962-1969	2000-2280	Dc	2	1	DHUNA
Nepeña	-	-	-	-	-	-
Casma	1922-1975	1490-3700	Oc,Dc	4	3	LA,DHUNA
Huarmey	-	-	-	-	-	-
Culebras	-	-	-	-	-	-
Fortaleza	1949-1970	2220-3080	Dc,Ja	4	3	LA,DHUNA
Pativilca	1952	2400	-	1	-	-
Supe	1939	2010	-	1	-	-
Huaura	1950-1970	1200-2400	Dc	2	1	LA
Huaral	1970-1973	2300-3000	Sp	2	1	DHUNA
Chillón	1925-1973	1500-2942	Ag-Dc,Fb	11	6	PI,LA,DHUNA
Quisquichaca	1972-1973	1650-3400	-	3	-	-
Rímac	1948-1973	2000-2250	Sp,Nv	2	2	LA,DHUNA
Lurín	1970	1600±	Sp,Ot,Nv	1	1	LA,DHUNA

1/ Main source: Holle, M., Rick, C.M. & Hunt, D.G. Catalog of Collections of green-fruited Lycopersicon species and Solanum pennellii found in watershed of Peru. Report of Tomato Genetics Cooperative 28: 49-78, 1978 and 29: 63-91, 1979.

2/ PI (Plant Introduction) - USDA collection
LA (Lycopersicon Accessions) - Dr. C.M. Rick's collection, University of California, Davis
DHUNA (Departamento de Horticultura de la Universidad Nacional Agraria) - Collection at Universidad Nacional Agraria La Molina, Lima, Peru
H (Hawkes) - Dr. Hawkes's collection, University of Birmingham, England

APPENDIX I
(continued)

Species/Watersheds	Range of years collected	Altitude range (m)	Month seed collected	Collection sites	Sites with seed	Sources of seed
L. hirsutum (cont.)						
Chilca	-	-	-	-	-	-
Mala	-	-	-	-	-	-
Asia	-	-	-	-	-	-
Cañete	1952-1976	-	-	-	-	LA,DHUNA
Topará	-	-	-	-	-	-
Chincha	1972	2200±	Je	1	1	-
Pisco	1976	3000±	Je	1	1	LA, DHUNA
L. chilense						
Río Lomas	1911	900-1000	-	1	-	-
"Lomas" Chala-Camaná	1800-1958	300- 400	Nv	2	1	LA
Vítor/Siguas	1925-1943	2200-3000	Ja	5	2	PI,LA
Tambo	1919-1956	10-1300±	Dc,Ja,AP	2	2	PI,LA
Moquegua	1925-1964	700-1800	Dc,Fb,Mr	5	2	PI,LA
Sama	1938-1957	300- 700	Fb,Mr	2	2	LA
Tacna	1922-1964	470-2900	Nv,Dc,Mr,Ap	7	5	PI,LA
Chile	1836-1957	30-1200±	Ja,Mr	11	5	PI,LA
L. peruvianum						
Ecuador	1974	330	Jl	1	1	PI
Tumbes	1972	0	-	1	-	-
Chira,	-	-	-	-	-	-
Piura	1954-1972	50-2000±	Jl	2	1	DHUNA
Olmos	-	-	-	-	-	-
Reque-Chancay	1956-1970	1000-1200±	Dc	2	1	LA
Zaña	-	-	-	-	-	-
Jequetepeque	1937-1971	800-2800	Je,Ag,Sp,Dc	10	9	PI,LA,DHUNA
Chicama	1953-1956	1200-2000	Ag	3	1	PI,LA
"Lomas" Chicama-Moche	1948-1957	200- 750	Dc	3	1	PI,LA
Moche	1937-1970	1500-2900	Dc,Fb	6	3	PI,LA
Virú	-	-	-	-	-	-
Chao	-	-	-	-	-	-
Santa	1970	2800	-	2	-	-
Nepeña	-	-	-	-	-	-
Casma	1960-1972	200-2000	Je,Ag,Dc	4	3	PL,LA,DHUNA
Culebras	1937-1956	70- 300±	Ag,Dc	1	1	PI,LA
Huarmey	1938-1971	50-2000	Dc	4	1	-
Fortaleza	1949-1974	20-2920	Jc,Dc,Ja	6	4	PI,LA
Pativilca	1952-1975	200-3200	Jl	3	2	DHUNA
Supe	1948-1956	100	Ag,Dc,Ja	1	1	LA
Huaura	1948-1972	1200-2400	Sp,Dc,Fb	5	5	LA,DHUNA
"Lomas" Huaral-Huaral	1944-1972	200- 400	Je,Nv	4	2	PI,DHUNA
Huaral (2 forks)	1970-1974	500-3000	Ag-Ot	6	5	LA,DHUNA

APPENDIX I
(continued)

Species/Watersheds	Range of years collected	Altitude range (m)	Month seed collected	Collection sites	Sites with seed	Sources of seed
L. peruvianum (cont.)						
"Lomas" Huaral-Chillón	1937-1949	0- 200	Dc	4	1	PI,LA
Chillón	1937-1973	750-3000	Ag,Fb,Ap	16	11	PI,LA,DHUNA
Quisquichaca	1972-[illegible]73	16-2450	-	3	-	-
Rímac	17[illegible]74	0-3300	Je,Fb	50	26	PI,LA,DHUNA
Metropolitan area	17[illegible]1973	0- 250	Ot,Nv,Ja	7	3	PI,LA,DHUNA
Lomas	1874-1973	100- 500	-	3	-	-
Lower drainage	1947-1973	300- 850	Je,Sep,Nv,Dc	9	6	LA,DHUNA
Middle drainage	1874-1973	800-2600	Ag,Nv,Fb	17	9	PI,LA,DHUNA
Upper drainage	1937-1974	2389-3300	Ag,Dc	7	6	PI,LA DHUNA
Sta. Eulalia	1935-1973	950-2000	Je,Dc,Ja	7	4	LA, DHUNA
Lurín	1953-1973	10-2000±	Ot	7	3	LA
Chilca	1948-1973	50- 400	Nv	2	1	LA
Mala	1965	100	-	1	-	-
Asia/Lomas	1948-1975	50-1200	Ot,Dc,Fb	4	3	LA,DHUNA
Cañete	-	-	-	-	-	-
Topará	1971-1976	450- 600	My,Ag,Fb	3	3	DHUNA
Chincha	1956-1975	100-1200±	Sp,Dc,Ap	2	2	LA,DHUNA
Pisco	1951-1970	100-2960	Ot,Dc	4	2	LA
ICA	-	-	-	-	-	-
Rio Grande	-	-	-	-	-	-
Palpa	-	-	-	-	-	-
El Ingenio	-	-	-	-	-	-
Nazca	1949-1975	480-2400	Nv,Mr	3	1	PI,LA,DHUNA
Río Lomas	-	-	-	-	-	-
"Lomas" and valleys between Chala-Camaná	1883-1975	0-1600	Mr,Jl,Ag, Nv,Dc	8	4	PI,LA,DHUNA
Vítor/Siguas	1863-1975	2000-3000	Ag,Dc	11	2	LA,DHUNA
Tambo	1925-1972	3-1300	Dc	4	2	LA
Moquegua	-	-	-	-	-	-
Sama	1957	500±	-	1	-	-
Tacna	-	-	-	-	-	-
Chile	1914-1957	-	Ja	3	3	LA
Solanum pennellii						
Chicama	1957-1972	600-2000±	Ot	-	2	-
"Lomas" Chicama to Moche	-	-	-	-	-	-
Moche	-	-	-	-	-	-
Virú	-	-	-	-	-	-
Chao	-	-	-	-	-	-
Santa	1972	800-1000	Ot	1	1	LA,DHUNA
Nepeña	1970	600	Dc	1	1	LA
Casma	1975	200-600±	Ot	2	1	DHUNA
Culebras	-	-	-	-	-	-
Huarmey	-	-	-	-	-	-

APPENDIX I
(continued)

Species/Watersheds	Range of years collected	Altitude range (m)	Month seed collected	Collection sites	Sites with seed	Sources of seed
Solanum pennellii (cont.)						
Fortaleza	-	-	-	-	-	-
Pativilca	-	-	-	-	-	-
Supe	-	-	-	-	-	-
Huarra	1970-1972	1000±	Sp,Nv,Dc	2	2	LA,DHUNA
"Lomas" Huaura-Huaral	1961-1972	150- 300±	Ot,Nv	2	1	DHUNA
Huaral	1970-1971	850-2300	Ot	5	4	LA
Chillón	1948-1971	800-1800±	Ot,Ja	4	3	LA,H
Rímac	1923-1970	800-1400	Dc	4	1	LA
Lurín	1970-1972	10-1600±	Ot,Nv	3	1	LA
Chilca	-	-	-	-	-	-
Mala	-	-	-	-	-	-
Asia/Lomas	-	-	-	-	-	-
Cañete	-	-	-	-	-	-
Topará	1976	500±	Fb	1	1	DHUNA
Chincha	1975	1200±	Sp	1	1	DHUNA
Pisco	1970	700-1550	Ot	2	2	LA
Ica	-	-	-	-	-	-
Rio Grande	-	-	-	-	-	-
Palpa	-	-	-	-	-	-
El Ingenio/Nazca	1959-1975	500- 600	Jl,Dc	2	2	LA,DHUNA,H
Río Lomas	-	-	-	-	-	-
"Lomas" Chala-Camaná	1955	50- 300	-	2	1	PI,LA

APPENDIX II

SUMMARY OF THE IBPGR COLLECTING MISSIONS IN ECUADOR AND PERU IN 1980

To speed up action to implement the recommendations for collection in this report even before being published, the IBPGR supported two missions to collect Lycopersicon species in Peru and Ecuador during the summer of 1980. The mission to Ecuador was coordinated by the IBPGR Secretariat in cooperation with the FAO office in Quito and the one to Peru was coordinated by the Universidad Nacional Agraria La Molina in Lima, Peru. Both missions were led by local scientists and benefitted by the participation of Dr. C.M. Rick, University of California.

Maps and tables showing itineraries and giving information on the collections made are provided on the following pages. Samples of the Ecuadorian accessions are available at the Instituto de Ciencias Naturales, Universidad Central de Quito, Casilla 633, Quito, Ecuador, and the Peruvian material is at the Departamento de Horticultura, Universidad Nacional Agraria, Apartado 456, La Molina, Lima, Peru. All accessions are also available at the Department of Vegetable Crops, University of California at Davis, CA 95616. The collection will be multiplied and duplicates sent to the long-term storage depositories designated by IBPGR.

Table 7. List of Lycopersicon accessions collected in the Ecuadorian expedition, August 1980

Field No.	Species	Site	Administrative Division	Alt.(m)
SAL 4931	L. hirsutum f. glabratum	Chiñuko	Chimborazo	
SAL 4932	L. pimpinellifolium	La Union	El Oro	300
SAL 4933	L. esculentum prim. cv	El Naranjo	El Oro	1200
SAL 4934	L. esculentum v. cerasiforme	La Cidra	Loja	
SAL 4935	L. pimpinellifolium	Playa	"	
SAL 4936	L. "	Macará	"	
SAL 4937	L. hirsutum f. glabratum	Sabianga	"	700
SAL 4938	L. " "	" - Sozorango	"	1000
SAL 4939	L. " "	Sozorango	"	1200
SAL 4940	L. " "	Cariamanga	"	1800
SAL 4941	L. pimpinellifolium	El Lucero	"	1000
SAL 4942	L. hirsutum f. glabratum	Lansaca	"	1600
SAL 4943	L. " "	Peña Negra	"	2400
SAL 4944	L. " "	Jardin Botanico	"	2200
SAL 4945	L. " "	Yambra	"	1700
SAL 4946	L. " "	Los Lirios	"	2100
SAL 4947	L. " "	Anganumo	"	2300
SAL 4948	L. " "	Yangana #1	"	2100
SAL 4949	L. " "	Yangana #2	"	2100
SAL 4950	L. pimpinellifolium	Ptc. Guayaval	"	
SAL 4951	L. "	above Hda. Monterrey	"	
SAL 4952	L. parviflorum	above La Toma	"	
SAL 4953	L. hirsutum f. glabratum	San Juan	"	1950

Table 7. (cont.)

APPENDIX II
(Continued)

Field No.	Species	Site	Administrative Division	Alt.(m)
SAL 4954	L. hirsutum f. glabratum	Pucala	"	1850
SAL 4955	L. " "	Las Juntas	"	2000
SAL 4956	S. ochranthum	Tuntún	"	2200
SAL 4957	S. "	San Lucas	"	2500
SAL 4958	L. hirsutum f. glabratum	Saraguro	"	2500
SAL 4959	S. juglandifolium	Sabanilla	Zamora-Chinchipe	2000
SAL 4960	L. esculentum v. cerasiforme	Yacuambi roadhead	" "	1000
SAL 4961	L. " prim. cv	"	" "	1000
SAL 4962	L. " " "	La Saquea	" "	1000
SAL 4963	L. hirsutum f. glabratum	Cumbaratza	" "	1000
SAL 4964	L. esculentum prim. cv	Paquisha	" "	1000
SAL 4965	L. " " "	El Dorado	" "	1100
SAL 4966	L. " " "	Zumbi	" "	1000
SAL 4967	L. hirsutum f. glabratum	Zumbi	" "	1000
SAL 4968	L. esculentum prim. cv	San Roque	" "	1200
SAL 4969	L. " " "	Gualaquiza	" "	1400
SAL 4970	L. " " "	Bomboiza	" "	1300
SAL 4971	L. " " "	Chuchumbetza	" "	900
SAL 4972	L. " " "	Pangui	" "	900
SAL 4973	L. parviflorum	Oña	Azuay	2000
SAL 4974	S. juglandifolium	Tinajillas	Morona-Santiago	2200
SAL 4975	L. esculentum v. cerasiforme	Limón	" "	1300
SAL 4976	L. esculentum prim. cv	Bella Union (nr. Mendez)	" "	600
SAL 4977	L. esculentum v. cerasiforme	Tayusa	" "	600
SAL 4978	L. " "	Chinimpini	" "	700
SAL 4979	L. " "	Logroño	" "	800
SAL 4980	L. " "	Huambi	" "	900
SAL 4981	L. " "	Rio Blanco	" "	1000
SAL 4982	L. " "	Cambanaca	" "	600
SAL 4983	L. esculentum prim. cv	Nuevo Rosario	" "	1200
SAL 4984	L. hirsutum f. glabratum	Chanchán	Chimborazo	1700

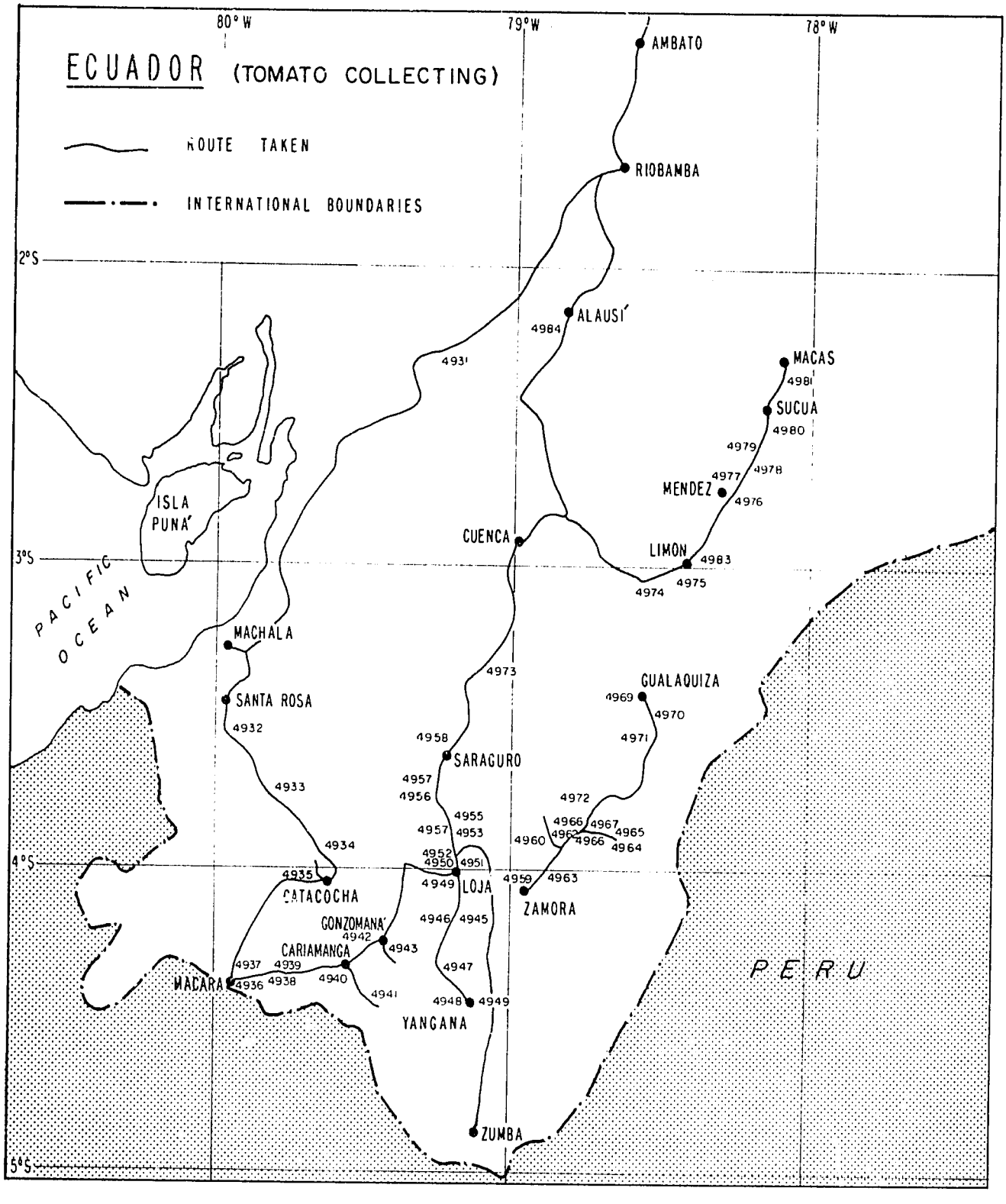


Figure 20. Map of southern Ecuador showing route and sites of collection of the Lycopersicon collecting expedition of August 1980

N.B. Collecting sites are identified by "field number" for each sample.

APPENDIX II
(Continued)

Table 8. List of Lycopersicon accessions collected in the Peruvian expedition, August 1980

Field No.	Species	Site	Administrative Division	Alt.(m)
SAL 4991	L. pimpinellifolium	Limoncarro	La Libertad	200
SAL 4992	L. "	Yube	Cajamarca	550
SAL 4993	L. peruvianum	Llallan	"	650
SAL 4994	L. pimpinellifolium	Pte. Muyuna	"	850
SAL 4995	L. peruvianum	Pte. Muyuna	"	850
SAL 4996	L. " var. humifusum	Morochupa	"	1800
SAL 4997	L. " " "	San Juan No. 1	"	2150
SAL 4998	L. " " "	San Juan No. 2	"	2800
SAL 4999	L. hirsutum	Bambamarca	"	2500
SAL 5000	L. "	Maydasbamba	"	2600
SAL 5001	L. "	Ingenio Montán	"	1700
SAL 5002	L. peruvianum	Tunel Chotano	"	1600
SAL 5003	L. hirsutum	Río Chotano	"	1500
SAL 5004	L. "	Atunpampa	"	1700
SAL 5005	S. ochranthum	Acuñác	"	2400
SAL 5006	S. "	Cruz Roja	"	2550
SAL 5007	S. "	Yatún	"	2400
SAL 5008	L. peruvianum	Cochabamba-Yamalúc	"	1800-1900
SAL 5009	L. "	Yamalúc	"	2000
SAL 5010	S. ochranthum	Rocoto	"	2200
SAL 5011	S. "	Pacopampa	"	2300
SAL 5012	L. hirsutum	Cajamarca-Cementorio	"	2750
SAL 5013	L. peruvianum	San Marcos	"	2550
SAL 5014	L. "	Cochabamba-Cutervo	"	1700
SAL 5015	L. pimpinellifolium	Pai Pai	La Libertad	350
SAL 5016	L. hirsutum	El Molino	Piura	800
SAL 5017	L. peruvianum	Cuvita	Cajamarca	1200
SAL 5018	L. pimpinellifolium	Cruz de Huaquillo	"	450
SAL 5019	L. hirsutum f. glabratum	" Chinchipe	"	1300
SAL 5020	L. " " "	Timbaruca	"	1150
SAL 5021	L. pimpinellifolium	"	"	1150
SAL 5022	L. esculentum var. cerasiforme	San Ignacio	"	1300
SAL 5023	L. pimpinellifolium	Tororume	"	700
SAL 5024	L. "	Tamboripa-La Manga	"	1000
SAL 5025	L. "	La Coipa	"	1200
SAL 5026	L. "	Balsahuaico	"	850
SAL 5027	L. "	Cumba	Amazonas	450
SAL 5028	L. "	Corral Quemado	"	400
SAL 5029	L. "	Bagua (Casual)	"	450
SAL 5030	L. peruvianum	Pongo de Rentema	"	450
SAL 5031	L. pimpinellifolium	El Salos	"	550
SAL 5032	L. "	La Caldera	"	650
SAL 5033	L. "	Machugal No. 1	"	700

Table 8. (cont.)

APPENDIX II
(Continued)

Field No.	Species	Site	Administrative Division	Alt.(m)
SAL 5034	L. pimpinellifolium	Machugal No. 2	"	850
SAL 5035	L. parviflorum	Tialango	"	900
SAL 5036	L. "	Campamiento Ingenio	"	1100-1200
SAL 5037	L. "	Pedro Ruíz	"	-
SAL 5038	L. "	Churuja	"	1300
SAL 5039	L. "	Chachapoyas W.	"	1900-2000
SAL 5040	L. "	Cáclic	"	1650
SAL 5041	L. hirsutum f. glabratum	"	Amazonas	1600
SAL 5042	L. parviflorum	Luya	"	1800-2100
SAL 5043	L. "	Chachapoyas E.	"	1900-2100
SAL 5044	L. hirsutum f. glabratum	" "	"	2000
SAL 5045	L. parviflorum	Choipiaco	"	1900
SAL 5046	L. "	Pípus	"	1900
SAL 5047	L. "	Tingobamba	"	1500
SAL 5048	L. ochranthum	Pomacochas	"	2200
SAL 5049	L. hirsutum f. glabratum	Balsapata	"	1900
SAL 5050	L. esculentum var. cerasiforme	Sta. Rosa de Mirador	San Martín	1100
SAL 5051	L. " " "	Naranjillo	" "	1000
SAL 5052-SAL 5057	L. " " "	Bajo Naranjillo	" "	1000
SAL 5058-SAL 5065	L. " " "	Nuevo Cajamarca	" "	1000
SAL 5066-SAL 5080	L. " " "	Moyobamba mercado	" "	850
SAL 5081-SAL 5089	L. " " "	Habana	" "	900
SAL 5090-SAL 5098	L. " " "	Soritor	" "	900
SAL 5099-SAL 6001	L. " " "	Puerto Moyobamba	" "	800
SAL 6102	L. " " "	Moyo: Hotel Albricias	" "	850
SAL 6103	L. " " "	Yantaló	" "	850
SAL 6104	L. " " "	Moyobamba mercado	" "	850
SAL 6105-SAL 6109	L. " " "	La Huarpía	" "	800
SAL 6109A-SAL 6112	L. " " "	Casaría de Pacaisapa	" "	800
SAL 6113-SAL 6121	L. " " "	Km. 57	" "	700
SAL 6122-SAL 6126	L. " " "	Tabalosos	" "	600
SAL 6127-SAL 6151	L. " primitive cultivars	Tarapoto: mercado	" "	350
SAL 6152	L. esculentum var. cerasiforme	San Francisco	" "	300
SAL 6153-SAL 6155	L. " "	Pto. Santa Cruz	" "	300

Table 8. (cont.)

APPENDIX II
(Continued)

Field No.	Species	Site	Administrative Division	Alt.(m)
SAL 6156	L. esculentum var. cerasiforme	Jumbilla No. 1	Amazonas	2100
SAL 6157	L. " "	Jumbilla No. 2	"	2100
SAL 6158	L. hirsutum f. glabratum	San Francisco	"	1650
SAL 6159	L. parviflorum	Sargento	"	1700
SAL 6160	L. esculentum var. cerasiforme	"	"	1700
SAL 6161	L. parviflorum	Zuta	"	1900
SAL 6162	L. "	Tambo	"	2000
SAL 6163	L. "	Chirico	"	2100
SAL 6164	S. ochranthum	"	"	2100
SAL 6165	L. hirsutum f. glabratum	"	"	2100
SAL 6166	L. hirsutum	Chancleta	"	2150
SAL 6167	S. ochranthum	Leimebamba	"	2300
SAL 6168	L. hirsutum f. glabratum	"	"	2300
SAL 6169	L. parviflorum	Above Balsas	"	1500-1800
SAL 6170	L. peruvianum	" "	"	500-1800
SAL 6171	L. "	Aguas Calientes	Camamarca	2400
SAL 6172	L. "	Aricapampa	La Libertad	2300-2500
SAL 6173	L. hirsutum	"	"	2450
SAL 6174	L. peruvianum	Chagual	"	1700
SAL 6175	L. "	Agallpampa	"	2500
SAL 6176	L. hirsutum	"	"	2500
SAL 6177	L. peruvianum	Casmiche	"	2000

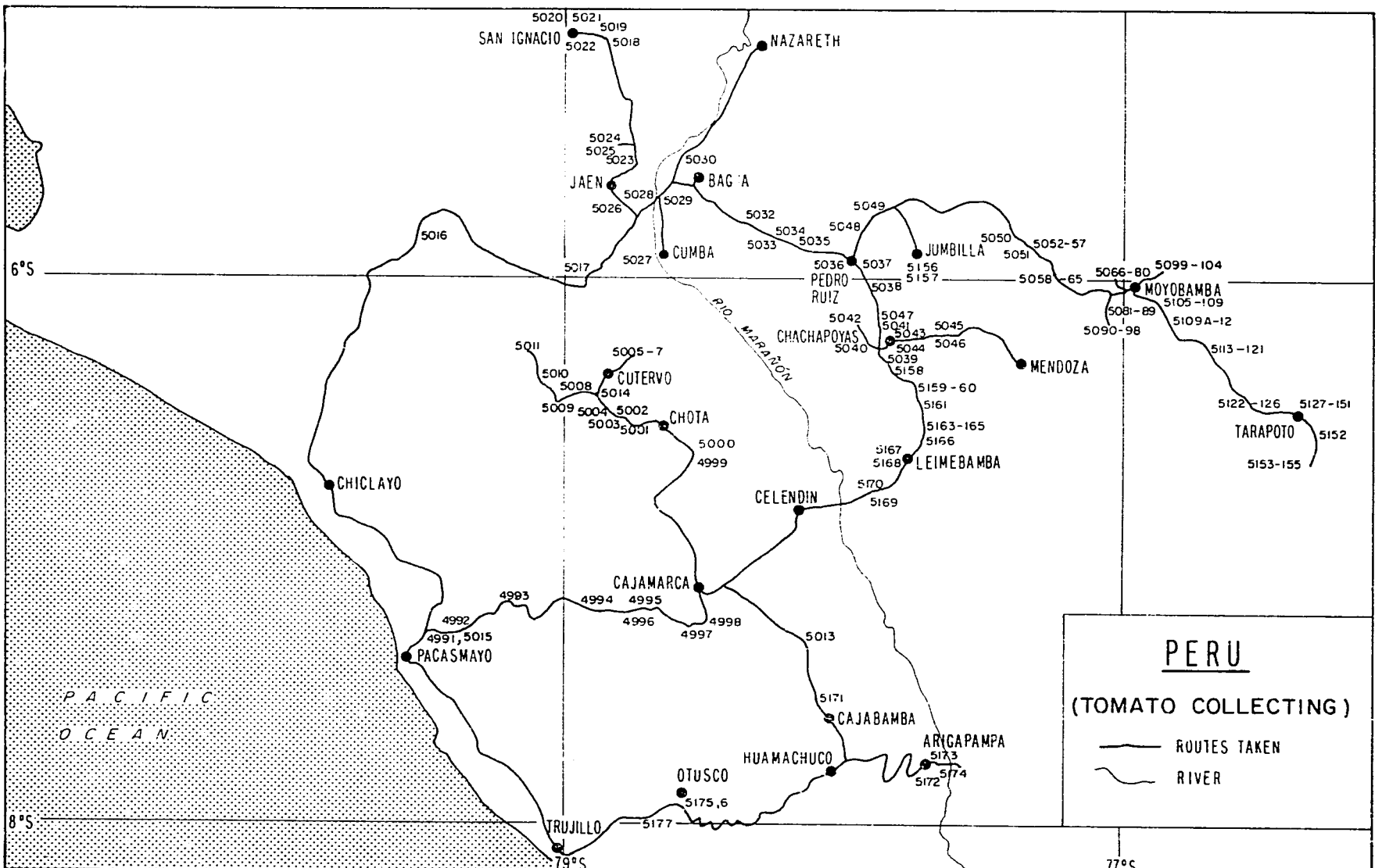


Figure 21. Map of northern Peru showing route and sites of collection of the Lycopersicon collecting expedition of September 1980

N.B. Collecting sites are identified by "field number" for each sample.

APPENDIX III

DESCRIPTOR LIST FOR LYCOPERSICON SPECIES

The following definitions are now used in genetic resources documentation.

(i) passport data (accession identifiers and information recorded by collectors);

(ii) characterization (consists of recording those characters which are highly heritable, can be easily seen by the eye and are expressed in all environments);

(iii) preliminary evaluation (consists of recording a limited number of additional traits thought desirable by a consensus of users of the particular crop).

Characterization and preliminary evaluation will be the responsibility of the curators who can record this data at the time of multiplication or regeneration. Further evaluation should be carried out by the plant breeder and data should be fed back to the curator who will maintain a data file. In this list there are a large number of characterization descriptors. Those which, at present, are considered least useful have been termed further characterization.

Many descriptors which are continuously variable are recorded on a 1-9 scale. Sometimes only a selection of the states, e.g. 3, 5 and 7 for such descriptors has been described. Where this has been done the full range of codes is available for use by extension of the codes given or by using values between them, e.g. INTERIOR FLESH COLOUR INTENSITY (5.5) could also be recorded as:

1 Very light

or

6 Medium dark

It is recommended for all descriptors that the code 0 be used for absence of character, whereas a blank code means either "unknown" or "not yet scored". Heterogeneity within accessions can be represented by the code "X". Drawings illustrating this descriptor list have been kindly provided by UPOV.

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 if an accession is lost, its assigned number is still not available for re-use. Letters should occur before the number to identify the genebank.

APPENDIX III
(continued)

1.2 SCIENTIFIC NAME

1.2.1 Genus

1.2.2 Species

1.2.3 Varietal name

1.3 DATE OF LAST MULTIPLICATION OR REGENERATION

Year of last multiplication or regeneration

1.4 DONOR NAME

Name of institution or individual responsible for donating the germplasm

1.5 DONOR NUMBER

Accession number or accession name assigned by the donor

1.6 ANY OTHER NAMES OR NUMBERS ASSOCIATED WITH THE ACCESSION

e.g. USDA Plant Introduction number, common name, other accession numbers, etc. (not collection number, see 2.2)

2. COLLECTION DATA

Data to be recorded when the sample is collected in the field

2.1 COLLECTING INSTITUTE

Institute or person collecting the original sample

2.2 ORIGINAL NUMBER ASSIGNED BY COLLECTOR OF THE SAMPLE

Normally composed of the name or initials of the collector(s) followed by a number. This item is essential for identifying duplicates held in different collections and should always accompany sub-samples wherever they are sent.

2.3 DATE OF COLLECTION OF ORIGINAL SAMPLE

Expressed as day/month/year, e.g. 20 September 1981 as 200981

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.

APPENDIX III
(continued)

2.5 LATITUDE OF COLLECTION SITE

Degrees and minutes followed by N (north) or S (south), e.g. 1030 S

2.6 LONGITUDE OF COLLECTION SITE

Degrees and minutes followed by E (east) or W (west), e.g. 7625 W

2.7 PROVINCE/STATE

Name of the administrative subdivision of the country in which the sample was collected

2.8 LOCATION OF COLLECTION SITE

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

2.9 ALTITUDE OF COLLECTION SITE

Elevation above sea level in metres

2.10 COLLECTION SOURCE

1 Natural habitat
2 Field
3 Market
4 Farm store
5 Agricultural institute

2.11 TYPE OF SAMPLE

1 Wild
2 Weedy
3 Breeder's line
4 Primitive cultivar
5 Advanced cultivar

2.12 OTHER NOTES FROM COLLECTOR

Some collectors will record soil characteristics, topography, estimates of rainfall, exposure to sun, etc.

CHARACTERIZATION AND PRELIMINARY EVALUATION

APPENDIX III
(Continued)

3. GENERAL

3.1 SITE OF CHARACTERIZATION AND PRELIMINARY EVALUATION

3.2 PLANTING DATE

Expressed as day/month/year, e.g. 5 March 1981 as 050381

3.3 HARVEST DATE

Expressed as day/month/year, as in 3.2

4. PLANT CHARACTERISTICS

4.1 ANTHOCYANIN COLOURATION OF HYPOCOTYL

0 Absent
+ Present

4.2 GROWTH

1 Indeterminate
2 Determinate large
3 Determinate intermediate
4 Determinate compact
5 Dwarf

4.3 STYLE PUBESCENCE

0 Absent
+ Present

5. FRUIT CHARACTERISTICS

Unless otherwise indicated, all observations on the fruit should be taken, when possible, on the 3rd fruit of the 2nd and 3rd truss at the beginning of the colouring of the fruit apex, provided normal fertilization has occurred.

5.1 SIZE

	Reference Variety
1 Very small (<3 cms)	Cerise
3 Small (3-5 cms)	Freude
5 Medium (5-8 cms)	Vollendung
7 Large (8-10 cms)	Bonset
9 Very large (>10 cms)	Grosse rote, Fleischtomate

5.2 PREDOMINANT SHAPE

See Figure 22

1 Flattened
2 Slightly flattened
3 Round
4 High-round
5 Heartshaped
6 Lengthened cylindrical
7 Pearshaped
8 Plumshaped

5.3 EXTERIOR COLOUR OF IMMATURE FRUIT

1 Dark, greenback present
2 Light, greenback present
3 Dark, greenback absent
4 Light, greenback absent

5.4 SKIN COLOUR, RIPE FRUIT

1 Colourless
2 Yellow

5.5 INTERIOR FLESH COLOUR

1 Green
2 Yellow
3 Orange
4 Red
5 Tangerine
6 Yellow and red
7 Yellow and tangerine
8 Tangerine and red
9 Yellow, tangerine and red

5.6 INTERIOR FLESH COLOUR INTENSITY

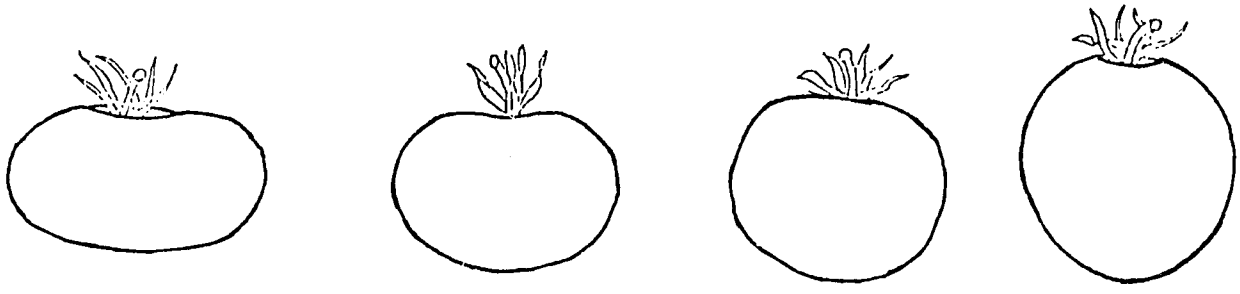
3 Light
5 Medium
7 Dark

5.7 TRANSVERSE SECTION

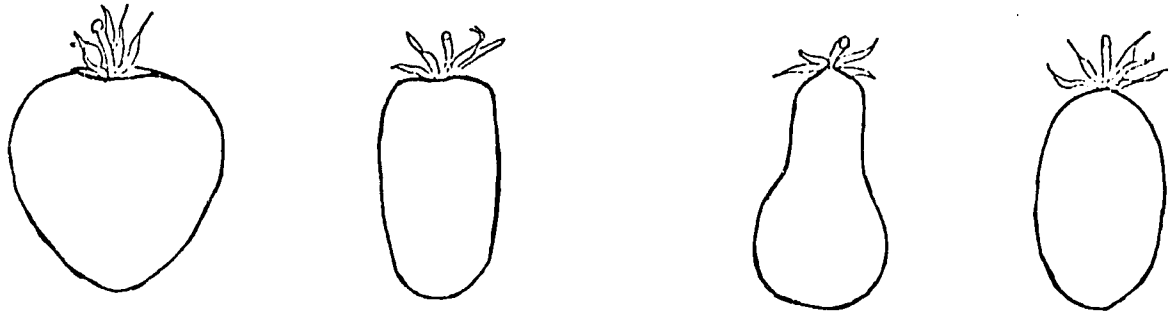
See Figure 23

1 Round
2 Angular
3 Irregular

APPENDIX III
(Continued)



Flattened | Slightly flattened | Round | High-round



Heartshaped | Lengthened cylindrical | Pearshaped | Plumshaped

Figure 22. Fruit: Predominant shape

APPENDIX III
(Continued)

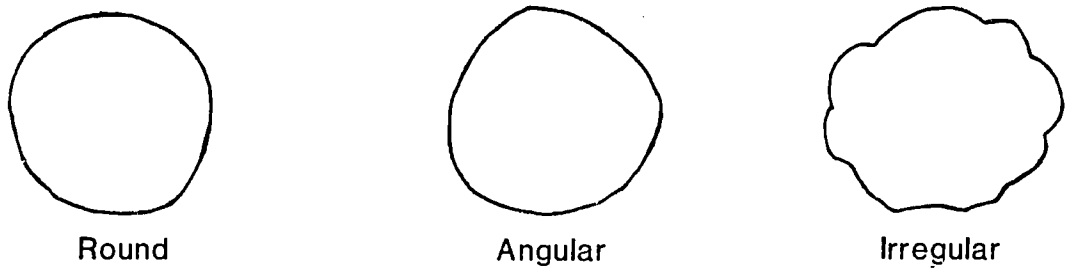


Figure 23. Fruit: Transverse section

5.8 PRESENCE OF JOINTLESS PEDICEL

0 Absent
+ Present

5.9 RIBBING AT CALYX END

		Reference Variety
0	Absent	Cerise
3	Slight	Allround
5	Medium	Saint-Pierre
7	Strong	Supermarmande

5.10 BLOSSOM END: SCAR SIZE

3 Small
5 Medium
7 Large

5.11 FIRMNESS

3 Soft
5 Medium
7 Firm

5.12 RADIAL CRACKING

1 None
3 Slight
5 Medium
7 Medium to severe
9 Severe

5.13 CONCENTRIC CRACKING

1 None
3 Slight
5 Medium
7 Medium to severe
9 Severe

APPENDIX III
(Continued)

5.14 FRUIT FASCIATION

1 Smooth
3 Slight fasciation
5 Medium fasciation
7 Fasciated
9 Severe fasciation

6. PRELIMINARY EVALUATION

6.1 TIME OF MATURITY

	Reference Variety
3 Early	Rossol, Harzfeuer
5 Medium	Supermarmande
7 Late	Rheinlands, Ruhm, Pieraline

6.2 RIPENING UNIFORMITY

3 Poor
5 Medium
7 Good

FURTHER CHARACTERIZATION AND EVALUATION

The acronym of the institute supplying the information on a specific descriptor should be added to its value - e.g. if the Asian Vegetable Research and Development Center scores an accession as immune to Cucumber mosaic virus then the code for descriptor 9.4.1 would be - 1 AVRDC

7. PLANT CHARACTERISTICS

7.1 LOW TEMPERATURE GERMINATION SENSITIVITY

Germination suppression at 10 °C or less. Coded from 1-9 where 1 = Not sensitive and 9 = Very sensitive

7.2 STEM TYPE

	Reference Variety
1 Inflexible	Dwarf, Champion
2 Flexible	Saint-Pierre
3 Both	

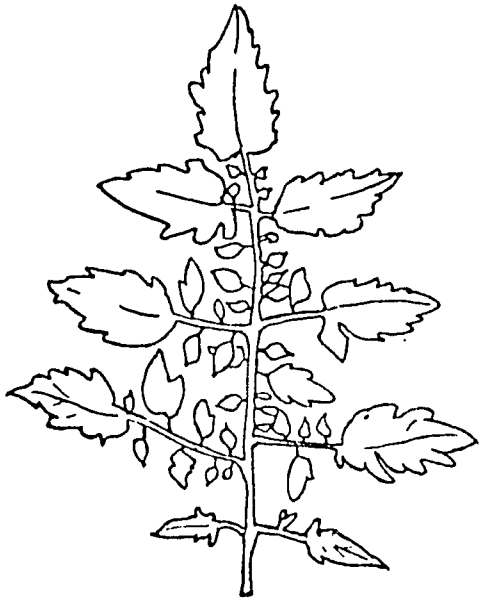
7.3 STEM PUBESCENCE

0 Absent
3 Weak
5 Medium
7 Strong

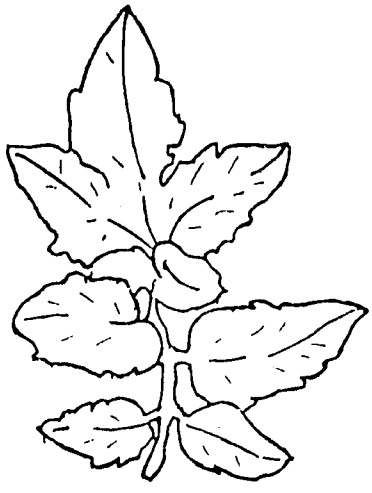
APPENDIX III
(Continued)

		Reference Variety
7.4 NUMBER OF LEAVES UNDER FIRST INFLORESCENCE		
3	Few (<6)	Early North
5	Medium (6-8)	
7	Many (>8)	Saint-Pierre
7.5 INTERNODE LENGTH		
Measured between first and fourth inflorescence		
3	Short	Supermarmande
5	Medium	
7	Long	Saint-Pierre
7.6 LEAF ATTITUDE		
3	Semi-erect	
5	Horizontal	
7	Drooping	
7.7 LEAF TYPE		
See Figure 24		
1	Type 1	Lukullus
2	Type 2	Immun
3	Type 3	Allround
4	Type 4	Pilot, Mikado
7.8 ANTHOCYANIN COLOURATION OF LEAF VEINS		
0	Absent	
+	Present	
7.9 INFLORESCENCE TYPE		
Information should be taken from the 2nd and 3rd truss		
1	Generally uniparous	
2	Generally multiparous	
7.10 FLOWER FASCIATION		
Information should be taken from 1st flower of inflorescence		
0	Absent	
+	Present	

APPENDIX III
(Continued)

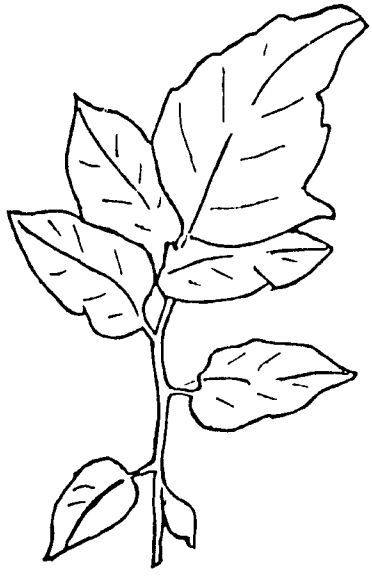


Type 1



Type 2

Type 3



Type 4

Figure 24. Leaf type

7.11 PLANT SIZE AT FLOWERING

Subjective evaluation based upon comparison to a local reference variety

3 Small
5 Medium
7 Large

7.12 FOLIAGE COVER

Subjective evaluation based upon comparison to a local reference variety

3 Poor
5 Fair
7 Good

7.13 HIGH TEMPERATURE FRUIT SET

Subjective evaluation based upon comparison to a local reference variety. A record of whether fruit sets at temperatures that normally inhibit fruit set in the area of evaluation

3 Light
5 Medium
7 Heavy

7.14 LOW TEMPERATURE FRUIT SET

Subjective evaluation based upon comparison to a local reference variety. A record of whether fruit sets at temperatures that normally inhibit fruit set in the area of evaluation

3 Light
5 Medium
7 Heavy

7.15 ALUMINIUM CONCENTRATION SENSITIVITY

Determined by the degree of root growth suppression and coded from 1 to 9 where 1 = Not sensitive and 9 = Very sensitive

8. FRUIT CHARACTERISTICS

8.1 FRUIT LENGTH

Measured in millimetres

8.2 SIZE VARIABILITY

Variability within a plant, coded from 1-9 where 1 = Uniform and 9 = Extremely variable

8.3 SECONDARY SHAPE

See Figure 22

1 Flattened
2 Slightly flattened
3 Round
4 High-round
5 Heartshaped
6 Lengthened cylindrical
7 Pearshaped
8 Plumshaped

8.4 INTENSITY OF GREENBACK

Before maturity

3 Slight
5 Medium
7 Strong

8.5 COLOUR

Before maturity

8.6 EXTERIOR COLOUR

1 Green
2 Yellow
3 Orange
4 Red
5 Crimson
6 Tangerine
7 Yellow and red
8 Tangerine and red
9 Yellow, tangerine and red

8.7 NUMBER OF LOCULES

Actual number of locules

8.8 THICKNESS OF PERICARP

Measured in millimetres from an equatorial section of the fruit

8.9 SIZE OF CORE

In cross-section	Reference Variety
3 Small	Rossol
7 Large	Pierril

8.10 PEDICEL LENGTH

		Reference Variety
3	Short	Rossol
7	Long	Porphyre

Measured from abscission layer to calyx (see Figure 25)

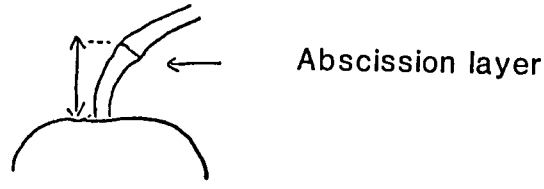


Figure 25. Pedicel length

8.11 PEDICEL AREA

See Figure 26

1	Flat	Rossol
3	Slightly depressed	
5	Moderately depressed	Saint-Pierre
7	Strongly depressed	

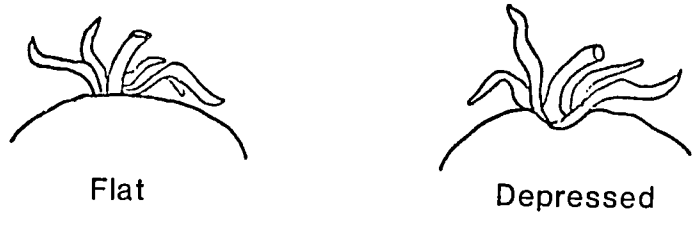


Figure 26. Pedicel area

8.12 SIZE OF PEDICEL SCAR

3	Small	Rossol
5	Medium	
7	Large	Dwarf Champion

8.13 SIZE OF CORKY AREA AROUND PEDICEL SCAR

3	Small	Rossol
5	Medium	Supermarmande
7	Large	Pieraline

8.14 SHAPE OF PISTIL SCAR

See Figure 27

1 Dot
2 Stellate
3 Linear
4 Irregular

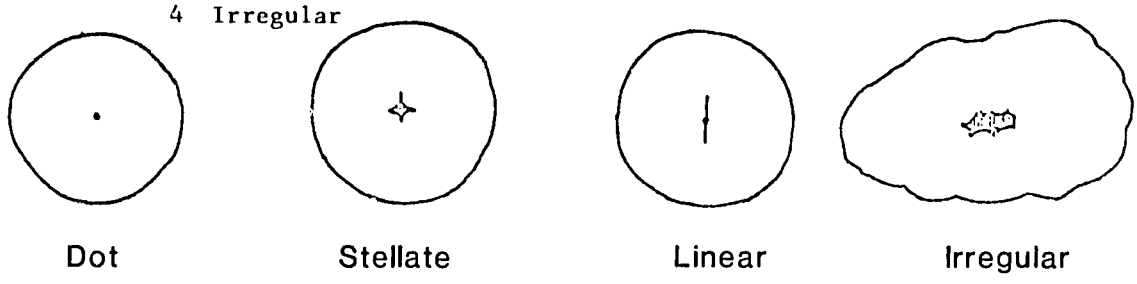


Figure 27. Shape of pistil scar

8.15 BLOSSOM END SHAPE

See Figure 28

1 Indented
2 Flat
3 Pointed

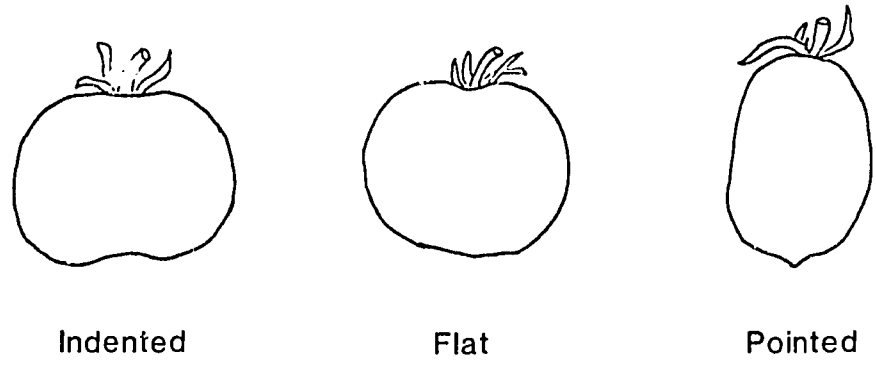


Figure 28. Blossom end shape

8.16 BLOSSOM END SCAR CONDITION

1 Open
2 Closed

8.17 PUFFINESS

Estimate of incidence and severity of puffiness in an accession coded from 1-9 where 1 = No incidence and 9 = Many fruits with severe puffiness

8.18 EASINESS OF PEELING

3 Poor
5 Fair
7 Good

8.19 EASINESS OF STEM REMOVAL

3 Poor
5 Fair
7 Good

8.20 BLOTCHY RIPENING

Coded from 1-9 where 1 = No blotches and 9 = Very blotchy

8.21 BLOSSOM END ROT

Measured on plants that are under stress as the degree of incidence of Blossom End Rot, where 0 = Absent and 9 = Severe

8.22 PH

The pH of raw expressed juice squeezed from ripe tomatoes

8.23 TITRATABLE ACIDITY

Mean of at least two samples of the titratable acidity (using NaOH) of the above sample expressed as percent of citric acid equivalent

8.24 SOLUBLE SOLIDS

Mean of at least two samples recorded as percent solids read directly from a Brix scale superimposed over the refractive index scale

8.25 TOTAL SOLIDS

Expressed as percent of dry matter of fruit with seeds and skin removed

9. STRESS SUSCEPTIBILITY

Coded on a 0-9 scale, where:

0 No symptoms
3 Slight
7 Severe

9.1 LOW TEMPERATURE

9.2 HIGH TEMPERATURE

9.3 DROUGHT

9.4 HUMIDITY

APPENDIX III
(Continued)

10. DISEASE AND PEST SUSCEPTIBILITY

Coded on a 0-9 scale, where:

0 No symptoms
3 Slight
7 Severe

10.1 SUSCEPTIBILITY TO PESTS

10.1.1 Aphids

10.1.2 Drosophilas

10.1.3 Flea beetles

10.1.4 Root-knot nematodes

10.1.5 Spider mites

10.1.6 Whiteflies

10.1.7 Fruit worms

10.2 SUSCEPTIBILITY TO FUNGI

10.2.1 *Alternaria solani*

10.2.2 *Cladosporium fulvum race A*

10.2.3 *Cladosporium fulvum race B1*

10.2.4 *Cladosporium fulvum race B2*

10.2.5 *Colletotrichum phomoides*

10.2.6 *Fusarium oxysporum f.sp. lycopersici race 1*

10.2.7 *Fusarium oxysporum f.sp. lycopersici race 2*

10.2.8 *Fusarium oxysporum f.sp. lycopersici race 3*

10.2.9 *Phytophthora infestans*

10.2.10 *Septoria lycopersici*

10.2.11 *Verticillium albo-atrum race 1*

10.2.12 *Verticillium albo-atrum race 2*

10.2.13 *Phytophora parasitica*

10.2.14 *Pythium* spp.

10.3 SUSCEPTIBILITY TO BACTERIA

10.3.1 *Corynebacterium michiganense*

10.3.2 *Pseudomonas solanaceanum*

10.3.3 *Xanthomonas vesicatoria*

10.4 SUSCEPTIBILITY TO VIRUSES

10.4.1 Cucumber mosaic virus

10.4.2 Double streak virus

10.4.3 Tobacco mosaic strain 0

10.4.4 Tobacco mosaic strain 1

10.4.5 Tobacco mosaic strain 2

11. ALLOENZYME COMPOSITION AND ZYMOTYPE

This has proved to be a powerful tool to characterize *Lycopersicon* populations.

12. CYTOLOGICAL CHARACTERS AND INDENTIFIED GENES