In: Cammpbell,D. and H.D.Hammond (1989) Floristic Inventory of Tropical
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Collecting Tropical Plant Germplasm

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I. Introduction

Along with the diversity in numbers of plant species in the tropical rainforest, there is also a vast diversity of uses and potential uses for many plants. A number of economically important cultivated crops have wild relatives found only in rain forests, and these related species possess many valuable genes, such as for disease and insect resistance, improved nutrition, better agronomic habit, drought tolerance, etc. Many other species are used by local people for a variety of subsistence and commercial purposes. It is possible to say that, from the standpoint of utilization, the flora in many regions of the Tropics is more unknown than known to botanical scientists, and that discoveries of potentially great consequence to all of humankind still await us in the future.

Given the heavy rate of deforestation mentioned elsewhere in this volume, many of these potential contributions will never be possible, as the plants, and the human cultures which utilize them, will be destroyed. Thus, it is essential to incorporate into our inventory programs the collection of genetic material (germplasm) of as many useful or potentially useful tropical plants as possible, and to safeguard this genetic material in a viable form for the future. Unfortunately, even with the best facilities, germplasm is often lost after being collected. Ultimately, then, the only sure way of preserving the diversity of tropical forest plant life for future utilization is to preserve the forest itself.

II. Methods

Ayad (1980) in his glossary of plant genetic resources terms, defined plant germplasm as the "sum total of the genetic material in a plant." For the purposes of this contribution, however, germplasm can be defined as a living physical unit containing the genetic composition of a particular organism with the ability to be reproduced. Thus, germplasm can be collected and stored as seeds, plants, cuttings, pollen, and/or tissue culture, depending on the species.

In recent years the International Board for Plant Genetic Resources (IBPGR) has taken global responsibility for the coordination of germplasm collection and repository efforts, and for resolving the problem of the loss of genetic diversity of economic plants. Plants have been preserved on a priority basis, and by 1981, fifty crops were assigned "first priority" status (IBPGR, 1981). Most of the priority species are the major and minor cultivated crops, and a smaller proportion of the organization's resources have been devoted to the so-called underexploited plants (National Academy of Sciences, 1975). Work with these species has proceeded at a slower pace, and has been the research responsibility of universities, botanical gardens and governmental institutions in the Tropics.

The usual procedure is to send out germplasm expeditions with a specific mission, led by knowledgeable specialists in the particular group under study. During the expedition, other germplasm can be collected and brought back, assuming that proper storage or growth facilities are available.

While the germplasm centers for the major crops are relatively well funded, those for lesser-known species often are not. A germplasm bank has a wide range of responsibilities, which require physical infrastructure, a skilled staff and stable financial support. Ellis (1985) divided these responsibilities into four main tasks:

1. Banking: storing the accessions and keeping a current inventory
2. Monitoring: taking care of the accessions according to proper procedures
3. Regeneration: reproducing fresh material from all the accessions in the collection
4. Distribution: sending out living material to those who request it.

Problems in germplasm banking still exist. While the collecting expeditions are relatively well funded, material that might be transferred back to an agronomic station or tissue culture laboratory does not always survive due to problems in shipping, handling upon receipt or with long-term maintenance of the material itself. A simple occurrence such as a power failure in a tropical country might, within a few hours' time, result in the destruction of important plant cultures. Or, an unpredicted drought or labor problem could result in the loss of a complete nursery or recently planted field or important genetic material. However, in the past decade the situation has improved, at least for the major crops, and funding agencies have provided resources to the international germplasm centers that work with these agencies.

The IBPGR has published directories of germplasm collections, such as the one on tropical and subtropical fruits and tree nuts by Gulick and van Sloten (1984). Using the species index, researchers can locate germplasm collections for hundreds of fruits and nuts around the world.

The tropical biologist is therefore presented with an opportunity to collect and distribute germplasm of plants seen

EMBRAPA

CENARGEN (CEN) BRASÍLIA-BRASIL

NOME CIENTÍFICO				
FAMÍLIA	NOME COMUM LOCAL			
NOME DO COLETOR(OU COLETORES)		Nº DO COLETOR	DATA DA COLETA	
NOME DO DETERMINADOR E DATA	MATERIAL COLETADO			
HÁBITO DE CRESCIMENTO				
COR DA FLOR	COR DO FRUTO	INTERESSE ECONÔMICO		
AMBIENTE GERAL				
SUBSTRATO GERAL				
RELEVO	FREQUÊNCIA RELATIVA			
PAÍS	REGIÃO	ESTADO, TERRITÓRIO OU SIMILAR		
MUNICÍPIO	LATITUDE	LONGITUDE	ALTITUDE	
LOCAL DA COLETA:				
	CÓDIGO DO PRODUTO	CÓDIGO DO ACESSO		
OBSERVAÇÕES:				

FIG. 1. Germplasm collection format, reproduced from the field books used by CENARGEN/EMBRAPA in Brazil.

during fieldwork, plants which otherwise might not be preserved in collections. This is an especially attractive opportunity when working in areas that are soon to be destroyed, such as dam sites, or amongst indigenous groups who are losing their knowledge of the local flora. When appropriate, fieldwork should include a concern for, and awareness of, local useful plants.

The ideal situation would be to negotiate in advance with researchers utilizing germplasm, and obtain specific instructions for the collection, storage, and shipment of that material. Alternatively, one can also collect interesting material as it appears in the field and hope to transmit this to qualified researchers upon return to the home base. While the techniques for collection and storage of germplasm of commercially important tropical and temperate crops such as rice, wheat, corn, etc. are relatively advanced, methodology for the collection of tropical germplasm is now in an embryonic stage. At the present time there is no overall protocol for handling the quantity and variety of material of interesting and useful plants that one could possibly observe during an expedition. Within a single family, such as the palms, the seeds of some species must be germinated within a few days' time and handled quite carefully, while others will tolerate a year of storage, even treatment with fire, while still remaining viable.

Germplasm collection requires careful documentation of the location and material (accessions). For most of the major crops, descriptor lists have been written; for many of the underexploited crops, no such information exists. Basically, the descriptor list involves passport information, data on characterization and preliminary evaluation. The passport data includes accession and collection data and this is, for the most part, obtained in the field. Characterization and preliminary evaluation are done in the germplasm bank. Further characterization and evaluation can be carried out in the germplasm bank or at other sites where plant breeders are working.

Figure 1 is a page reproduced from the field books used by the Centro Nacional de Recursos Genéticos/Empresa Brasileira de Pesquisa Agropecuária (CENARGEN/EMBRAPA) in Brazil in their very extensive program of germplasm collection, characterization and evaluation. The preformatted type of field book leaves little room for error or omission when collecting data on germplasm. Booklets, such as those published on sunflower descriptors (IBPGR, 1985), coconut (IBPGR, 1978), *Capsicum* (IBPGR, 1983), or the increasing number of descriptor lists being produced for other crops, provide an excellent format for the description of germplasm, and can be modified for other crops. Probably the most detailed list of descriptors for a neotropical palm has been produced by Clement (1986) as his

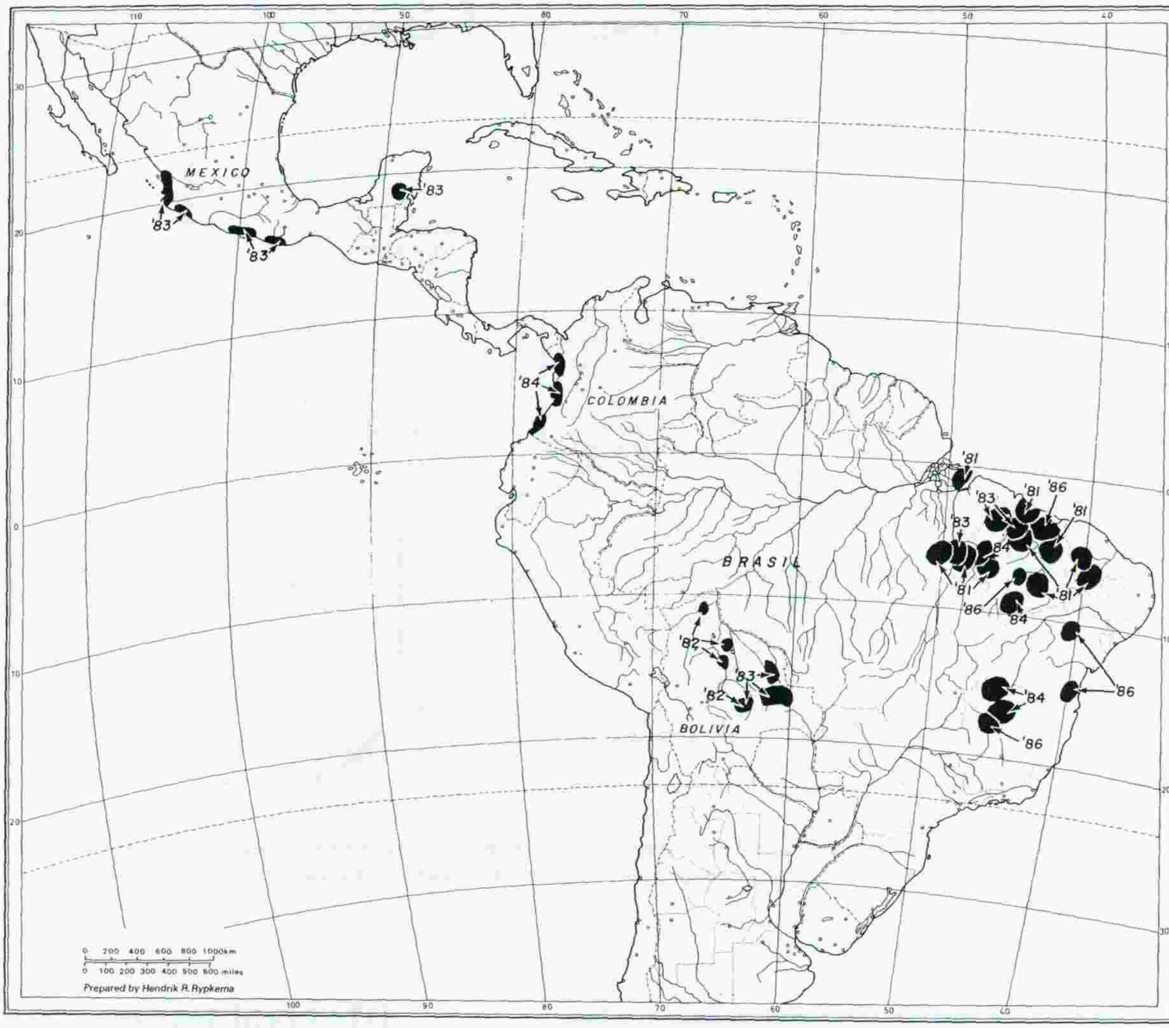


FIG. 2. Collecting sites for the babassu domestication program during 1981-1986.

masters degree research on the peach palm, *Bactris gasipaes* H.B.K.

It may be useful to discuss a specific example of germplasm collection and conservation to illustrate some of the functions of the collector and the role of the germplasm bank. The New York Botanical Garden Institute of Economic Botany has been involved in a program of domestication of the babassu palm complex (*Orbignya* spp.) since 1980. This program was initiated with the full collaboration of CENARGEN in Brazil, as well as a state institution in Piauí, Brazil, Unidada de Execução de Pesquisa de Ambito Estadual de Teresina (UEPAE de Teresina).

Under this program, one germplasm expedition is undertaken each year with joint funding from U.S./Brazilian sources. Babassu palms are a source of edible oil, charcoal, fiber, and a host of subsistence products, and comprise the largest oilseed industry in the world dependent on a wild species for total production. These palms were selected because of their commercial value, over US$ 150,000,000 annually (Pick et al., 1985), and because the entire industry is based on the harvest of wild palms.

There are two germplasm banks for babassu in Brazil, in Bacabal, Maranhão and Teresina, Piauí. The objective of the domestication program is to assemble, grow and select superior palms for utilization, either as agroforestry crops for smallholder production, or for industrialization. Since 1980, expeditions have been carried out in a number of countries (Mexico, Bolivia, Brazil and Colombia) and, as of March 1986, 369 individuals from 46 populations had been sampled, for a total of 19,360 fruits collected. These have been deposited in germplasm banks in Brazil, distributed elsewhere for field trials, and used in laboratory analyses to further domestication studies. Figure 2 is a map of the areas that have been collected during this multinational effort. Figure 3 is a flowchart of activities involved in the collection and characterization of babassu germplasm.

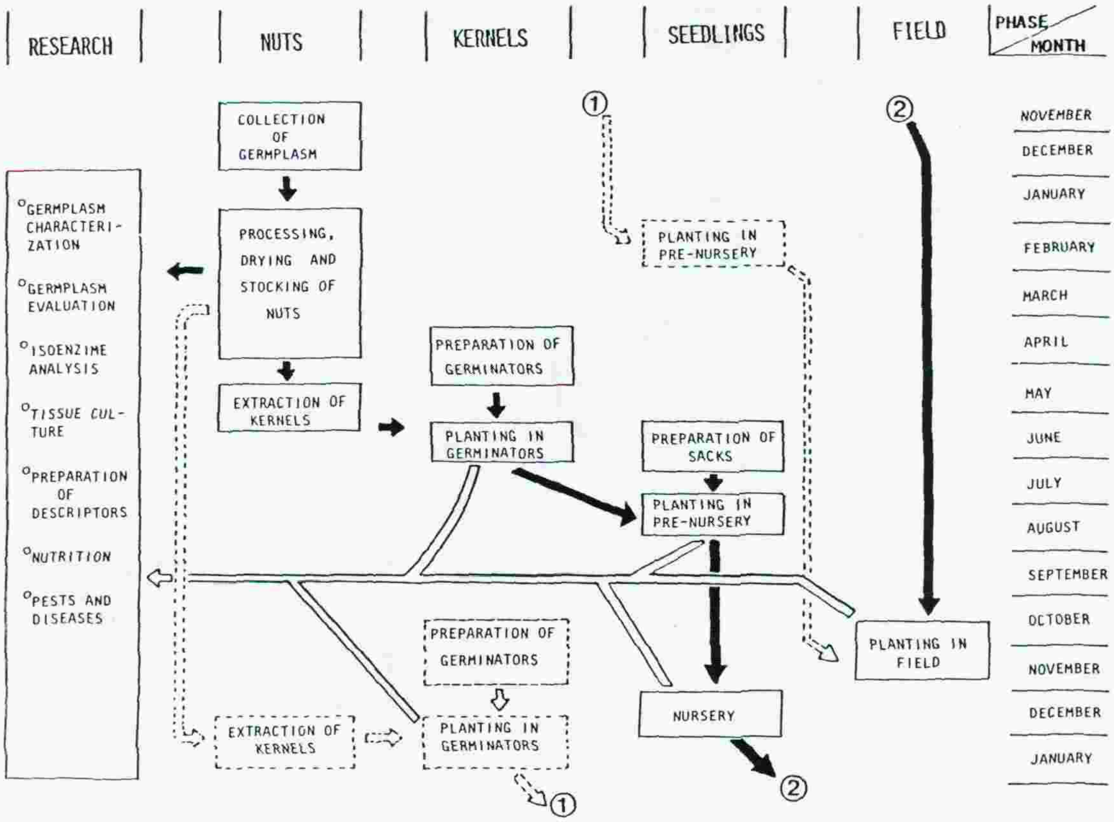


FIG. 3. Flowchart of activities involved in the collection and conservation of babassu germplasm. Black arrows: flow of material; white arrows: flow of research data; dotted arrows: alternate flow of material. Reporduced from Frazão and Pinheiro, 1986.

During these expeditions, an attempt is made to collect a minimum of 20 individual trees per population, and ca. 70 fruits per individual. This is not always possible. For example, because *Orbignya cuatrecasana* is an endangered species and difficult to locate, fewer collections were made. Additionally, as each panicle of this species contains only 10–15 fruits, it is difficult to harvest 70 fruits per tree. In general, a minimum conserved population size of 50 individuals is necessary to maintain genetic variability for genetic adaptation (Frankel, 1983).

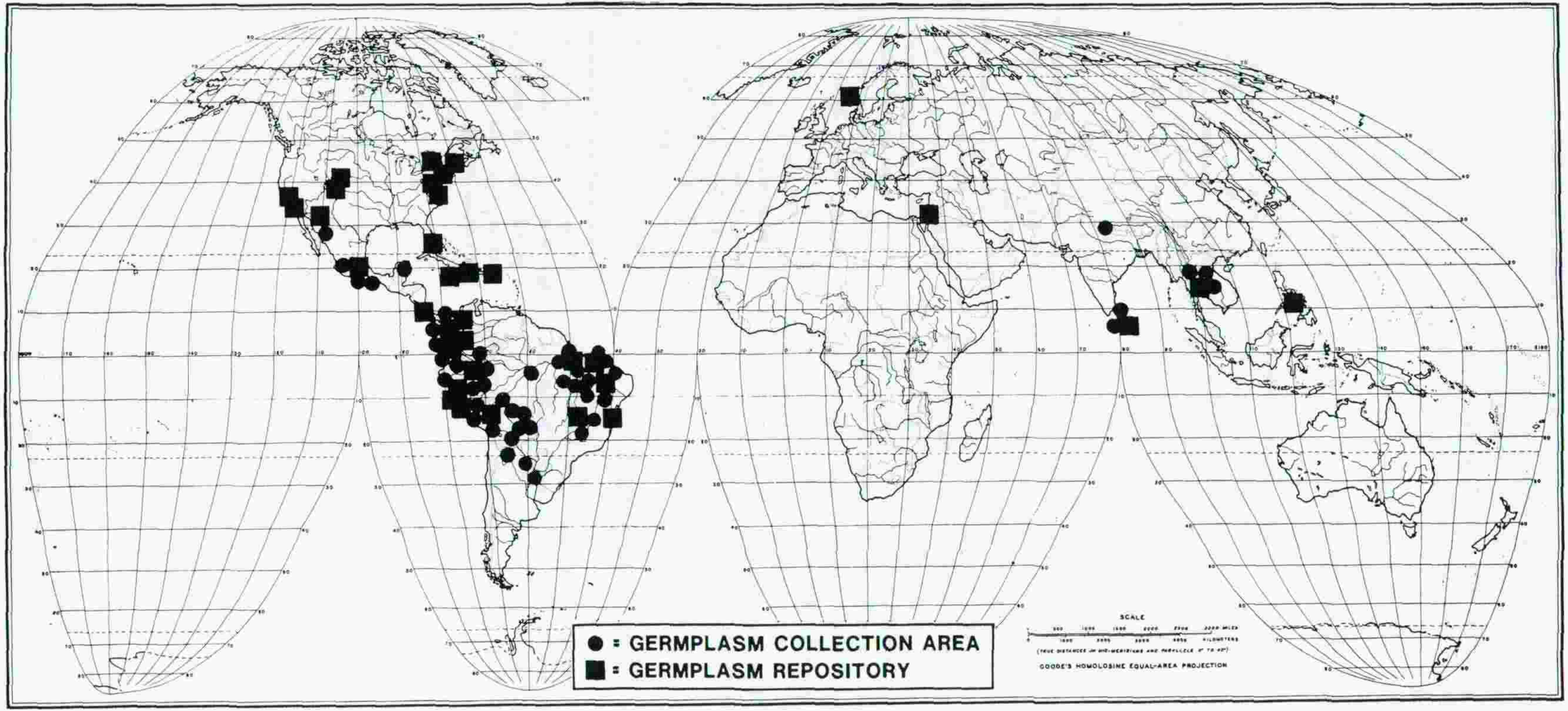
Further details on the babassu domestication program, along with information on another effort to domesticate *Bactris gasipaes*, the peach palm, is presented in Balick (1984). Future fieldwork will be designed to collect the diversity in critical areas of palm distribution outlined in Lleras et al. (1983). This effort to domesticate useful palms is but a small part of the overall germplasm collection/conservation effort being undertaken by the Institute of Economic Botany in collaboration with local institutions at sites around the world (Fig. 4), but it is a useful example of how an international project can be developed that unites systematic biological studies with ecology, agronomic utilization and economics, with the aim of developing a better strategy for utilization of the tropical ecosystem.

III. Local Permits

One problem facing the tropical collector in many countries is that the movement of germplasm is tightly controlled both inside and outside the national boundaries. Because tropical germplasm is now recognized as an important natural resource by many governments, local laws in many countries limit or control its transmittal outside of the individual country. Other laws have been developed to limit the transfer of living material for fear of spreading disease.

Strict legislation has been passed in some countries allowing the collection of living material, but only for use within that particular country. The collector should be aware of local germplasm facilities and supply these with material whenever possible. As germplasm is usually traded by scientific organizations working on specific crops, it is often more appropriate to leave germplasm in a country where it can be conserved, utilized and distributed, than to take it outside the national boundaries for use elsewhere. It is essential that one become familiar with any local laws dealing with the exchange of plant material and adhere to them rigorously. The collection and deposition of germplasm in an institution in its country of origin is a worthy goal in itself; one does

INSTITUTE OF ECONOMIC BOTANY
GERMPLASM COLLECTION PROGRAM



not always have to distribute it elsewhere for successful conservation to be achieved. For specific information on the collection, documentation and curation of germplasm, the reader is referred to Hawkes (1980), who discusses some of the general philosophy and methodology for crop plant germplasm collection.

IV. Conclusion

It is impossible to address all of the problems of working with tropical plant germplasm in the few pages allotted. While this is not considered the main responsibility of the tropical biologist at present, it is critical for researchers to develop a better understanding of the magnitude of the problem of the loss of tropical plant germplasm, as well as the reduction in the diversity of all tropical life. While most tropical biologists do not wish to assume the role of a full time germplasm collector, niches exist where contributions to this kind of work can and are being made. Working with local governmental agencies responsible for germplasm collection and banking is a good way to strengthen both one's own research program as well as overall institutional relations. Scientists and policymakers in tropical countries are increasingly expressing the opinion that, given the increasing rate of forest destruction, the collection of herbarium specimens and the preparation of floras and monographs is not enough. These countries, and indeed the world economy, do and will continue to require useful plants from the tropical forests for many purposes. Efforts by biologists toward meeting this need are very important and are a vital and lasting contribution to biology.

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FIG. 4. Germplasm collecting sites and repositories for material collected during 1981–1985 by the staff of the Institute of Economic Botany (NYBG) in collaboration with local institutions.