COLLECTION PRIORITIES FOR CASSAVA (MANIHOT ESCULENTA) AND WILD MANIHOT SPECIES IN LATIN AMERICA [1/]

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1/ Proposal to be submitted to the Second IBPGR Working Group on Cassava, 2-4 February 1982, Rome. A summary report condensed principally from trip reports of V.M. Patiño, 1-30 Sept. and 20 May - 17 June, 1981.

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1. INTRODUCTION

An IBPGR ad hoc Working Group on Genetic Resources of Cassava met at the Centro Internacional de Agricultura Tropical (CIAT) in Cali, Colombia from 9-11 December, 1980. Among the topics discussed one of the most important was that of priorities for future collections of both cultivated cassava and wild Manihot species. The group tentatively listed priorities based on areas of genetic diversity, collections already made, and danger of genetic erosion. Since only representatives from Latin American countries attended the meeting, discussion was limited to priorities for collection in the western hemisphere. Nevertheless it was felt that further study was required to positively define priority areas and procedures to follow for collection. For this purpose the IBPGR funded a consultancy for Dr. Victor Manuel Patiño, Director, Jardin Botanico del Valle, Cali, Colombia. The following is a summary report of the information and recommendations resulting from that consultancy. A detailed trip report is available in Spanish either from CIAT or IBPGR.

2. OBJECTIVES

Objectives of the consultancy as outlined by IBPGR/CIAT were:

1) Determine priority areas and strategies to follow for collection of Manihot species (both cultivated cassava and wild species) in Latin America;

2) Make contacts with national program administrators and researchers to facilitate coordination of future collection activities.

3. ITINERARY

The study involved two major trips by Dr. Patiño, which are outlined below.

Dates	City/Country
May 20	Cali - Quito
May 21	Ecuador
May 22	Quito - Lima
May 23-25	Peru
May 26	Lima - La Paz
May 27-28	Bolivia
May 28	La Paz - Santa Cruz
May 29	Santa Cruz - Asuncion
Mayo 30-June 2	Paraguay
June 3	Asuncion - Rio de Janeiro
June 4-16	Brazil
June 17	Lima - Cali
Sept. 1	Cali - Panama
Sept. 2	Panama
Sept. 3	Panama - La Habana
Sept. 4-8	Cuba
Sept. 9	La Habana - Mexico City
Sept. 10-15	Mexico
Sept. 16	Mexico City - Tegucigalpa
Sept. 17-18	Honduras
Sept. 18	Tegucigalpa - Managua
Sept. 19-21	Nicaragua
Sept. 21	Managua - San Jose
Sept. 22-23	Costa Rica
Sept. 24	San Jose - Santo Domingo
Sept. 25-26	Dominican Republic
Sept. 27	Santo Doming - Caracas
Sept. 28-29	Venezuela
Sept. 30	Caracas - Cali

4. CONCLUSIONS ON CULTIVATED CASSAVA (MANIHOT ESCULENTA)

4.1 AREAS OF GENETIC DIVERSITY

The estimates of relative genetic diversity in cassava are based on highly subjective criteria, including the authors' field experience in

observing cassava all over Latin America, and that of scientists interviewed during the period of the consultancy. Areas of primary, secondary and tertiary diversity are illustrated in Figure 1.

4.1.1 AREAS OF PRIMARY DIVERSITY

In the regions designated as areas of primary diversity, cassava is a widely cultivated crop, and is a traditional crop of the area. Farmers often grow simultaneously several different clones, and across relatively small distances, varieties change considerably.

Three principal regions are defined as having primary diversity. The first is a large area including parts of northeast, east central, southeast and southern Brazil, and Paraguay. This includes some of the most intensive cassava - producing regions of the world. A second region covers southern Venezuela and northern Brazil, extending south to the Amazon river and north along the Orinoco river. This region is sparsely populated, but cassava is a crop of primary importance in inhabited areas. Because cultivated areas may be widely separated, with limited communication, a myriad of different genotypes has evolved throughout the area. Nevertheless, much of this area has not been studied, so the estimates of genetic diversity can only be very tentative. The third area of primary diversity is centered in Nicaragua and extends south to Panama, and north into Honduras. This region is also one of traditional cassava culture in small plots. In addition this is an edapho-climatically diverse region, which has lent an additional evolutionary force to the

diversification of cassava germplasm.

4.1.2. AREAS OF SECONDARY DIVERSITY

Secondary diversity in cassava is defined for those areas where cassava is grown as an important or moderately important crop, but appears to be less genetically variable. This may be due to rather wide distribution of only a few clones, or in other areas due to only moderate importance of the crop. Most of Colombia and Bolivia, a large part of the Amazon basin, southern Mexico and northeast Brazil fall in this category.

Do you really believe this? Maybe areas of Colombia.

4.1.3. AREAS OF TERTIARY DIVERSITY

Areas of tertiary diversity for cassava include areas where cassava is either a minor crop, varieties seem to be rather similar across broad regions, or information is lacking on the extent of cassava cultivation and diversity.

4.2 COLLECTIONS MADE, MAINTAINED AND UTILIZED

A summary of existing cassava collections is reported in the Directory of Germplasm Collections: Root Crops (AGP: IBPGR/80/49) and modifications made by the IBPGR/CIAT 1980 Working Group on Cassava. With the exception of Brazil, Latin American countries have placed a low priority on collection of native cassava varieties. In some countries, previously made collections have been lost due to neglect. Nor is there much assurance that collections made in the near future would be maintained any better than those in the past. Since cassava most be main-

tained vegetatively, constant attention is required, and loss due to diseases, insects, poor soil conditions or general lack of maintenance is always a danger.

Figure 2 gives approximations of the areas collected and number of accessions from each area maintained by national programs. Figure 3 shows which areas are represented in CIAT's cassava collection. Since in many cases there is little information on area of origin of an accession, these figures on only rough estimates of areas collected. Several countries maintain collections which have not been transferred to CIAT. These represent an easily available additional source of variability which could be added to CIAT's world collection (see Section 7.1).

Active evaluation and utilization of broad-based cassava collections is carried out only in Brazil, Colombia, Mexico and Cuba. A continuing emphasis of CIAT is to train national program personnel in germplasm evaluation and utilization.

4.3 DANGER OF GENETIC EROSION

Genetic erosion may occur by displacement of local native varieties by new varieties, by changing from cultivation of cassava to other crops, or by encroachment of urban areas and other development projects into agricultural areas.

In most areas of genetic diversity of cassava, cassava is a traditional crop of small farmers. As yet there has been relatively

little displacement of land varieties by new varieties. Nevertheless, with new technology being developed by national and international institutes, new varieties will soon be adopted on a larger scale. Thus there ~~can~~ should be no delay in preserving the presently existing genetic diversity. Little information exists on genetic erosion due to land clearing and development projects. Nevertheless, in both Brazil and Mexico this is known to be a serious problem at present, and is likely to be aggravated in the future.

4.4 AREAS OF PRIORITY FOR COLLECTION

Collection priorities for cassava are outlined in Figure 4. Determination of priorities was made based on areas of diversity, areas already collected, and areas in danger of genetic erosion where information is available. Nicaragua, Honduras, Venezuela, Peru, Brazil, Bolivia and Paraguay have large regions included in the areas of highest priority. Areas of Brazil of highest priority include parts of the Amazon basin, which has only been sparsely explored, and the southwest along the Paraguayan and Bolivian borders. Also smaller areas in the central and northeastern regions have not been fully collected. In Venezuela the llanos region and the Orinoco basin have not been well collected. In Central America little collection has been done to date; thus the areas of collecting priorities are essentially the same as those for areas of diversity.

5. CONCLUSIONS ON WILD MANIHOT SPECIES

5.1 AREAS OF DIVERSITY

Studies of centers of diversity of Manihot species have been done principally by Rogers and Appan (1973) and Nassar (1979). The present study was too limited in scope to further define areas of diversity, so those previous works, plus previous experience of Dr. Patiño, have provided the basis for definition of areas given here. Best estimates of areas of diversity of Manihot species are outlined in Figure 5.

5.1.1. AREAS OF PRIMARY DIVERSITY

Two large areas of primary diversity of Manihot species are defined, one encompassing central, eastern and southern Brazil, Paraguay and northern Argentina. The other major area extends along the eastern coast of Mexico, and across to the eastern coast toward the southern end of the central plateau.

5.1.2. AREAS OF SECONDARY DIVERSITY

At a lower level of diversity, wild species extend through Central America and along the Caribbean coast of South America to north-central Venezuela. The lowlands of Bolivia, the upper Amazon region of Peru and parts of Brazil, and the Guyanas are relatively unknown with respect to diversity of Manihot species, but are areas which should be explored.

5.1.3. AREAS OF TERTIARY DIVERSITY

Manihot species are widely distributed through nearly

all areas of lowland tropical Latin America. Those areas not included as areas of primary or secondary diversity are considered as areas of tertiary diversity.

5.2 COLLECTIONS MADE, MAINTAINED AND UTILIZED

Systematic collection of Manihot species has been made in Brazil, Mexico and Central America, but most collections have been preserved only as herbarium specimens. A recent IBPGR - sponsored collection in Mexico, Costa Rica and Panama produced 11 species, which have been introduced to CIAT in seed form.

Brazil has the only national program active in the collection and preservation of wild species. They have collected approximately 26 different species, either as stakes, seeds or whole plants. The exact status of these collections is not known by the authors. Some are maintained as plants under controlled environmental conditions, some as a field collection, some as a seed collection, and others exist only as herbarium specimans.

Propagation of wild Manihot species is notoriously difficult, which has impeded their collection and maintenance. Only Brazil has personnel trained in Manihot species collection, identification and maintenance.

Wild species have been utilized on only a very limited basis in Latin America. Dr. Nassar in Brazil has made experimental crosses between M. esculenta and several wild species. In Africa,

M. glazziovii was utilized as a source of genes for resistance to African Mosaic Disease.

5.3. DANGER OF GENETIC EROSION

Little information exists on the extent of genetic erosion which has already occurred, or the future potential of genetic erosion of Manihot spp. Experts in the Brazilian national program have expressed concern about loss of germplasm due to land clearing and development projects. Apart from collection of material, maintenance of preserves where Manihot spp. exist naturally may be feasible in some countries.

5.4. AREAS OF PRIORITY FOR COLLECTION

Since relatively little collection of wild species has taken place, the areas defined as having the highest genetic diversity can essentially be considered also the areas of priority for collection (Figure 5). In Brazil, some collections have been made in the states of Goias, Pernambuco, Paraiba and Ceará. In Mexico the western coast area has been moderately well collected. Thus in these regions there could be somewhat less initial emphasis. However they still remain first priority areas due to the diversity of species there.

6. GENERAL RECOMMENDATIONS ON COLLECTIONS

6.1. PERSONNEL

Among national programs, only Colombia Brazil and Cuba have personnel trained in collection of cassava, and for wild species, only Brazil. This necessitates the use of trained collectors working across several

countries. Through training at CIAT national programs may reinforce their capacity to do their own collection.

6.2 BASES FOR COLLECTION

Within the priority collection areas, centers have been defined which could serve as bases from which to make collection expeditions. These centers would provide minimum adequate facilities and resources for making collecting trips. Figure 6 shows locations of the centers.

Some of the areas of priority for cultivated and wild Manihot overlap; thus it is logical to collect both in these areas of overlap.

6.3 TIME FRAME

It is expected that adequate collection in priority 1 and 2 areas could be done within a four - year period.

6.4 INFORMATION GATHERING

In order to provide maximum information possible both on the areas collected and the material collected, it will be essential to use a standardized format for information collection. Models are given in the report of the first IBPGR/CIAT Cassava Working Group, and should be distributed to all collectors.

Since very little information is available on the dangers of genetic erosion, for either the wild or cultivated species, we

suggest that such estimates be made by collectors during each collection expedition.

7. IN-COUNTRY ESTABLISHMENT AND MAINTENANCE OF COLLECTIONS AND TRANSFER TO CIAT

7.1 CULTIVATED CASSAVA

Cultivated cassava is generally easy to propagate either by seeds, stakes or meristems. Because all cassava vegetative material must enter Colombia as meristems, where CIAT would act as the principal repository, material would first need to be established within each country as a field collection. Each country should be encouraged to provide resources to continue maintenance, and future evaluations of the collections, but there has been limited success in this in the past. It is imperative therefore that transfer of collections be made to CIAT soon after establishment at a centralized location within each country. National programs should be provided financial help and training for the establishment and evaluation phases so that additional expense and effort can be avoided later in replacing lost collections.

Several national program collections already exist, which have not been transferred yet to CIAT. These represent a readily available genetic resource, and early efforts should be made to introduce this material to the world collection at CIAT. The following list is an approximation of these collections:

Country	Number of Accessions
Brazil	1000
Cuba	100
Honduras	75
Puerto Rico	60
Paraguay	40
Haiti	30
Nicaragua	25

7.2 WILD SPECIES

Because of the difficulty of propagating and maintaining wild species, probably due in part to a high environmental specificity, we suggest regional centers be designated to receive and maintain collected material. These could be located in Brazil, Colombia, and either Mexico or Costa Rica. Further studies are required on means of propagation of wild species. Even in instances where stem pieces can serve as propagative material, there are often problems of quarantine regulations against importation of such material. Meristem culture of wild species had been only moderately successful, and apparently requires further refinements in the culture media. Embryo culture of material collected as true seed appears promising according to preliminary results.

8. RESOURCES REQUIRED [1/]

8.1 APPROXIMATE COLLECTION EXPENSES BY COUNTRY [2/]

Country	Days	Food and Lodging for 2 collectors at $ 70/day	Gasoline at $ 3 / gallon x 10 gal./day	Total
Bolivia	60	4,200	1,800	6,000
Brazil	120	8,400	3,600	12,000
Colombia	60	4,200	1,800	6,000
Costa Rica	30	2,100	900	3,000
Cuba	48	3,360	1,440	4,800
Ecuador	40	2,800	1,200	4,000
Guatemala	45	3.150	1,350	4,500
Honduras	30	2,100	900	3,000
Mexico	120	8,400	3,600	12,000
Nicaragua	40	2,800	1,200	4,000
Panama	30	2,100	900	3,000
Paraguay	90	6,300	2,700	9,000
Peru	60	4,200	1,800	6,000
Dominican Rep.	30	2,100	900	3,000
Venezuela	60	4,200	1,800	6,000
The Guyanas	30	2,100	900	3,000
		62,510	26,790	89,300
			Plus 10% unanticipated costs:	8930
			Total: $	98,230

1/ All figures given in 1981 U.S. dollars, calculated over a period of four years but not allowing for inflation

2/ Excluding costs related to trained collector

8.2 COSTS FOR TRAINED COLLECTORS

Trained collectors will need to be contracted for all countries except Colombia, Brazil and Cuba, which can provide their own collectors. Each expedition should be headed by one trained collector.

Item	Days	Cost / Day	Subtotal
Salary/honorarium	615	100	61,500
Food & lodging	615	60	36,900
Air fare			12,000
		Total:	$ 110,400

8.3 GERMPLASM MAINTENANCE AND TRANSFER COSTS

Most countries will require assistance in establishing the collected materials in experiment stations. Transfer to CIAT, and/or other repositories outside the country of origin will have to be done by meristem culture. Included in this category also are costs for transfer of materials already existing in collections of institutes willing to provide duplicates.

Over a period of four years: $ 100,000

8.4 SUMMARY EXPENSE ESTIMATES

In-Country collection expenses	:	98,230
Collector salary/honorarium	:	61,500
Collector expenses for food & lodging	:	36,900
Collector air fare expenses	:	12,000
Germplasm maintenance and transfer costs:		100,000

Total over a four-year period: $ 308,630

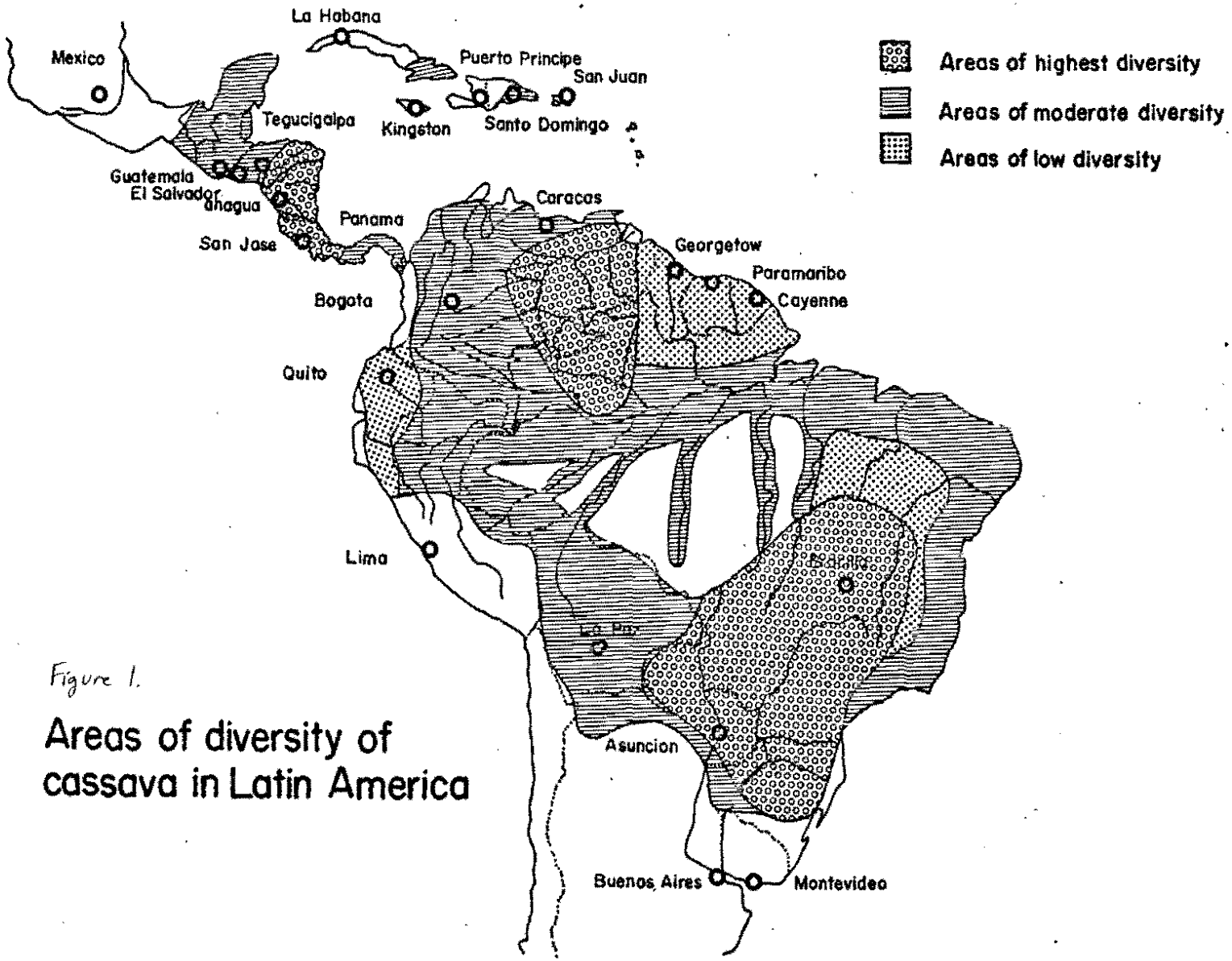

Figure 1.

Areas of diversity of cassava in Latin America

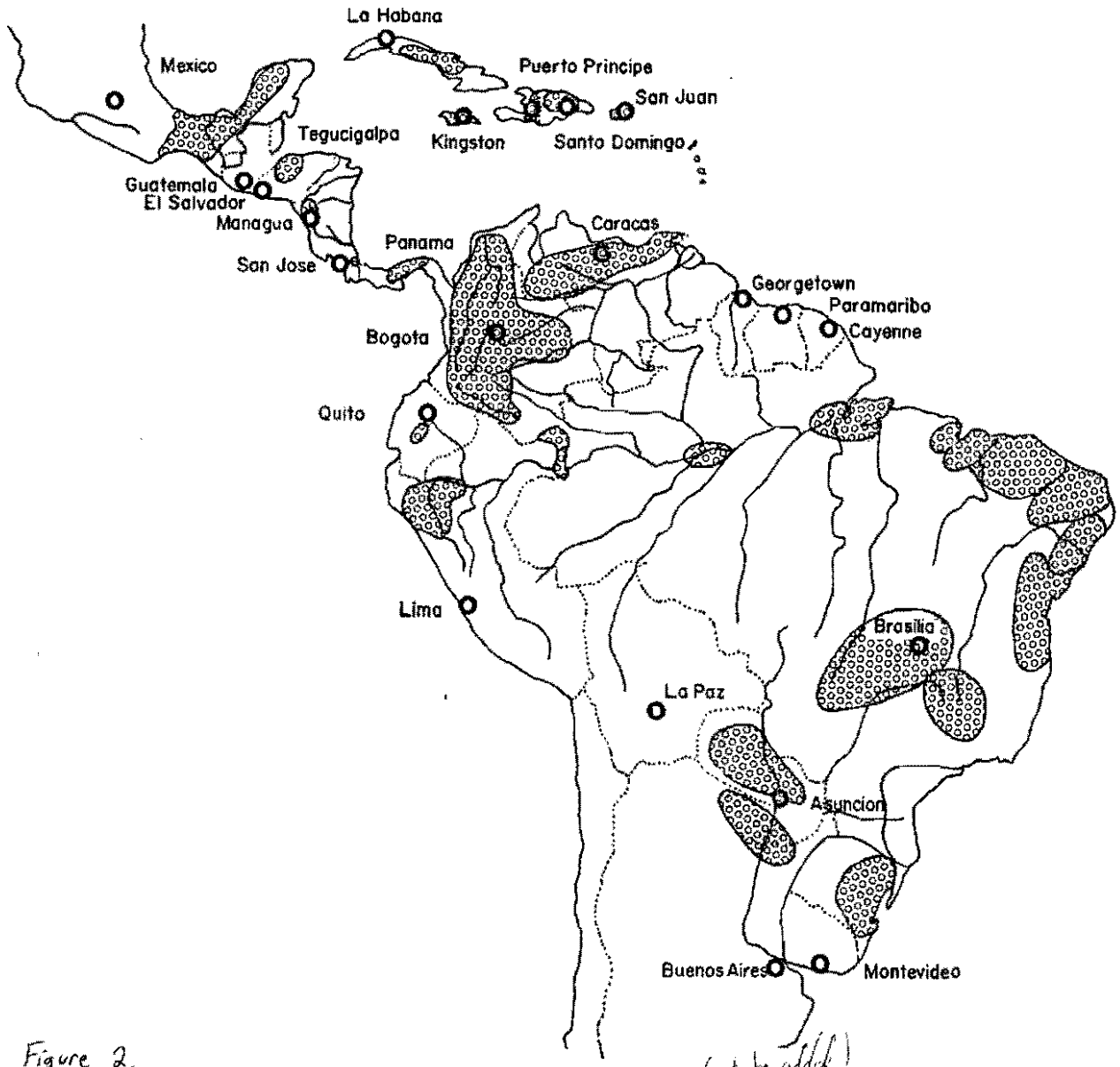

Figure 2.

Representative areas collected and (to be added) number of cassava accessions maintained by national programs and International centers in Latin America

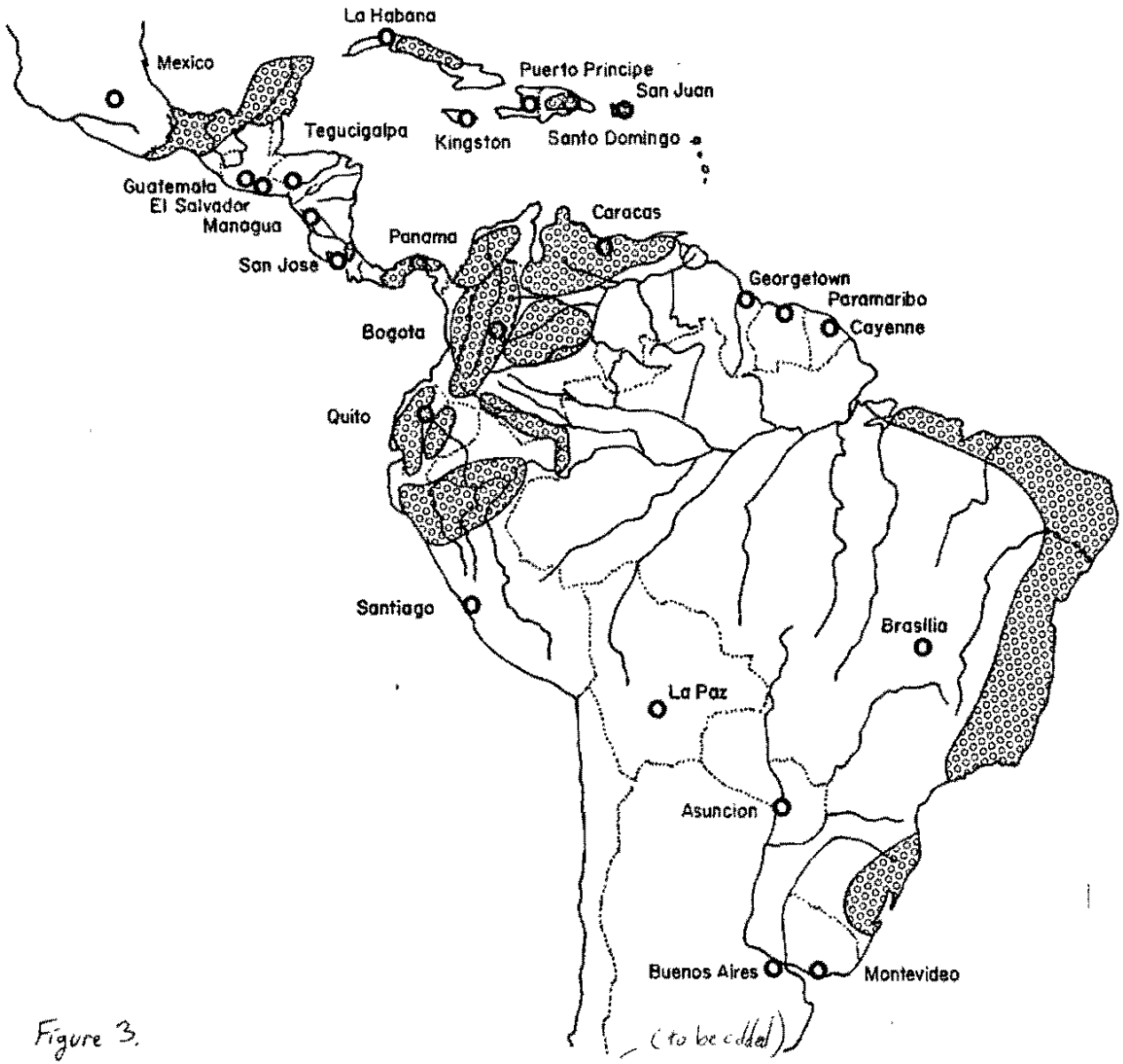

Figure 3.

Areas represented and number of cassava accessions maintainet by the Centro Internacional de Agricultura Tropical (CIAT) in Colombia

Figure 4.

PRIORITY AREAS FOR COLLECTION OF CASSAVA IN LATIN AMERICA

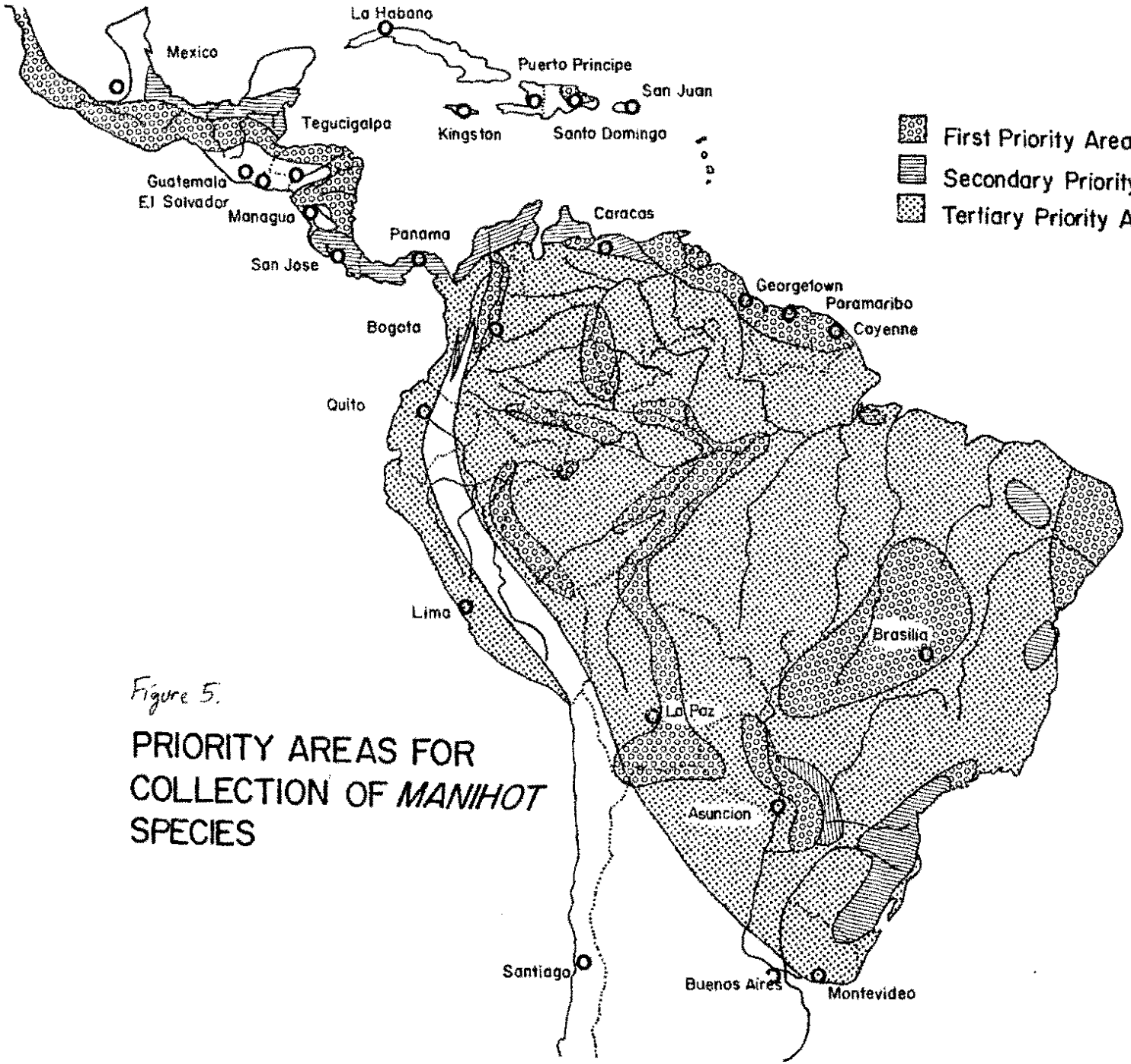

Figure 5.

PRIORITY AREAS FOR COLLECTION OF *MANIHOT* SPECIES

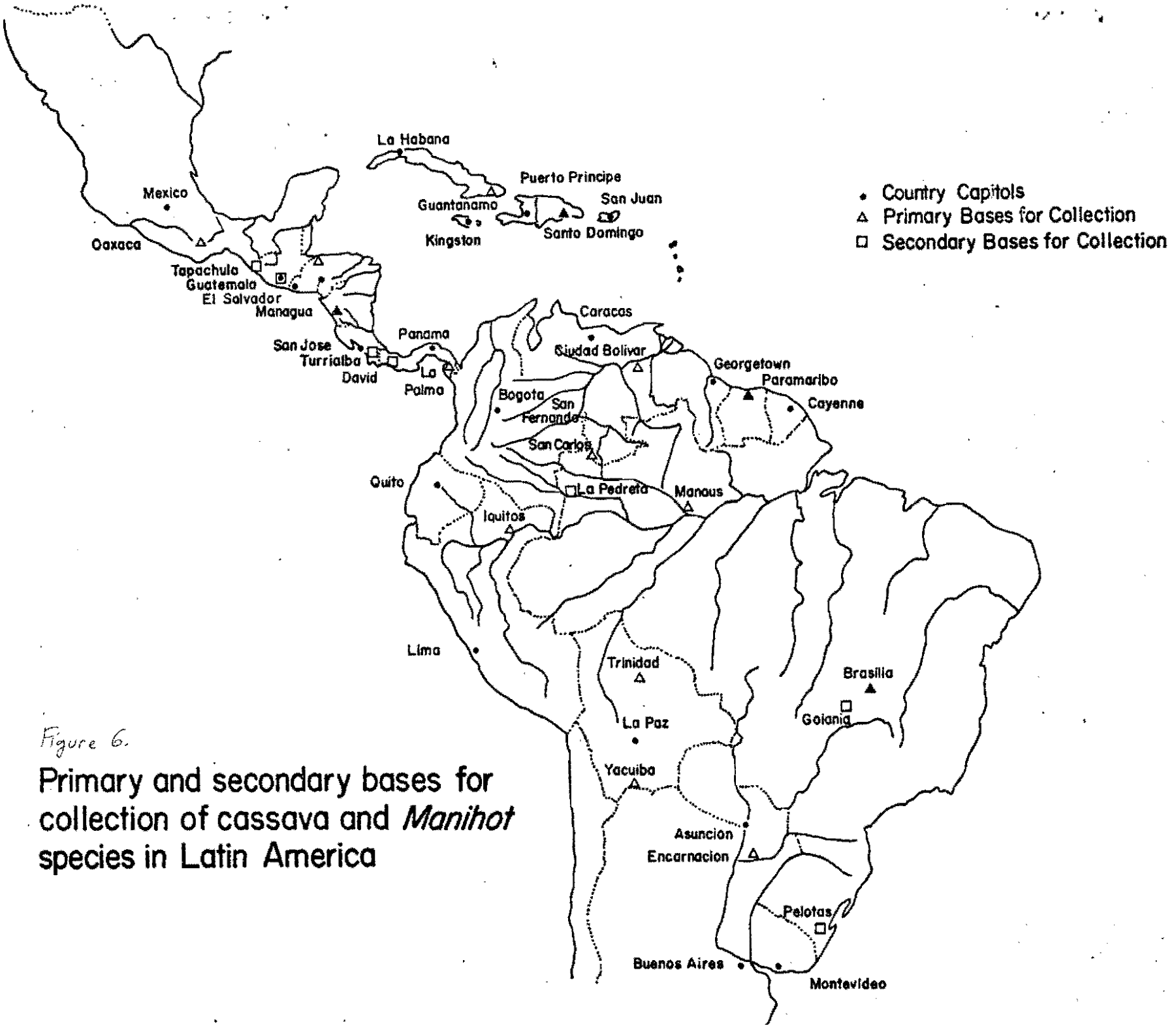

Figure 6.

Primary and secondary bases for collection of cassava and *Manihot* species in Latin America