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GENETIC RESOURCES
OF
TROPICAL CROPS

by Jorge León

Turrialba. CATIE

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Dr. Jorge León

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EXPLANATION

In this paper the genetic resources of tropical crops are discussed in terms of their geographical origin. This is done in first place, because in most of them the genetic resources are still restricted to primitive cultivars and wild allies. In other words, their diversity is still concentrated in the area where they were domesticated, with a few cases of transdomestication, and/or of selection and breeding.

In the second place, the genus is being considered as the basic unit to treat crops, in large part because taxonomic studies are scarce in certain tropical families, and therefore the differentitation at species level is not always clear.

A third approach is to treat the crops by their main use; i.e. coconuts as an oil crop, although it is also used a fruit, for construction material, shade, etc.

Finally, many of the species mentioned do not qualify to be classified as crops by the standards of advanced agriculture. However, these species may have the potential materials to become new crops. Ornamentals and medicinal plants are not included.

Jorge Leon
CATIE Turrialba
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GERMPLASM CONSERVATION AND UTILIZATION OF TROPICAL CROPS

1. INTRODUCTION

More has been written on the theoretical approaches of the conservation of crop genetic resources and its allied fields, than on the practical procedures to carry them on. The following discussions, based mainly on personal experience and information obtained from other people dealing directly with those problems, are aimed to cover the practical aspects of the establishment, management and utilization of living collections. Seed depositories are not included.

1.1 The first factor to consider is the high number of tropical crop species and cultivars, in comparison to the situation in temperate regions. An inventory of these crops and their possible centers of genetic diversity, is the main part of this work, and is done not only to emphasize the problems of genetic conservation, but also the present and potential use of tropical crops germplasm. This is by far, the richest concentration of plant genetic resources for the future, and special attention should merit the development of systems to preserve and utilize these resources.

1.2 The scientific knowledge on the vast majority of the tropical crops is still extremely poor, and consequently the development of the technology for their management and utilization. This applies even more to species which are utilized without being domesticated, or to the potential use of wild species. The knowledge on their properties is reduced to what the primitive people know about then, which is of considerable value but has no scientific validation. These empirical knowledge, which is at the base os all kind of utilization in tropical crops, is vanishing rapidly, in a way of cultural erosion similar to the loss of crop germplasm, as it is not maintained in a written form and therefore it is more exposed to the impact of cultural changes. Parallel to the measures of collecting and preserving crop germplasm, is the need for the collection and analysis of information on cultivated and wild plants still kept by "primitive" peoples. But there are still many thousand of tropical species which have no direct or indirect use to man; some of them may become "crops" if their properties are scientifically investigated.

1.3 The losses of crop germplasm, the so-called genetic erosion, is due in the tropics mainly to cultural aspects; changes in the consumption patterns, especially in foods, in which native crops are replaced by other of more social prestige but in most cases of inferior value as food; to the destruction of the native vegetation, especially the rainforests, in which grow wild populations of crop species or their allies; and in a minor degree, but often of quite spectacular results, to the pressure of natural selection, especially the effect of plant diseases. The replacement of cultivars, which is of importance in crops of advanced regions, is of lesser importance in the tropics, except in plantation crops, and is due principally to the effect of diseases, as mentioned above. The lack of breeding and selection programs in most tropical crops, prevents the development of new cultivars and consequently the replacement of primitive varieties, as occurs in advanced countries.

1.4 Genetic resources centers. The tasks of conservation, increase and supply of germplasm, require the establishment of genetic centers. These may be part of a scientific institutions or an organization per se.

The fundamental objective of a genetic center is the maintenance and increase of its germplasm collections. All other activities are secondary, and should be conducted to support the main purpose of the center. In the tropical crops this is more necessary, due to the need of preserving germplasm for future use. The improvement of temperate crops - and a few of the tropical ones-shows the importance of collections in the preliminary screenings and in supplying materials for breeding or horticultural improvement. The advances achieved in the temperate crops result not only of the utilization of the cultivars of the species, but also its weedy populations or wild allies. The sources for resistance, quality, earliness and many other economic traits, are incorporated in the advanced cultivars from primitive landraces or from related species.

The status of plant breeding in the large majority of tropical crops is at levels of underdevelopment in which they may stay for many years. The plant breeders in the whole of Latin America, for instance, are inferior in number and training than the breeders for any major crop in the USA. But there is no doubt that more and more breeders are going to be trained. The purpose of the genetic centers in the tropics is to mantain as much as possible of the crop genetic diversity to supply the future breeders with the materials they will need.

1.5 <u>The structure of the center</u>. Depending on its objectives, a genetic resources center may confine its work to one or a few related crops and its or their wild allies, or to a wide group of crops of regional interest. The physical set up includes installation for plant propagation, quarantine, and multiplication; documentation service; seed rooms for permanent storage, and services such as libraries and herbarium. For these reasons the genetic center can be established as a unit in a program or institution, more than as an indepent organization. If it is a part of a research/training institution, its role will be more effective, as it may become an integrated part of the activities in plant breeding or selection in crop diversification through introduction and exploration; in the conservation of natural resources or in agricultural development projects. It may function in the supply of plant materials and/or information on crop plants and on wild species of potential value as crops, and on the exchange of germplasm with other centers, institutions or private concerns, within and outside the region in which it operates. A crop genetic resources unit or center in the tropics is therefore something more than a gene reservoir. It may function as an instrument in agricultural development; and, as many crop species do not receive at present any attention from science or technology, as a depositary for the future advancement in their improvement; and as an agency for its immediate utilization.

1.6 Freedom of exchange and distribution. There should be no limits to the exchange or distribution of crop genetic resources, except if these activities may risk the depletion of the local gene pools or are restricted by phytosanitary conditions. Advanced cultivars and/or breeding are often of restricted distribution by government institutions. As these materials may be available from different sources, these distribution may not affect the whole operation of genetic conservation. The seed industry development, especially the production of high quality seed, although a very important fact in the agricultural development of the tropics, is an activity outside the scope of genetic centers. However, these may sypply the basic materials, especially in the early phases of selection and breeding.

1.7 Priorities are established in genetic resources activities following certain guidelines in reference to crops or to regions. The importance of the factors determining the rank of priorities may change with the time and circunstances, and only very general concepts may be considered in setting up the priorities, such as:

a) the importance of the crop, at present or in its potential value;

b) the degree of genetic erosion and the possibilities of preserving the germplasm;

c) the adaptability of the crop to the conditions where it is going to be maintained as a living collection or in seed storage.

From a practical point of view, crop or cultivar adaptabilitity is the key factor, as the majority of the tropical crops has to be maintained in living collections. Adaptability in this sense does not necessarily means high yields; a collection of avocados or mangos under certain conditions may not produce any fruit, but may supply abundant vegetative material for propagation.

1.8 The interaction of crops and regions has been widely recognized and has led to recommend regional centers in the areas of genetic diversity, as the most appropiate answer to the problems of conservation and distribution of crop genetic resources. Regional centers may function also as research and training centers, carry on work on preliminary screening and supply new materials for breeding or crop improvment programs.

2. ESTABLISHMENT OF LIVING COLLECTIONS

2.1 A large number of tropical crops have to be maintaned in living collections, because a) they produce seeds very rarely (taro), or only under certain environmental conditions (sweet potatoe), or at very long periods (agave); b) many species produce reluctant seeds; c) the need to maintain genetic identity through clonal propagation is obligatory in many species.

Living collections have many problems and limitations, a) their maintenance requires continuos care; b) propagation materials may carry diseases and pests and are often bulky and perishable; c) there is a limit to cultivar adaptability, and therefore many entries have to be replaced frequently.

On the other hand, field collections a) may supply quickly large amounts of propagation materials; b) permit a constant evaluation of cultivars, and within some limitation, to carry on experimental work; c) observations may be conducted on phenology which may be very helpful in crop production; d) field collections may be used for teaching or demonstration purposes.

2.2 An alternative to field collections is to keep germplasm in tissue culture, which also has advantages and limitations. Among the first, a) the possibility of storing and distributing virus free material; b) the capacity of storing a large collection in a small space. BUt it is limited at present by the lack of information on the procedures to reproduce many crops, and it cannot replace field collections as a source of observations on the biology of the crop, or as an easy and quick source of propagation materials. Tissue culture is an integral part of a genetic center, as a complement of living collections, especially in the provision of clean material easy to transport and store.

2.3 Kinds of collections. Living collections established in field plots may be uniform stands of many entries of the same species, or mixed stands of different species, the so-called miscellaneous collections.

2.3.1 Uniform stand collections. Collections of the same species are the easiest to establish, as with a few exceptions, entries will be planted and managed under an uniform system. However, at the planning stage, a decision has to be reached on questions such as planting distances, pruning (if necessary) or other management practices.

A special problem is the maintenance of mutants or some entries which are not adapted to grow under the general conditions of the field collection. They may need special care, fertilization, disease control, light conditions, etc. which require special installations.

2.3.2 Mixed collections. Due to space limitations, it is a common practice at universities, experiment stations and other research centers, to grow together different crop species. These collections differ from botanic gardens in a) they are restricted to economic species; b) they are not arranged in a systematic order.

A miscellaneous or mixed collection may include one or a few plants of each entry, and species with very different growing habits. They have to be established and maintained as an unit, but each species has to be managed on its individual requirements.

2.5 Choice of site. In an experiment station or research center there are many limitations of different kinds, and only very general guidelines may be given for the establishment of a field collection. Primary considerations should concern the physical conditions; a) topography, b) soil: fertility, structure; c) drainage and facilities for irrigation; d) access: roads, trails or in some cases, isolation; e) possibilities for expansion.

2.6 Planting layout. The first consideration is how to divide the site in blocks, if possible of uniform size, by roads which will permit the maintenance operations: cleaning, pruning, harvesting, etc. Within the assigned space, the blocks could be arranged, when it is feasible by the topography and soil conditions, in some symmetric way. However, if there are soil features like rock outcrops, swampy or sandy places, that may prevent the normal growth of plants, it is then advisable to leave these sites empty, instead of trying to correct or improve their conditions.

The dimensions of the blocks in uniform stand collections, depend on practical considerations, such as the use of equipment for disease control, irrigation, harvesting, etc. which varies from crop to crop. Long blocks are preferable in flat or gently sloping land, with wide roads of access along their length, and narrow roads cutting across their width. The dimensions may fit the planting lay-out according to the species. For instance one or several entries planted in line, may determine either the width or the length of each block.

In a miscellaneous collection, with uniform distances between rows and different distances between plants in the rows, the block layout may be more complicated, and has to be adjusted to the different planting distances.

An alternative to the blocks layout is to plant in clusters. These are isolated groups of the same or different species, often trees, vines, etc. growing together. They produce a striking landscape effect, as may be seen in some botanic gardens, especially if the clusters are well spaced. However, they are expensive to montain, and for evaluation and identification purposes, this planting system is far from satisfactory.

2.7 Planting distances. The distance between plants in a collection is a function of biological factors. such as type of plant and reproduction system, and of practical arrangments: uniform stand or mixed collections.

2.7.1 Plant type. In establishing a permanent or semipermanent collection, the type of habit and growth pattern are of foremost importance, especially in connection with management practices, such as pruning and renovation. Tropical crops offer a wide range of habits and growth patterns. Some of the most common are the following:

a) trees. The architecture of the most commom "models" of tropical trees have been described by Hall, F., Oldeman, R. A., A. Tomlimson, P. B. 1978. Tropical trees and forests, Berlin, Springer. Although the approach is highly theoretical, the information may be applied to certain practices, like pruning and vegetative multiplication. The architecture, growth pattern and certain characteristics like leaf fall, may vary between species of the same genus and even within cultivars. The information on height and canopy size and shape, found in floras and monographs, is also useful in planning the planting distances.

b) palms. Several kinds may be distinguished: single stem, like coconut, African oil palm, babasu; clump: asai, pejibaye; climbing: rattans. In clump palms a common practice is to reduce the stems to one or few. In spacing palms, consideration should be given to their special root systems.

c) bananas. As the clump grows outwards it should be replaced periodically-every four years or less-. When possible, a banana collection should be replanted in a different site. The soil requirements are well known; soil disinfection against nematodes is a desirable practice.

d) ginger, cardamomons, arrowroot, etc. The lenght of life, like in bananas, may be of several years. But as the aerial parts dry almost continually, it is necessary to rejuventae the clump by planting new and strong shoots every year for ginger, arrowroot, curcuma, etc., and every 3-4 years for cardamomon.

e) yams. Most yams could live for several years; however, as the edible part is harvested annually, it should be replanted if possible from large, entire tubers. Yams require support, and where permanent installations are built the tubers may be replanted in the same sites, if the soil is of good fertility.

f) sugar cane. Clumps may last up to 8-10 years, provide they are cut annualy and are well fertilized.

g) vines, such as black pepper or vanilla, may be planted in separate blocks or under trees, in both cases requiring supports to grow.

2.7.2 Reproductive system. In cross pollinated species, the pollen dispersal may define distances and often isolations, between cultivars or species. Dioecious plants, on the contrary, may be planted closer for pollination, and the excess of male plants, could be eliminated later. Self-incompatibility is another factor to consider, both in number of plants and planting distances.

2.7.3 Practical arrangments. For uniform stand collections, information on planting distances is obtained from experimental trials on optimum distances and plant populations; such information is available for cacao, coffee, coconuts, sugar cane, etc. Studies on root distribution and size of canopy are also very helpful in establishing planting distances.

In mixed collections the situation is more complex, as each species may have different space requirements. It is a good practice to plant them in rows of uniform width, chosen according to experience /6-8 m seems to adapt to most species), and then to plant each entry in the row at its most convenient distance. There are some advantages in this layout; a) it makes identification easier (each plant may be located by number of the row and its position in the row); b) it facilitates routine operations: cleaning, spraying, harvesting, etc; c) it may be easier for the comparison of plant types: height, branching pattern, etc.

2.8 Number of plants per entry. The number of individual plants per accession to be established in a collection, depends on practical and theoretical considerations. Among the first, the space available is most important; also maintenance (labor, etc) and seed production requirements. Theoretically, the type of reproductive mechanism is the main factor.

a) clonal accessions may be represented by only one plant, but the risk of loosing it or the supply of seed may require more than one;

b) autogamous crops or apomictics, also require a low number of plants per entry, with the same risks than the clonal accessions;

c) open pollinated crops should be represented by the largest possible number of individuals. However, space limitations do not permit to have a sufficient representation, and the entry is generally reduced to a low number of plants.

d) dioecious plants, (nutmeg, papaya, rambutan) require enough plants to insure an efficient pollination.

2.9 Clonal gardens. A possibility to overcome the problems of mantaining the genetic identity in open pollinated crops, is to establish clonal gardens. In doing so, the natural variability of a crop is reduced to the number of genetypes planted as clones, although diversity could be released if hybrids are established among clones. This has been done in several forest trees and is applied also in some crop collections. In cacao, clonal gardens are easily established by rooting cutings or leaves or air layering. In citrus, cashew, mangoes, avocado, etc. by grafting. This last procedure requires a careful managment and to know the compatibility between scion and graft, something that may take years to find out.

The practical advantage in clonal collections of reducing the number of plants per entry, is balanced by the need of establishing many clones to represent the natural variability of the species.

A kind of clonal garden is the so-called "small orchard", which has been developed for certain temperate fruits and could be tried in tropical crops. In this system seedlings are planted at close distances and on them are grafted scions of different cultivars. In this way a small planting may provide vegetative materials of a large number of cultivars in the case of autogamous crops, it may supply also seeds in limited quantities.

3. MANAGEMENT

3.1 Management of a living collection may follow the same agronomic practices: fertilization, pruning, weed control, maintenance of an optimum phytosanitary condition, harvesting, etc. as in a commercial farm operation. The problem, however, is that in most tropical crops the basic information available on plant growth, nutrition, reproductive systems and other, is very scarce and often misleading. Besides the usual practices mentioned above, a living collection requires special tasks, such as identification, phenological observations, etc.

3.2 Soil fertilization. Information on soils - maps and analysis -, and on the conditions of the plant - tissue analysis - supply general guidelines for fertilization programs. In an uniform collection the same fertilizer formula may be applied, but in a mixed collection it is not possible to adapt a formula that will respond to the requirements of all species. Information on the general soil deficiencies in the area and on their correction using certain fertilizers, may lead to adapt a general formula. In some cases, seed production (for distribution, storage, etc.) is affected by deficiencies in certain oligoelements (boron, sulphur,etc) which may determine a poor set; corrections are easy through soil or foliar applications.

Besides the contents of a fertilizer formula, the time of application is of foremost importance. Experimental trials or the local experience from commercial plantings, may provide guidelines to establish an application program.

3.3 Pruning. A foremost consideration in the management of a living collection is the decision to adopt a system of pruning, to leave the plants at free growth or to leave them without pruning for a certain period and then to prune them according to a established pattern. In some tropical crops like coffee, tea, cacao, mangoes, for instance, pruning systems have been developed, often adapted to different cultivars; but in most crops the pruning systems are not known and often the morphological and growth studies do not supply the necessary information. If a pruning system is adopted, it is indispensable to consider that any system affects, more or less drastically, the architecture of the plant. As this is a varietal character, often of considrable value for the identification of the cultivar and in determing cultural practices, the decision of pruning should be carefully considered. Once any pruning is applied, the information on plant architechture and growth pattern, is lost and cannot be retrieved.

Some general considerations have to be taken in mind: a) pruning is aimed at renovating the organs of the plant that yield a commercial product: leaves, seeds, fruits, and so each species, and often a cultivar, require a different system. This leads to keep in mind the changes of systems, according to experimental results; in coffee, for instance, the "fancy" systems have been replaced for a mass pruning by rows of plants; b) pruning varies according to the planting material; in cacao and other dimorphic crops, a seedlings is treated differently than a plant coming from a rooted cutting; c) pruning, once started, is an operation that has to be repeated according to the crop, and may require also the continuos removal of undesirable shoots. This is expensive, it may require trained people and it is often a source of infections.

When the architecture of the plant is not well known, neither its growth pattern, the best solution is to leave the plant as it is, removing only the dead or infected parts. Free growth, however, creates some problems. The lack of new producing branches may curtail seed production in many Dicot species, after the first periods of production. In some Monocots, "pruning", if this is the term, consists in removing lateral shoots, to permit an optimum growth of the central stems.

3.4 Phytosanitary control. The control of diseases and pests is probably the most important task in the maintenance of a living collection. It may also be the most expensive in labor and materials, and therefore it should be given full consideration in the planning of the lay-out of the collection. It requires roads to move equipment and materials, water for the sprayers and the spacing between rows or plants to be established according to the spraying equipment: small pumps handled by workers, large machines, etc.

The control of diseases and pest requires a continuous supervision of the collections. An outbreak of a disease or a massive attack by insects, may destroy years of plant growth or delay it considerable.

Also, other less visible organisms, such as nematodes, or the action of viruses, micoplasma, etc. have to be continuously observed and controlled. Nematodes are a serious problem in many crops, and their effect may be detected only after some time, when the plantings are already established. A census of the nematode population is not a difficult task and may give valuable advice in the selection of sites for a collection. If for these reasons alone, the best place for a living collection is an experiment station or training center, where specialists are available to be consulted on phytosanitary problems.

3.5 Weed control. Weed control is not a serious problem in certain crops if the distance between plants does not to permit their growth, as in sugar cane and cacao. In most cases, however, it is a very expensive operation. It enough funds are available, either mechanical or herbicide control (or a combination of both), may keep the ground clean and prevent weed competition; this is a most desirable measure. However, in collections of trees or shrubs, a common solution is to plant lawn grasses (Paspalum notatum, P. conjugatum, Axonopus scoparius, Stenotaphrum secundatum, etc.), which may be mowed by machine. The areas around the trees are cleaned by hand or by applying weed killers. A grass cover of this kind does not seriously compete with the collection trees, improve the soil structure, facilitates the observations of the trees and provides a good landscape effect. However, competition for soil nutrients may result of planting grasses or legume cover crops very close to trees and shrubs; some palms are especially susceptible. Yellowing of the leaves and poor growth may be sings of root competition, and this requires immediate action.

3.6 Drainage and irrigation. In wet areas surface drainage is of upmost importance. Most tropical crops, especially trees, may stand water for several days, but an excess of water in the soil does a permanent dammage to roots. Underground drainage is expensive and require maintenance. Suface drainage: shallow ditches to discharge excess water, may be open along blocks, and deep ditches has to be open for the general drainage of the collection area.

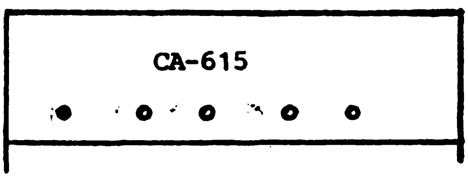
Irrigation facilities are necessary in certain conditions, especially in new plantings, and the distribution of water lines should be considered in laying out the collection plans.

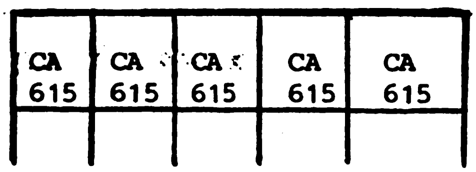
4. IDENTIFICATION PROCEDURES AND MATERIALS

In a living collection each individual plant should be identified by more than one procedure: a) identification marks in the plant, rows or groups and b) identification in maps, lists or catalogues. For the first kind of identification are used i) metallic or plastic tags, generally attached by wire rings to the branches of trees and shrubs with the names or numbers embossed by machine in the case of metallic tapes, written with special ink or pencil in the plastic tags; ii) numbers or letters painted in a visible part of the plant; iii) metallic tags supported by wires or steel rods sunk in the ground; iv) concrete blocks or slabs with painted numbers or letters. Perhaps the most satisfactory type is the aluminun tag with embossed letters or numbers, fixed to a ring wide enough so that it would not interfere with the growth of the branches. Aluminum or iron nails are not recommendable to fix tags to trees or shrubs. In semi-perennial crops, like sugar cane, concrete slabs are used to mark rows or blocks of plants, which may be moved to a new site when necessary.

No one of the identification system is perfect and only the experience may show which is the most suitable. All them require careful inspection and checking, as it is not rare to see a branch strangled by the wire ring of a metalic tag; or have identifications that have to be replaced or repainted.

The second kind of identification are <u>maps</u>. Living collections should be mapped in such way that a plant could be identified even if it does not bear any tag or other identification mark. Maps could be of many kinds, but they shoald be drawn at a scale that permits its use in the field, and duplicate copies should be kept in files. For field use it is a common practice to draw separate maps for each block of the collection. Plants are represented by dots, with the identification letter or number, or as squares in which each one has the identification, as below:





Maps should be printed in strong paper, durable and resistant. For field work, it is convenient to fix them to hard pieces of cardboard, which are placed in envelopes made of a sheet of transparent and heavy plastic. The maps written with strong pencil which permit deletions and corrections are most convenient for field work, while in the files the final copies should be written or drawn in a permanent way.

5. PLANT PROPAGATION

Genetic centers require installations for both seed and vegetative propagation. The information on the standard practices and the necessary equipment in plant propagation could be in texts, such as Hartmann & Kester's.

5.1 Propagation facility. A living collection should have a propagation facility, in which to grow different materials in the kind and quantity required by the programs. It may consist of: 5.1.1. A room to desinfect seeds or vegetative materials and to dispose of discarded materials; 5.1.2 A germination room; soil heating equipment is necessary for the germination of certain plants (palms, etc.). 5.1.3 A room for grafting or budding. (The last two rooms should have, beside the usual tables and cabinets, refrigerators to keep seeds and budsticks. Also concrete boxes to store rooting media: soil, sphagnum moss, sand, vermiculite, etc., and equipment to prepare the mixtures). 5.1.4 Soil desinfection facility, either permanent: concrete tanks with wood cover, or temporary: plastic sheets to cover the soil. A heating unit to desinfect soil is very convenient for large quantities; an autoclave could be used for small quantities. 5.1.5 Propagators. a) the simplest kind is a serie of concrete boxes with a glass or plastic cover over which water runs continuosly. The cuttings or grafts are placed in racks in the boxes and watered by hand. b) mist propagators are indispensable in the rooting of certain materials; c) a room with mist spray, continuous or periodic, and controled illumination, is necessary for rooting in some species.

5.1.6 Greenhouses and lathouses. Some kind of installation is necessary to grow seedlings or clonal materials under conditions that may protect them from the damage by extreme temperature, light or air moisture. a) The standard greenhouse used in temperate regions has to be provided in the tropics with instruments for cooling and moisture control, which are expensive to install and maintain. In case of electric power failure, the young plants may suffer considerable damage. b) a lathouse is cheaper and quite appropiate for dry areas, but in wet conditions the air retains a high humidity and requires proper ventilation. The roof may be built of metalic laths, quite expensive, or wood; the later is cheaper but last only for a few years. c) a common kind of building for propagation is a wood structure with plastic roof and walls covered with metalic or plastic screens. The algae may reduce quickly the light coming through the roof, which requires periodic cleaning. d) Saran lathouses, in which the roof and sides are covered or only the roof, are quite common. They are specially suitable for shade living plants and for those that require hardening before transplanting. e) non permanent shelters, with thatched roof and no walls, are quite satisfactory for growing seedlings and grafts, provided that there is plenty of light inside.

5.1.7 Tissue culture facilities, for conservation and distribution of germplasm.

5.1.8 Micrografting instrumentation, either separate or as part of the tissue culture operations.

5.2 Containers. The kind of containers to be used in propagators, greenhouse in the field, are discussed in several publications. See, for instance, DICKEY, R. D. et al. 1978. Container growing of woody ornamental plants in Florida, University of Florida Agric. Exp. Sta. Bull. 793; TINUS, R.W. & MACDONALD, S.E., 1979. How to grow tree seedlings in containers in greenhouses. USDA Forest Service Techn. Rep. RM-60. These two bulletins contain also up to date information on propagators, rooting media and greenhouse managment. There are several new types of containers which are easy to obtain or build in tropical countries, especially of plastic.

5.3 Lay-Out. The plans to build the propagation facility shoud consider the space available and its location in reference to the collection plantings, offices and quarantine instalation. Access roads, places to dump discarded materials, water and electricity supply, obstacles that may interfer with natural illumination, wind direction, and sun path are important factorsin the location and design.

5.4 Miscellaneous. A) Air-layering is a propagation technique very common in tropical crops. At present it is done using a plastic sheet, but aluminium foil is also used. This is a field operation that permits to obtain materials to multiply an entry or to fill gaps in the living collections. B) Trained workers are the most important factor in plant propagation. Grafting, rooting of stems and leaves, air-layering and the general care in rising seedlings and clonal material ,are a matter of personal experience. Any genetic center should train, encourage and mantain a permanent labor force capable, responsible and intelligent in propagation procedures.

6. COLLECTION OF FIELD DATA

6.1 Kinds of data. In a living collection a series of phenological data has to be registered, in order to plan the management of the collection, particularly in the obtention of seeds or other propagation materials. It should be considered that this kind of information has several limitations, as it comes from samples which rarely permit a statistical analysis. Yield data, especially obtained from one plant or from a non replicated plot, has a very limited value. Phenological data include a) measurement of growth, expressed as plant height, trunk diameter, etc; b) leaf flush and fall, which in many tropical species occur more than once a year, and is of practical importance in spraying; c) blooming, dates and degrees; d) fruit setting and seed maturation. e) disease and pest attacks, signs of deficiencies.

6.2 Registration. a) Phenological observation, when possible, should be taken by individual plant s. This may lead to detect variants (mutations or hybrids), of special value; b) data should be registered on a periodic base, and the establishment of the lapse between dates should receive special consideration. For an uniform collection (one species or several species of the same genus), the frecuency of data recording is easier to establish than in a mixed collection, where growth patterns vary with the species. One solution is to take the information 2 to 4 times a month, especially at the beginning, and afterwards reduce it to 1 or 2 registrations per month or less. It should be remembered that in most tropical crops such phenomenon as leaf flush or blooming, may take only 2-3 days, and may go unrecorded easily. Special notebooks of resistant paper and hard pencils (as used by engineers), binoculars, tapes, instruments to measure tree height, etc. are necessary for field work. Finally, it should be remembered that biological cycles change from one year to other, and that many tropical crops (coffee, mango) show a marked biennial bearing; thus spur elongation, which is a pattern very common in tropical trees, should be registered in relation to flowering and seed seting. This pattern varies according to the species and often with individual trees, in the same year.

6.3 Data analysis. The data collected tabulated and analyzed permits in a few years of observation to establish the time and duration of cyclic processes, such as the shoot elongation, leaf flush, flowering, fruiting, production of shoots, etc. A graphic representation of the data is very useful in planning managment operations and for studies in reproductive biology, fruit growth, etc.

7. SOURCES OF GERMPLASM

A germplasm collection depends for the increase or renewal of its materials, on two main sources: plant exploration and plant introduction.

7.1 Exploration. Plant exploration is one of the main activities of a genetic center, aimed to obtain new germplasm of priority crops or to explore areas of special interest for the germplasm they contain. In a genetic center exploration is a continuos operation, in importance second to conservation. It is done through expeditions or permanent collectors.

7.1.2 Expeditions. Two kinds are recognized: expeditions to collect only one species and its allies, or to collect widely all the materials available in a selected area. In the tropics is very difficult to apply a systematic sampling in the collecting expeditions, and the materials collected result in a non-random sample of what was available at the moment. A collecting expedition should be carefully planned and prepared (see Hawkes, J.G. Manual of field collectors. FAO, 1976). Its scope and duration depend on the funds available, and the field operations on the quantity and diversity of the materials that may be collected. Therefore the success of an expedition depends largely on the training and personnel abilities of the collectors. The experience in the tropics indicates that plant explorers should have a) a thorough knowledge of the crop or crops to be collected and of the wild populations or species of the same genus. In this connection, it is important that the explorers study the floras of the area (for most tropical countries or regions there are already published), and to visit local herbaria to determine collection sites. Also to discuss with botanists, agronomist, farmers, etc., the location of sites where the species may grow. Herbarium sheets have specimens mostly in flower, and that may give some indication on fruiting periods. b) a good knowledge of the geography of the area, its agricultural systems and the cultural background, especially of the autochtonous groups. Ethnic groups keep their own cultivars, and in countries with different indigenous populations, the plant explorer should look for distinctive signs: dresses, types of houses, etc. that may indicate a different ethnic group. c) has to be familiar with maps, publications and aerial photographs of the area.

Before starting any of his collection trips, Vavilov spent weeks of intensive study of the geography, climate, vegetation, history of a country or region. Also of the maps available. At present there are detailed maps of most parts of the tropics; aerial photographs on reduced scale that permit the identification of individual trees, houses, etc. and that may help to pinpoint collection site. On the other hand, satellites photographs supply an accurate view of plant formations on a large scale, showing deforested areas, etc. which are very helpful in planning collecting trips.

but most of the introductions may fail. However, plant introduction in all countries is the base of agriculture. As a rule, the important crops of a country or region, are exotic.

In the tropics plant introductions may replace up to some point, the lack of breeding programs. A well planned program of introduction, screening and propagation, may supply the immediate needs for agricultural development, and provide the bases for future breeding projects. But most of the tropical countries have no organizations to utilize the genetic materials available elsewhere. For this reason, a genetics center working on a national or regional basis, has to have a strong component in plant introduction. It is a mechanism that if follows the quarantine regulations, may have a strong and rapid impact in the agriculture of the region.

As mentioned above, the base of plant introduction is to test the adaptability of a genotype to a new environment. By environment, in the case of crops, should be understood not only the physical factors: soil, climate, etc, in their relationships or other parameters determined by them, such as degree of infection, but also the cultural factors: agricultural systems or practices already operating in the site where the genotype is introduced. The success of a crop in a new habitat, depends on its adaptation, and therefore it is neccessary to test as many genotypes as possible to find the most adapted. It is a well known fact that in testing germplasm of a crop, it should be done on the widest geographic range. Accessions from a country or region, due to selection, offer different characteristics than those from other countries or regions. In the choice of genotypes for introduction, crop ecological requirements give a broad guideline, but they cannot measure the degree of adaptability; this can only come from field tests.

7.2.2 Operations. The first step is to locate the material desirable in experiment stations, genetic centers, seed exchange services, botanic gardens, private collections, etc. This requires a knowledge of lists (index seminum), catalogues, etc., or addresses of scientists, in charge of collections. A large share of germplasm exchange is based on personal relations.

In the tropics ther are very few collections that publish lists of their genetic materials, and the trend to put them in computers does not facilitate the person needing such materials to locate and obtain them. There is also no regional organization to promote the exchange of information and germplasm, and only the FAO Seed Exchange at Rome offers this service and in a limited way. It is important to note that the three main regions of genetic diversity in the tropics: SE Asia, West Africa and tropical America are not only disconected geographically but also culturally.

7.2.3 Screening. Once the germplasm source has been located, a request should be sent stating the amount of seed or propagation materials required. (It should be remembered that some countries impose strict restrictions in the distribution of some germplasm). The request should be accompanied, when necessary, of the import permits issued by the government of the country where the center is located. Quite often this goverment requires a phytosanitary certificate accompanying the seed, and issued by a competent authority in the country of origin. A few countries (Brasil, U.S.A.) have special permits, the green-yellow tags, with numbers and addresses. In those cases the materials sent by mail go to a central office for inspection and recording. It is also common to send packing and shipping instructions (see FAO Handbook N°93 for information on these subjects).

7.2.4 Once the materials has been received, it is given the corresponding <u>introduction number</u>, and when necessary, passed to post-entry quarantine.

7.2.5 There are large plant introduction services in countries which have subtropical areas, in which germplasm of interest to the tropical countries is mantained in collections. In there countries, especially Australia and U.S.A., the plant introduction services cooperate in locating and supply germplasm.

8. EVALUATION

8.1 Evaluation is aimed to screening plant collections for the presence, quantity and quality of a special character, such as pectin content, lauric oil, resistance to witche's broom. These operations are done when the special character is needed in a breeding scheme. The evaluation of the most important crop characteristic, yield, requires replicated trials at different locations and times, and is a task for research stations or crop centers.

8.2 The role of a genetic center in evaluation is therefore to supply the widest possible range of well identified genotypes. It has been the experience in advanced breeding, than the more diverse in geographic procedencies in a collection, the more chances are of finding useful genes. In barley, the cultivar 'Atlas', has genes originating in accessions from Spain, Turkey, Ethiopia, Algeria, Russia, Manchuria, etc.

8.3 However, there are activities in which a genetic center may advance the knowledge on crop characteristics for future utilization, based on the systematic study of the phenology of collections and on the establishment of well organized sets of descriptors for species and cultivars. In the less developed crops -which is the majority in the tropics- a carefully prepared list of characters may help to detect differences, such as color of a fruit, resistance to diseases, earliness or other differences which may be very valuable for selection or breeding.

Single characters, like different fruit size or color, may imply a potential value for transportation and marketing; . a compact, short plant may influence planting density and easier harvesting. These are discrete characters, and their inheritance has to be tested in a progeny trial. With less constrasting characters, due to continuos variation, the environmental component is generally important and therefore the evaluation requires a more detailed trial, at different environments. In the detection of variants, one person with experience in the crop and ability to observe differences, often un-untrained laborer, may contribute more than a trained scientist but unfamiliar with the crop.

8.4 Finally it should be repeated that to supply an ample source of germplasm for screening is one of the main task of a genetic center. But evaluation activities without any clear purpose in a genetic center, may divert funds that should be better spent in which is its main objective: the maintenance and increase of its germpalsm.

9. INFORMATION SYSTEM

9.1 An information documentation system has to be based on the needs of the people that are going to use it. Quite commonly, however, the documentalist point of view prevails, and the result is the accumulation of information in computers and other systems, to which the users who need more the information, have difficult or no access at all.

9.2 In developing regions the information on genetic resources is required mainly to locate crop species or cultivars, to the contrary of advanced countries where breeding programs require mostly genes for specific purposes. A genetic center in a tropical region, therefore, should have the information on new cultivars, how to locate them and when necessary, how to obtain propagation materials. The task is not especially difficult, due to the reduced number of active breeding stations, but is complicated by the lack of a publication, like the Register of Cultivars of the USDA, where periodically appears the description of new varieties. Only a careful search of the literature may permit to list the new cultivars of tropical crops and their characteristics. Only in sugarcane there is a permanent germplasm committee, which may supply up to date information. Very few research stations in the tropics publish lists of their germplasm collections or index seminum. Some of them are included later, as references in the regional treatments.

9.3 The basic source of documentation in genetic centers in the tropics are a) plant introduction register, in a book form, that would record the number by consecutive order; identification (scientific and/or common name); origin, and date. Eventually this information may be put in lists, cards or computers. b) lists by species, including for each cultivar: number of introduction; name; origin; date of register; location in the field. c) information file by species or cultivars; in which phenological data, evaluation results, photographs, printed information, etc. may be placed together. Photographs and drawings by a trained artist, may be extremely useful in identification work and the preparation of publications. d) collection of catalogues of germplasm from experiment stations, private companies etc; index seminum. This information requires up dating and if the number of requests justify it, to be placed in punched cards or computers.

9.4 Descriptor lists. When a genetic center has accumulated enough germplasm to have a good representation of the genetic diversity of a crop, or when there is a special interest a descriptor list should be prepared and tested. A descriptor list requires a careful study of the morphology of the plant and its main agronomic problems, and therefore is advisable to consult experts in the different problems. But, first of all, requires to go through the botanical literature to find out plant characteristics; previous description of cultivars, genetic traits, especially in terms of mutations, and methodological hints in the preparation of the descriptors list.

9.5 Identification of germplasm materials. An important function of genetic information system is the correct identification of its materials. At the species level, identification is not difficult in most cases, but if there is some doubt, it could be checked by a trained botanist or sent ot a well known herbarium. At cultivar level, materials are identified by common name, ('Chocosito' maize), by abbreviatons used by the collector ('SCA-6' cacao) or by breeding or selection identification ('IRRI-4'). Although the International Code of Nomenclature of Cultivated Plants (1979), permits changes in the name of a cultivar, this practice should be restricted to a minimum. Giving new names in the registration to introductions that have already well known names, as practiced in some experiment stations in order to give them the numbers or names of the station, should always be discouraged. Such practices lead to a confusion in the breeding or selection work; each time the new name is used, the original name or the breeding lines should be given, as requested by the Code.

9.6 Herbarium. In some centers it may be necessary to establish a herbarium as a reference unit. This requires a) well trained collectors; b) relations with othr herbaria in which materials may be properly identified; c) and installations to mantain the samples in a proper condition, a task which in the tropics is especially difficult (see Fosberg, F. R. & Sachet, H. 1965. Manual for tropical herbaria. Regnum Veget. 39.). Besides, an herbarium requires an extensive and specialized library.

To create an herbarium could be only justified if in the country there is no such institution, but if there is, it would be an unnecesary duplication.

9.7 Reference library. One of the main reasons to have a genetic center as part or close to a research or teaching institution, is to have access to a good library. However, a genetio center should have a reference library, with the floras of the area; general books on cultivated plants; bibliographies and monographs on genera or species in which the center is especially interested; geographic information; collections of maps and reference books on the region it operates.

10. QUARANTINE

10.1 The risk of introducing pathogens, pests or weeds with new germplasm, should always be present in the operation of a genetic resources center.

A first step is to assess, in planning the introduction or exploration of new germplasm, the phytosanitary situation in the sources of materials. FAO and other organizations publish maps showing the distribution of pests and diseases in the world, and regional phytosanitary offices may supply information on new outbreaks. One consideration to keep in mind is that often the center of diversity of a crop does not coincide with the area of concentration of biotypes of its pathogens. This means that introducing or collecting materials from an area of low crop diversity, there may be a risk of introducing a new pathogen.

10.2 A second consideration is that quarantine laws and regulations are mandatory acts on part of governments or organizations, and they tend to be rigid and in some ways of difficult acceptance on the part of breeders. At the same time in most tropical countries, quarantine regulations are difficult to enforce by local authorities, and there is not enough staff or facilities to implement them. Quarantine inspection becomes a routine operation, often only a superficial examination of the material before its release. Whatever the situation is, the responsibility of a genetic center is not only to comply with the local regulations, but to do anything at hand to prevent the introduction and spread of new pathogens or pests.

Therefore a genetic center should have the minimum installations to handle foreing plant material = disinfection facilities (fumigation chambers); a greenhouse adapted to quarantine (FAO has plans of this kind of greenhouse for tropical conditions; a facility to destroy planting materials and containers or wrappers; isolation plots to observe and check living plants from virus, micoplasma, etc.

10.3 In the distribution and exchange of plant materials, an unwritten but generally accepted assumption is that the compliance of quarantine regulations is at the receiving end of the distribution. The sender complies with the usual regulation of obtaining a certificate stating that the material is "apparently free" of fungi, insects, etc., but the person or institution at the receiving end is responsible for the safe introduction of the material.

10.4 Tissue culture and to some extent micrografting, are means to supply clean materials, which usually do not need to pass through quarantine regulations. But technology has been developed only for a restricted number of crops, and depends on the availability of materials at a center or institution where tissue culture is operated.

10.5 There are international systems of germplasm exchange that have quarantine components, as in the case of coffee in the Western Hemisphere through USDA and cacao also for this continent through USDA and from the old World through Kew Gardens.

B. REGIONAL DIVERSITY

1. SOUTHEAST ASIA

I. SOUTHEAST ASIA

1. INTRODUCTION

Southeast Asia, as defined below, is one of the three tropical regions of germplasm concentration in the world. The other are West-East Africa and tropical America. De Candolle (1883), who was the first to establish the independent origin of cultivated plants in the Old and the New World, did not elaborate further on the regional concentration of germplasm within the hemispheres. De Candolle pointed out the antiquity of agriculture in China, India and other regions, based mainly on historical and linguistic evidence. Almost half a century later, N. I. Vavilov (1927), in creating the hypothesis of the "centers of origin of cultivated plants", considered India, including Burma and excluding the NW area, as one of the "primary centers", to which he assigned the No. 2 (No. 1 was China), Indo-Malaysia, including Indochina and the Malay archipielago, was considered as a separate center, No. 2a. This Vavilovian approach was followed by Darlington and Janaki Ammal (1945), Kupzov (1955), Zhukovsky (1968) and others.

Sauer (1952), without establishing geographic delimitations, considered SE Asia as one of the hearths of world agriculture, with plant and animal domestication, development of agricultural systems and the spread of its crops and domestic animals to other regions in the Old World.

In some ways opposite to Sauer's ideas, was the approach of Burkill (1953) on the habits of man and the origins of crops in the Old World. Burkill followed the prevailing trend in his time, that agriculture was invented in the Near East as part of the "neolithical revolution", and although he did not state it clearly, the implication is that he accepted that plant domestication started in the Near East and as a continuous process expanded eastwards until it reached the Pacific. Darlington (1970) states this approach more precisely.

For Harlan (1971), South East Asian and the South Pacific form a "non center" of crop genetic diversity, while Zeven and Zhukowsky (1975) go back to the Vavilovian ideas and divide the region in two centers: Indochinese - Indonesian and Hindustani.

2. DELIMITATION OF THE REGION

The Indomalayan region from the standpoint of crop genetic resources could be considered as a continuum from western India to Polynesia. Geographically it is formed by two components: one continental and one insular. The continental part is formed by a) the belt south of the Himalayas and the mountains of SW China, limited to the west by the Thar, the large desert of India, and includes the Gangetic plain, the Himalayan foothills and the Deccan peninsula; b) the area south of the Yangtzee in China, which is considered by most anthropologists as part of SE Asia; c) the peninsula areas of Thailand - Indochina - Malaya. In a political division, the continent component of the region includes most of India, Sri Lanka, Bangladesh, Burma, Thailand, Kampuchea, Laos, Viet Nam, Malaysia, Singapore.

The island component includes= a) the Great Sunda islands, which some geographers call "Island South East-Asia"= Sumatra, Java, Kalimantan (Borneo), Sulawesi (Celebes), Halmahera, Ceram and others; b) the Lesser Sunda islands; c) New Guinea and Melanesia; d) Micronesia; e) Philippines; f) Taiwan; g) Polynesia.

3. NATURAL FACTORS AFFECTING CROP GENETIC RESOURCES

The crop diversity of a region results of the interaction of natural and human factors. Among the first, natural vegetation is the most important, as it supplies the basic materials for domestication. The richness and complexity of the vegetation are due to the origin and evolution of its flora, as determined by the geological history and the environmental conditions (mainly climate and soils) of the region.

3.1 Geological background

The relation between the three continental masses of the Indomalayan region: India, SE Asia and Australia, provide the explanation for the distribution of plant families and genera within the region, and in some ways, for their relation to the flora of Africa. It was the eminent Indian paleobotanist B. Sahni (1936), the first to adopt the continental drift theory to explain the relations of the Paleozoic and Mesozoic floras of India, China and Indochina. The three large continental masses: India, SE Asia and Australia, as parts of Gondwanaland, split in Triasic and Early Cretacic. India and Australia maintained their relative positions, while SE Asia moved anticlockwise to reach its present position (Ridd, 1971). According to Sahni (1936) the rise of the Himalayas as a result of the collision of the Indian and Central Asian plates, formed a barrier to the expansion of Asiatic plants into India.

The other important feature in the morphology of the region in relation to plant distribution, are the two large continental shelves, the Sunda and the Sahul. The Sunda shelf, the largest in the world, extends from SE Asia to Sumatra, Java, Borneo and Philippines. Its submarine surfaces is quite even; a drop of 50 m in the present sea level would join the Great Sunda Islands and Philippines to Asia. The Sahul shelf extends from Australia into New Guinea, and is even less deep than the Sunda; a drop in the sea level of 25 m would join Australia, New Guinea and the neighboring islands to the east. Between the two shelves the sea floor sinks to considerable depths, 14.800 m in the Philippinean Trench; this geologically unstable area, includes Celebes, Moluccas, the Lesser Sunda islands and the Southern islands of the Philippines. The continental shelves were recognized since the last century to be of primary importance in the distribution of animal and plant life in the Indomalayan region. They could have provided in the geological past, land connections, one between continental Asia and the Great Sunda islands, other from Australia to New Guinea. The intermediate area, called "Wallacea" (Merrill, 1954), was on the contrary a barrier to East-West distribution. Several limits, or "lines", with a South-North direction, have been suggested to separate the biological distribution in the intermediate area, by Wallace, Weber and others. The present limit to the West is accepted now as the Wallace line, with some modifications, and the Weber line as the eastern limit of the intermediate area. A clear example of the importance of Wallacea is the distribution of _Eucalyptus_; it spread northwards from Australia to Philippines, but is not found east or west of the intermediate zone.

3.2 Natural vegetation

The area from SE Asia (Indochina and the Malay peninsula) to New Guinea

called Malasia by plant geographers (van Steenis, 1950) is the core of the flora of the Indomalayan region. Most of the elements of this flora are of local origin, and have moved into SE Asia and India.
On a broad generalization, the vegetation of the Indomalayan region is associated to climatic factors, especially amount and distribution of rainfall, and secondarily to edaphic factors. The main elements, in order of importance, are i) the rainforest; ii) the monsoon forests; iii) sayannas, and iv) highland vegetation; the last is reduced to a few areas in New Guinea and Burma.
Since Schimper (1903) the rain forest have been considered as the main component of the vegetation of SE Asia. They extend from the Western Ghats to Assam, Burma, southern Malaya, Sumatra to the northern part to of New Guinea; also the Oceanic islands and a large part of Philippines. The rain forests all over the Indomalayan region have been severely disturbed or destroyed, the action of man being very ancient (Rambo, 1979) but has intensified in the last century due to timber extraction or agricultural expansion (Whitemore, 1975). The rainforests of the Indomalayan area are in terms of number, the most important source of cultivated plants in the region, and its destruction is the most serious threat to genetic resources in the Old World.
The monsoon forest covers a large part of India; the Deccan peninsula and the Gangetic plain and parts of Burma and Indochina, northern Malaysia, western Java and the Lesser Sunda islands. In some ways, the monsoon forests have been more affected by the action of man than the rainforests, especially as they have less power of recovery, and some of the savannas

in Indochina and Thailand may be the result of the combination of edaphic factors, vegetation and the action of man, the later mainly by burning. The monsoon forest may have a special role in plant domestication; Burkill (1951) has placed the origin of yam cultivation in areas of monsoon forest, due to the adaptation of these species to alternate season.

On the origin of the flora of the Indomalayan region, the most accepted view is that Asian elements extended through former land connections to the great Sunda Islands (Goods, 1964). However, A. C. Smith (1970) has proposed a different explanation. The center of Angiosperm evolution, according to this hypothesis, was in Malasia, and from the Angiosperm spread towards Asia, Africa, and the Pacific islands, as the continents split. Smith supports his view on the high number of species found in Malasia, and on the presence of the most primitive taxa amon flowering plants: Degeneria, Tropodendron, Eupomatia and others.

The Malasian center of plant diversity as defined by von Steenis (195), includes the Malay peninsula south of the Kra strait, Philippine, the Sunda islands and New Guinea. This area contains more than 25.000 species of flowering plants, that is 10% of the world flora; 40% of the genera are endemic.

3.2.1 Plants forms

The diversity in plant forms in this area is, for domestication, more important than than the number of species. Trees with different kinds of fruits or nuts; vines with tuberous stems; grasses with large seeds; herbs with pungent principles, and others; offer a wide range of domestication materials. The following groups merit special attention: i) trees with edible fruits are abundant in the Indomalayan forest, some with arils and husks of appealing colors and forms (Corner, 1964). Fruit gathering by transhumant tribes in the forest has led to the selection of superior trees in Durio, Nephelium, Mangifera and other genera, and to their accidental multiplication as their seeds are scattered in the forest; ii) trees and shrubs are utilized in SE Asia for the tender twigs, shoots and leaves, which are eaten cooked or fresh, like in Gnetum, Sauropus, or for the flowers like Sesbania; iii) nuts are important as food and for oil, used in differente ways: Canarium, Terminalia, Aleurites; iv) the Monocots are of special importance as food sources, for the tubers or corms, like Dioscorea, Colocasia and other Aroids, or for the essential oil contained in tubers: Zingiber, or in the seeds: Elettaria; v) sugar cane, the most efficient plant in sugar formation; iv) palms provide oil and food: Cocos; sago: Metroxylon; sugar: Nipa; fibers: Raphia and many other uses; vii) grain seeds (cereals) include rice and Coix.

The abundance and diversity of natural plant products in the Indomalayan region could, in one way, promote the easy domestication of many species. On the other, their abundance in natural conditions could be taken as a factor which did not push man to cultivate or domesticate wild plants. In SE Asia the primitive agriculturist used only a very small fraction of the natural vegetation it the domesticated plants form a reduced number of the total of plants whose properties are known to the agriculturists of the region.

4. MAN AND CROPS IN SE ASIA.

4.1 Peopling

The presence of man or his ancestors, is very ancient in the Indomalayan region. Rests of an early hominid, 2.000,000 years old, were found in Java, and of Homo erectus, estimated at 600,000 years, in Java and continental Asia. The earliest true human rests come from Sarawak, date at 39.600 BC, which is the oldest record in the world (Rambo, 1979). It was generally assumed that the early human occupancy in the region resulted of the continuos migration of people from Central Asia, which moved first to SE Asia, then to the Great Sunda islands and eventually all over the Pacific, in a West-East direction (Shapiro, 1964). This simple pattern is now questioned (Bellwood, 1978), as it is assumed that the first occupants were Australoids, which spread in the late Pliocene or Holocene to SE Asia, through land connections in the Sahul and Sunda shelves. The remnants of these populations are now scattered in parts of India, Andaman islands, Malaya, Melanesia, Philippines and New Guinea. A second group, Mongoloid, moved many centuries later from SE Asia to Malaysia, Philippines and Indonesia, swamped over the Australasians, although at present some mixed populations show introgression with the former. The Mongoloids were hunters, gatherers or fishers, and there is no proof they brought domesticated plants and animals, exept the dog.

Some areas within the region merit special consideration in terms of human settlement.

4.1.1 New Guinea

Human occupancy in the highlands is proved at a level dated 19-26,000 BP, and it was quite complex (Keleny, 1962). In spite of such early settlement, the oldest agricultural traces date from 6000 BP (Bellwood, 1978). There are some indications that this process was an autochtonous development (Yen, 1980).

4.1.2 SE China - Indochina

The Haobinhian culture spread from Southern China to Northern Sumatra from 3000 BP to 4000 BP, and is known in isolated sites of Thailand, Vietnam, Malaya and Sumatra. The relation between this culture and the development of early agriculture in SE Asia, will be discussed later. The Bankao culture developed in Thailand, 6.000 - 5.000 BP, and in some of its pottery appear embedded rests of rice, presumably wild. The same crop and at more or less the same time, appears in the Lungshanoid culture in the lower Yangtzee valley. The relationship, if any, between the two cultures in relation to rice, is open to question. At present, the trend is to consider that rice was domesticated in SE Asia and moved north to China (Chang, 1977). Bellwood (1978) states that the assumption widely admitted before, that SE Asia was a "cultural province of China" could not be accepted anymore.

4.1.3 India

For its size, India is the most complex area in the world geographically, racially and culturally (Coon, 1965). Although the prehistory of India is poorly known, carbon-14 dates (Vishnu-Mittre, 1974) give the impression that its agriculture is rather recent in the tropical areas of the subcontinent.

4.1.4 Polynesia

The peopling of Indonesia is rather recent, starting Indonesia to Tonga or Marquesas, from which in many centuries the Polynesian triangle: Hawaii - New Zealand - Pascua was settled. Most of the domestic plants were taken from the West, possibly from Micronesia.

4.2 The Indomalayan region as one of the hearths of world agriculture

4.2.1 Introduction

The Indomalayan region concretely the SE of Asia and adjacent areas of India. was proposed by C. Sauer (1952) as the hearth of agriculture in the Old World. When this proposition was published, the prevalent hypothesis, still alive in some biological quarters, was that agriculture originated in the Near East as part of the Neolithic revolution, and from there spread on the rest of the Old World. Childe (1964), one of the main proponents, dismissed the possibility that agriculture had independently developed in Peru, Mexico or Ethiopia, on the lack of enough evidence. This hypothesis has a wide acceptance among biologists (Darlington, 1969, Burkill, 1953). However, some serious objections were raised to the hypothesis advocatin the Near East as the only center of origin of agriculture. First, plants domesticated in E. and SE Asia

3. MANAGEMENT

3.1 Management of a living collection may follow the same agronomic practices: fertilization, pruning, weed control, maintenance of an optimum phytosanitary condition, harvesting, etc. as in a commercial farm operation. The problem, however, is that in most tropical crops the basic information available on plant growth, nutrition, reproductive systems and other, is very scarce and often misleading. Besides the usual practices mentioned above, a living collection requires special tasks, such as identification, phenological observations, etc.

3.2 Soil fertilization. Information on soils - maps and analysis -, and on the conditions of the plant - tissue analysis - supply general guidelines for fertilization programs. In an uniform collection the same fertilizer formula may be applied, but in a mixed collection it is not possible to adapt a formula that will respond to the requirements of all species. Information on the general soil deficiencies in the area and on their correction using certain fertilizers, may lead to adapt a general formula. In some cases, seed production (for distribution, storage, etc.) is affected by deficiencies in certain oligoelements (boron, sulphur,etc) which may determine a poor set; corrections are easy through soil or foliar applications.

Besides the contents of a fertilizer formula, the time of application is of foremost importance. Experimental trials or the local experience from commercial plantings, may provide guidelines to establish an application program.

3.3 Pruning. A foremost consideration in the management of a living collection is the decision to adopt a system of pruning, to leave the plants at free growth or to leave them without pruning for a certain period and then to prune them according to a established pattern. In some tropical crops like coffee, tea, cacao, mangoes, for instance, pruning systems have been developed, often adapted to different cultivars; but in most crops the pruning systems are not known and often the morphological and growth studies do not supply the necessary information. If a pruning system is adopted, it is indispensable to consider that any system affects, more or less drastically, the architecture of the plant. As this is a varietal character, often of considrable value for the identification of the cultivar and in determing cultural practices, the decision of pruning should be carefully considered. Once any pruning is applied, the information on plant architechture and growth pattern, is lost and cannot be retriéved.

Some general considerations have to be taken in mind: a) pruning is aimed at renovating the organs of the plant that yield a commercial product: leaves, seeds, fruits, and so each species, and often a cultivar, require a different system. This leads to keep in mind the changes of systems, according to experimental results; in coffee, for instance, the "fancy" systems have been replaced for a mass pruning by rows of plants; b) pruning varies according to the planting material; in cacao and other dimorphic crops, a seedlings is treated differently than a plant coming from a rooted cutting; c) pruning, once started, is an operation that has to be repeated according to the crop, and may require also the continuos removal of undesirable shoots. This is expensive, it may require trained people and it is often a source of infections.

When the architecture of the plant is not well known, neither its growth pattern, the best solution is to leave the plant as it is, removing only the dead or infected parts. Free growth, however, creates some problems. The lack of new producing branches may curtail seed production in many Dicot species, after the first periods of production. In some Monocots, "pruning", if this is the term, consists in removing lateral shoots, to permit an optimum growth of the central stems.

3.4 Phytosanitary control. The control of diseases and pests is probably the most important task in the maintenance of a living collection. It may also be the most expensive in labor and materials, and therefore it should be given full consideration in the planning of the lay-out of the collection. It requires roads to move equipment and materials, water for the sprayers and the spacing between rows or plants to be established according to the spraying equipment: small pumps handled by workers, large machines, etc.

The control of diseases and pest requires a continuous supervision of the collections. An outbreak of a disease or a massive attack by insects, may destroy years of plant growth or delay it considerable.

Also, other less visible organisms, such as nematodes, or the action of viruses, micoplasma, etc. have to be continuously observed and controlled. Nematodes are a serious problem in many crops, and their effect may be detected only after some time, when the plantings are already established. A census of the nematode population is not a difficult task and may give valuable advice in the selection of sites for a collection. If for these reasons alone, the best place for a living collection is an experiment station or training center, where specialists are available to be consulted on phytosanitary problems.

3.5 Weed control. Weed control is not a serious problem in certain crops if the distance between plants does not to permit their growth, as in sugar cane and cacao. In most cases, however, it is a very expensive operation. It enough funds are available, either mechanical or herbicide control (or a combination of both), may keep the ground clean and prevent weed competition; this is a most desirable measure. However, in collections of trees or shrubs, a common solution is to plant lawn grasses (*Paspalum notatum*, *P. conjugatum*, *Axonopus scoparius*, *Stenotaphrum secundatum*, etc.), which may be mowed by machine. The areas around the trees are cleaned by hand or by applying weed killers. A grass cover of this kind does not seriously compete with the collection trees, improve the soil structure, facilitates the observations of the trees and provides a good landscape effect. However, competition for soil nutrients may result of planting grasses or legume cover crops very close to trees and shrubs; some palms are especially susceptible. Yellowing of the leaves and poor growth may be sings of root competition, and this requires immediate action.

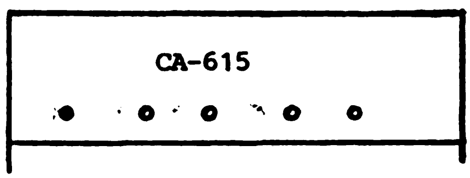
3.6 Drainage and irrigation. In wet areas surface drainage is of upmost importance. Most tropical crops, especially trees, may stand water for several days, but an excess of water in the soil does a permanent dammage to roots. Underground drainage is expensive and require maintenance. Suface drainage: shallow ditches to discharge excess water, may be open along blocks, and deep ditches has to be open for the general drainage of the collection area.
Irrigation facilities are necessary in certain conditions, especially in new plantings, and the distribution of water lines should be considered in laying out the collection plans.

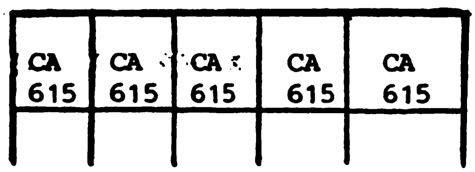
4. IDENTIFICATION PROCEDURES AND MATERIALS

In a living collection each individual plant should be identified by more than one procedure: a) identification marks in the plant, rows or groups and b) identification in maps, lists or catalogues. For the first kind of identification are used i) metallic or plastic tags, generally attached by wire rings to the branches of trees and shrubs with the names or numbers embossed by machine in the case of metallic tapes, written with special ink or pencil in the plastic tags; ii) numbers or letters painted in a visible part of the plant; iii) metallic tags supported by wires or steel rods sunk in the ground; iv) concrete blocks or slabs with painted numbers or letters. Perhaps the most satisfactory type is the aluminun tag with embossed letters or numbers, fixed to a ring wide enough so that it would not interfere with the growth of the branches. Aluminum or iron nails are not recommendable to fix tags to trees or shrubs. In semi-perennial crops, like sugar cane, concrete slabs are used to mark rows or blocks of plants, which may be moved to a new site when necessary.

No one of the identification system is perfect and only the experience may show which is the most suitable. All them require careful inspection and checking, as it is not rare to see a branch strangled by the wire ring of a metalic tag; or have identifications that have to be replaced or repainted.

The second kind of identification are <u>maps</u>. Living collections should be mapped in such way that a plant could be identified even if it does not bear any tag or other identification mark. Maps could be of many kinds, but they should be drawn at a scale that permits its use in the field, and duplicate copies should be kept in files. For field use it is a common practice to draw separate maps for each block of the collection. Plants are represented by dots, with the identification letter or number, or as squares in which each one has the identification, as below:





Maps should be printed in strong paper, durable and resistant. For field work, it is convenient to fix them to hard pieces of cardboard, which are placed in envelopes made of a sheet of transparent and heavy plastic. The maps written with strong pencil which permit deletions and corrections are most convenient for field work, while in the files the final copies should be written or drawn in a permanent way.

5. PLANT PROPAGATION

Genetic centers require installations for both seed and vegetative propagation. The information on the standard practices and the necessary equipment in plant propagation could be in texts, such as Hartmann & Kester's.

5.1 Propagation facility. A living collection should have a propagation facility, in which to grow different materials in the kind and quantity required by the programs. It may consist of: 5.1.1. A room to desinfect seeds or vegetative materials and to dispose of discarded materials; 5.1.2 A germination room; soil heating equipment is necessary for the germination of certain plants (palms, etc.). 5.1.3 A room for grafting or budding. (The last two rooms should have, beside the usual tables and cabinets, refrigerators to keep seeds and budsticks. Also concrete boxes to store rooting media: soil, sphagnum moss, sand, vermiculite, etc., and equipment to prepare the mixtures). 5.1.4 Soil desinfection facility, either permanent: concrete tanks with wood cover, or temporary: plastic sheets to cover the soil. A heating unit to desinfect soil is very convenient for large quantities; an autoclave could be used for small quantities. 5.1.5 Propagators. a) the simplest kind is a serie of concrete boxes with a glass or plastic cover over which water runs continuosly. The cuttings or grafts are placed in racks in the boxes and watered by hand. b) mist propagators are indispensable in the rooting of certain materials; c) a room with mist spray, continuous or periodic, and controled illumination, is necessary for rooting in some species.

5.1.6 Greenhouses and lathouses. Some kind of installation is necessary to grow seedlings or clonal materials under conditions that may protect them from the damage by extreme temperature, light or air moisture. a) The standard greenhouse used in temperate regions has to be provided in the tropics with instruments for cooling and moisture control, which are expensive to install and maintain. In case of electric power failure, the young plants may suffer considerable damage. b) a lathouse is cheaper and quite appropiate for dry areas, but in wet conditions the air retains a high humidity and requires proper ventilation. The roof may be built of metalic laths, quite expensive, or wood; the later is cheaper but last only for a few years. c) a common kind of building for propagation is a wood structure with plastic roof and walls covered with metalic or plastic screens. The algae may reduce quickly the light coming through the roof, which requires periodic cleaning. d) Saran lathouses, in which the roof and sides are covered or only the roof, are quite common. They are specially suitable for shade living plants and for those that require hardening before transplanting. e) non permanent shelters, with thatched roof and no walls, are quite satisfactory for growing seedlings and grafts, provided that there is plenty of light inside.

5.1.7 Tissue culture facilities, for conservation and distribution of germplasm.

5.1.8 Micrografting instrumentation, either separate or as part of the tissue culture operations.

5.2 Containers. The kind of containers to be used in propagators, greenhouse in the field, are discussed in several publications. See, for instance, DICKEY, R. D. et al. 1978. Container growing of woody ornamental plants in Florida, University of Florida Agric. Exp. Sta. Bull. 793; TINUS, R.W. & MACDONALD, S.E., 1979. How to grow tree seedlings in containers in greenhouses. USDA Forest Service Techn. Rep. RM-60. These two bulletins contain also up to date information on propagators, rooting media and greenhouse managment. There are several new types of containers which are easy to obtain or build in tropical countries, especially of plastic.

5.3 Lay-Out. The plans to build the propagation facility shoud consider the space available and its location in reference to the collection plantings, offices and quarantine instalation. Access roads, places to dump discarded materials, water and electricity supply, obstacles that may interfer with natural illumination, wind direction, and sun path are important factorsin the location and design.

5.4 Miscellaneous. A) Air-layering is a propagation technique very common in tropical crops. At present it is done using a plastic sheet, but aluminium foil is also used. This is a field operation that permits to obtain materials to multiply an entry or to fill gaps in the living collections. B) Trained workers are the most important factor in plant propagation. Grafting, rooting of stems and leaves, air-layering and the general care in rising seedlings and clonal material ,are a matter of personal experience. Any genetic center should train, encourage and mantain a permanent labor force capable, responsible and intelligent in propagation procedures.

6. COLLECTION OF FIELD DATA

6.1 Kinds of data. In a living collection a series of phenological data has to be registered, in order to plan the management of the collection, particularly in the obtention of seeds or other propagation materials. It should be considered that this kind of information has several limitations, as it comes from samples which rarely permit a statistical analysis. Yield data, especially obtained from one plant or from a non replicated plot, has a very limited value. Phenological data include a) measurement of growth, expressed as plant height, trunk diameter, etc; b) leaf flush and fall, which in many tropical species occur more than once a year, and is of practical importance in spraying; c) blooming, dates and degrees; d) fruit setting and seed maturation. e) disease and pest attacks, signs of deficiencies.

6.2 Registration. a) Phenological observation, when possible, should be taken by individual plants. This may lead to detect variants (mutations or hybrids), of special value; b) data should be registered on a periodic base, and the establishment of the lapse between dates should receive special consideration. For an uniform collection (one species or several species of the same genus), the frecuency of data recording is easier to establish than in a mixed collection, where growth patterns vary with the species. One solution is to take the information 2 to 4 times a month, especially at the beginning, and afterwards reduce it to 1 or 2 registrations per month or less. It should be remembered that in most tropical crops such phenomenon as leaf flush or blooming, may take only 2-3 days, and may go unrecorded easily. Special notebooks of resistant paper and hard pencils (as used by engineers), binoculars, tapes, instruments to measure tree height, etc. are necessary for field work. Finally, it should be remembered that biological cycles change from one year to other, and that many tropical crops (coffee, mango) show a marked biennial bearing; thus spur elongation, which is a pattern very common in tropical trees, should be registered in relation to flowering and seed seting. This pattern varies according to the species and often with individual trees, in the same year.

6.3 Data analysis. The data collected tabulated and analyzed permits in a few years of observation to establish the time and duration of cyclic processes, such as the shoot elongation, leaf flush, flowering, fruiting, production of shoots, etc. A graphic representation of the data is very useful in planning managment operations and for studies in reproductive biology, fruit growth, etc.

7. SOURCES OF GERMPLASM

A germplasm collection depends for the increase or renewal of its materials, on two main sources: plant exploration and plant introduction.

7.1 Exploration. Plant exploration is one of the main activities of a genetic center, aimed to obtain new germplasm of priority crops or to explore areas of special interest for the germplasm they contain. In a genetic center exploration is a continuos operation, in importance second to conservation. It is done through expeditions or permanent collectors.

7.1.2 Expeditions. Two kinds are recognized: expeditions to collect only one species and its allies, or to collect widely all the materials available in a selected area. In the tropics is very difficult to apply a systematic sampling in the collecting expeditions, and the materials collected result in a non-random sample of what was available at the moment. A collecting expedition should be carefully planned and prepared (see Hawkes, J.G. Manual of field collectors. FAO, 1976). Its scope and duration depend on the funds available, and the field operations on the quantity and diversity of the materials that may be collected. Therefore the success of an expedition depends largely on the training and personnel abilities of the collectors. The experience in the tropics indicates that plant explorers should have a) a thorough knowledge of the crop or crops to be collected and of the wild populations or species of the same genus. In this connection, it is important that the explorers study the floras of the area (for most tropical countries or regions there are already published), and to visit local herbaria to determine collection sites. Also to discuss with botanists, agronomist, farmers, etc., the location of sites where the species may grow. Herbarium sheets have specimens mostly in flower, and that may give some indication on fruiting periods. b) a good knowledge of the geography of the area, its agricultural systems and the cultural background, especially of the autochtonous groups. Ethnic groups keep their own cultivars, and in countries with different indigenous populations, the plant explorer should look for distinctive signs: dresses, types of houses, etc. that may indicate a different ethnic group. c) has to be familiar with maps, publications and aerial photographs of the area.

Before starting any of his collection trips, Vavilov spent weeks of intensive study of the geography, climate, vegetation, history of a country or region. Also of the maps available. At present there are detailed maps of most parts of the tropics; aerial photographs on reduced scale that permit the identification of individual trees, houses, etc. and that may help to pinpoint collection site. On the other hand, satellites photographs supply an accurate view of plant formations on a large scale, showing deforested areas, etc. which are very helpful in planning collecting trips.

but most of the introductions may fail. However, plant introduction in all countries is the base of agriculture. As a rule, the important crops of a country or region, are exotic.

In the tropics plant introductions may replace up to some point, the lack of breeding programs. A well planned program of introduction, screening and propagation, may supply the immediate needs for agricultural development, and provide the bases for future breeding projects. But most of the tropical countries have no organizations to utilize the genetic materials available elsewhere. For this reason, a genetics center working on a national or regional basis, has to have a strong component in plant introduction. It is a mechanism that if follows the quarantine regulations, may have a strong and rapid impact in the agriculture of the region.

As mentioned above, the base of plant introduction is to test the adaptability of a genotype to a new environment. By environment, in the case of crops, should be understood not only the physical factors: soil, climate, etc, in their relationships or other parameters determined by them, such as degree of infection, but also the cultural factors: agricultural systems or practices already operating in the site where the genotype is introduced. The success of a crop in a new habitat, depends on its adaptation, and therefore it is neccessary to test as many genotypes as possible to find the most adapted. It is a well known fact that in testing germplasm of a crop, it should be done on the widest geographic range. Accessions from a country or region, due to selection, offer different characteristics than those from other countries or regions. In the choice of genotypes for introduction, crop ecological requirements give a broad guideline, but they cannot measure the degree of adaptability; this can only come from field tests.

7.2.2 Operations. The first step is to locate the material desirable in experiment stations, genetic centers, seed exchange services, botanic gardens, private collections, etc. This requires a knowledge of lists (index seminum), catalogues, etc., or addresses of scientists, in charge of collections. A large share of germplasm exchange is based on personal relations.

In the tropics ther are very few collections that publish lists of their genetic materials, and the trend to put them in computers does not facilitate the person needing such materials to locate and obtain them. There is also no regional organization to promote the exchange of information and germplasm, and only the FAO Seed Exchange at Rome offers this service and in a limited way. It is important to note that the three main regions of genetic diversity in the tropics: SE Asia, West Africa and tropical America are not only disconected geographically but also culturally.

7.2.3 Screening. Once the germplasm source has been located, a request should be sent stating the amoount of seed or propagation materials required. (It should be remembered that some countries impose strict restrictions in the distribution of some germplasm). The request should be accompanied, when necessary, of the import permits issued by the government of the country where the center is located. Quite often this goverment requires a phytosanitary certificate accompanying the seed, and issued by a competent authority in the country of origin. A few countries (Brasil, U.S.A.) have special permits, the green-yellow tags, with numbers and addresses. In those cases the materials sent by mail go to a central office for inspection and recording. It is also common to send packing and shipping instructions (see FAO Handbook N°93 for information on these subjects).

7.2.4 Once the materials has been received, it is given the corresponding introduction number, and when necessary, passed to post-entry quarantine.

7.2.5 There are large plant introduction services in countries which have subtropical areas, in which germplasm of interest to the tropical countries is mantained in collections. In there countries, especially Australia and U.S.A., the plant introduction services cooperate in locating and supply germplasm.

8. EVALUATION

8.1 Evaluation is aimed to screening plant collections for the presence, quantity and quality of a special character, such as pectin content, lauric oil, resistance to witche's broom. These operations are done when the special character is needed in a breeding scheme. The evaluation of the most important crop characteristic, yield, requires replicated trials at different locations and times, and is a task for research stations or crop centers.

8.2 The role of a genetic center in evaluation is therefore to supply the widest possible range of well identified genotypes. It has been the experience in advanced breeding, than the more diverse in geographic procedencies in a collection, the more chances are of finding useful genes. In barley, the cultivar 'Atlas', has genes originating in accessions from Spain, Turkey, Ethiopia, Algeria, Russia, Manchuria, etc.

8.3 However, there are activities in which a genetic center may advance the knowledge on crop characteristics for future utilization, based on the systematic study of the phenology of collections and on the establishment of well organized sets of descriptors for species and cultivars. In the less developed crops -which is the majority in the tropics- a carefully prepared list of characters may help to detect differences, such as color of a fruit, resistance to diseases, earliness or other differences which may be very valuable for selection or breeding.

Single characters, like different fruit size or color, may imply a potential value for transportation and marketing; . a compact, short plant may influence planting density and easier harvesting. These are discrete characters, and their inheritance has to be tested in a progeny trial. With less constrasting characters, due to continuos variation, the environmental component is generally important and therefore the evaluation requires a more detailed trial, at different environments. In the detection of variants, one person with experience in the crop and ability to observe differences, often un-untrained laborer, may contribute more than a trained scientist but unfamiliar with the crop.

8.4 Finally it should be repeated that to supply an ample source of germplasm for screening is one of the main task of a genetic center. But evaluation activities without any clear purpose in a genetic center, may divert funds that should be better spent in which is its main objective: the maintenance and increase of its germpalsm.

9. INFORMATION SYSTEM

9.1 An information documentation system has to be based on the needs of the people that are going to use it. Quite commonly, however, the documentalist point of view prevails, and the result is the accumulation of information in computers and other systems, to which the users who need more the information, have difficult or no access at all.

9.2 In developing regions the information on genetic resources is required mainly to locate crop species or cultivars, to the contrary of advanced countries where breeding programs require mostly genes for specific purposes. A genetic center in a tropical region, therefore, should have the information on new cultivars, how to locate them and when necessary, how to obtain propagation materials. The task is not especially difficult, due to the reduced number of active breeding stations, but is complicated by the lack of a publication, like the Register of Cultivars of the USDA, where periodically appears the description of new varieties. Only a careful search of the literature may permit to list the new cultivars of tropical crops and their characteristics. Only in sugarcane there is a permanent germplasm committee, which may supply up to date information. Very few research stations in the tropics publish lists of their germplasm collections or index seminum. Some of them are included later, as references in the regional treatments.

9.3 The basic source of documentation in genetic centers in the tropics are a) plant introduction register, in a book form, that would record the number by consecutive order; identification (scientific and/or common name); origin, and date. Eventually this information may be put in lists, cards or computers. b) lists by species, including for each cultivar: number of introduction; name; origin; date of register; location in the field. c) information file by species or cultivars; in which phenological data, evaluation results, photographs, printed information, etc. may be placed together. Photographs and drawings by a trained artist, may be extremely useful in identification work and the preparation of publications. d) collection of catalogues of germplasm from experiment stations, private companies etc; index seminum. This information requires up dating and if the number of requests justify it, to be placed in punched cards or computers.

9.4 Descriptor lists. When a genetic center has accumulated enough germplasm to have a good representation of the genetic diversity of a crop, or when there is a special interest a descriptor list should be prepared and tested. A descriptor list requires a careful study of the morphology of the plant and its main agronomic problems, and therefore is advisable to consult experts in the different problems. But, first of all, requires to go through the botanical literature to find out plant characteristics; previous description of cultivars, genetic traits, especially in terms of mutations, and methodological hints in the preparation of the descriptors list.

9.5 Identification of germplasm materials. An important function of genetic information system is the correct identification of its materials. At the species level, identification is not difficult in most cases, but if there is some doubt, it could be checked by a trained botanist or sent ot a well known herbarium. At cultivar level, materials are identified by common name,('Chocosito' maize), by abbreviatons used by the collector ('SCA-6' cacao) or by breeding or selection identification ('IRRI-4'). Although the International Code of Nomenclature of Cultivated Plants (1979), permits changes in the name of a cultivar, this practice should be restricted to a minimum. Giving new names in the registration to introductions that have already well known names, as practiced in some experiment stations in order to give them the numbers or names of the station, should always be discouraged. Such practices lead to a confusion in the breeding or selection work; each time the new name is used, the original name or the breeding lines should be given, as requested by the Code.

9.6 Herbarium. In some centers it may be necessary to establish a herbarium as a reference unit. This requires a) well trained collectors; b) relations with othr herbaria in which materials may be properly identified; c) and installations to mantain the samples in a proper condition, a task which in the tropics is especially difficult (see Fosberg, F. R. & Sachet, H. 1965. Manual for tropical herbaria. Regnum Veget. 39.). Besides, an herbarium requires an extensive and specialized library.

To create an herbarium could be only justified if in the country there is no such institution, but if there is, it would be an unnecesary duplication.

9.7 Reference library. One of the main reasons to have a genetic center as part or close to a research or teaching institution, is to have access to a good library. However, a genetio center should have a reference library, with the floras of the area; general books on cultivated plants; bibliographies and monographs on genera or species in which the center is especially interested; geographic information; collections of maps and reference books on the region it operates.

10. QUARANTINE

10.1 The risk of introducing pathogens, pests or weeds with new germplasm, should always be present in the operation of a genetic resources center.

A first step is to assess, in planning the introduction or exploration of new germplasm, the phytosanitary situation in the sources of materials. FAO and other organizations publish maps showing the distribution of pests and diseases in the world, and regional phytosanitary offices may supply information on new outbreaks. One consideration to keep in mind is that often the center of diversity of a crop does not coincide with the area of concentration of biotypes of its pathogens. This means that in introducing or collecting materials from an area of low crop diversity, there may be a risk of introducing a new pathogen.

10.2 A second consideration is that quarantine laws and regulations are mandatory acts on part of governments or organizations, and they tend to be rigid and in some ways of difficult acceptance on the part of breeders. At the same time in most tropical countries, quarantine regulations are difficult to enforce by local authorities, and there is not enough staff or facilities to implement them. Quarantine inspection becomes a routine operation, often only a superficial examination of the material before its release. Whatever the situation is, the responsibility of a genetic center is not only to comply with the local regulations, but to do anything at hand to prevent the introduction and spread of new pathogens or pests.

Therefore a genetic center should have the minimum installations to handle foreing plant material = disinfection facilities (fumigation chambers); a greenhouse adapted to quarantine (FAO has plans of this kind of greenhouse for tropical conditions; a facility to destroy planting materials and containers or wrappers; isolation plots to observe and check living plants from virus, micoplasma, etc.

10.3 In the distribution and exchange of plant materials, an unwritten but generally accepted assumption is that the compliance of quarantine regulations is at the receiving end of the distribution. The sender complies with the usual regulation of obtaining a certificate stating that the material is "apparently free" of fungi, insects, etc., but the person or institution at the receiving end is responsible for the safe introduction of the material.

10.4 Tissue culture and to some extent micrografting, are means to supply clean materials, which usually do not need to pass through quarantine regulations. But technology has been developed only for a restricted number of crops, and depends on the availability of materials at a center or institution where tissue culture is operated.

10.5 There are international systems of germplasm exchange that have quarantine components, as in the case of coffee in the Western Hemisphere through USDA and cacao also for this continent through USDA and from the old World through Kew Gardens.

B. REGIONAL DIVERSITY

1. SOUTHEAST ASIA

I. SOUTHEAST ASIA

1. INTRODUCTION

Southeast Asia, as defined below, is one of the three tropical regions of germplasm concentration in the world. The other are West-East Africa and tropical America. De Candolle (1883), who was the first to establish the independent origin of cultivated plants in the Old and the New World, did not elaborate further on the regional concentration of germplasm within the hemispheres. De Candolle pointed out the antiquity of agriculture in China, India and other regions, based mainly on historical and linguistic evidence. Almost half a century later, N. I. Vavilov (1927), in creating the hypothesis of the "centers of origin of cultivated plants", considered India, including Burma and excluding the NW area, as one of the "primary centers", to which he assigned the No. 2 (No. 1 was China), Indo-Malaysia, including Indochina and the Malay archipielago, was considered as a separate center, No. 2a. This Vavilovian approach was followed by Darlington and Janaki Ammal (1945), Kupzov (1955), Zhukovsky (1968) and others.

Sauer (1952), without establishing geographic delimitations, considered SE Asia as one of the hearths of world agriculture, with plant and animal domestication, development of agricultural systems and the spread of its crops and domestic animals to other regions in the Old World.

In some ways opposite to Sauer's ideas, was the approach of Burkill (1953) on the habits of man and the origins of crops in the Old World. Burkill followed the prevailing trend in his time, that agriculture was invented in the Near East as part of the "neolithical revolution", and although he did not state it clearly, the implication is that he accepted that plant domestication started in the Near East and as a continuous process expanded eastwards until it reached the Pacific. Darlington (1970) states this approach more precisely.

For Harlan (1971), South East Asian and the South Pacific form a "non center" of crop genetic diversity, while Zeven and Zhukowsky (1975) go back to the Vavilovian ideas and divide the region in two centers: Indochinese - Indonesian and Hindustani.

2. DELIMITATION OF THE REGION

The Indomalayan region from the standpoint of crop genetic resources could be considered as a continuum from western India to Polynesia. Geographically it is formed by two components: one continental and one insular. The continental part is formed by a) the belt south of the Himalayas and the mountains of SW China, limited to the west by the Thar, the large desert of India, and includes the Gangetic plain, the Himalayan foothills and the Deccan peninsula; b) the area south of the Yangtzee in China, which is considered by most anthropologists as part of SE Asia; c) the peninsula areas of Thailand - Indochina - Malaya. In a political division, the continent component of the region includes most of India, Sri Lanka, Bangladesh, Burma, Thailand, Kampuchea, Laos, Viet Nam, Malaysia, Singapore.

The island component includes= a) the Great Sunda islands, which some geographers call "Island South East-Asia"= Sumatra, Java, Kalimantan (Borneo), Sulawesi (Celebes), Halmahera, Ceram and others; b) the Lesser Sunda islands; c) New Guinea and Melanesia; d) Micronesia; e) Philippines; f) Taiwan; g) Polynesia.

3. NATURAL FACTORS AFFECTING CROP GENETIC RESOURCES

The crop diversity of a region results of the interaction of natural and human factors. Among the first, natural vegetation is the most important, as it supplies the basic materials for domestication. The richness and complexity of the vegetation are due to the origin and evolution of its flora, as determined by the geological history and the environmental conditions (mainly climate and soils) of the region.

3.1 Geological background

The relation between the three continental masses of the Indomalayan region: India, SE Asia and Australia, provide the explanation for the distribution of plant families and genera within the region, and in some ways, for their relation to the flora of Africa. It was the eminent Indian paleobotanist B. Sahni (1936), the first to adopt the continental drift theory to explain the relations of the Paleozoic and Mesozoic floras of India, China and Indochina. The three large continental masses: India, SE Asia and Australia, as parts of Gondwanaland, split in Triasic and Early Cretacic. India and Australia maintained their relative positions, while SE Asia moved anticlockwise to reach its present position (Ridd, 1971). According to Sahni (1936) the rise of the Himalayas as a result of the collision of the Indian and Central Asian plates, formed a barrier to the expansion of Asiatic plants into India.

The other important feature in the morphology of the region in relation to plant distribution, are the two large continental shelves, the Sunda and the Sahul. The Sunda shelf, the largest in the world, extends from SE Asia to Sumatra, Java, Borneo and Philippines. Its submarine surfaces is quite even; a drop of 50 m in the present sea level would join the Great Sunda Islands and Philippines to Asia. The Sahul shelf extends from Australia into New Guinea, and is even less deep than the Sunda; a drop in the sea level of 25 m would join Australia, New Guinea and the neighboring islands to the east. Between the two shelves the sea floor sinks to considerable depths, 14.800 m in the Philippinean Trench; this geologically unstable area, includes Celebes, Moluccas, the Lesser Sunda islands and the Southern islands of the Philippines. The continental shelves were recognized since the last century to be of primary importance in the distribution of animal and plant life in the Indomalayan region. They could have provided in the geological past, land connections, one between continental Asia and the Great Sunda islands, other from Australia to New Guinea. The intermediate area, called "Wallacea" (Merrill, 1954), was on the contrary a barrier to East-West distribution. Several limits, or "lines", with a South-North direction, have been suggested to separate the biological distribution in the intermediate area, by Wallace, Weber and others. The present limit to the West is accepted now as the Wallace line, with some modifications, and the Weber line as the eastern limit of the intermediate area. A clear example of the importance of Wallacea is the distribution of Eucalyptus; it spread northwards from Australia to Philippines, but is not found east or west of the intermediate zone.

3.2 Natural vegetation

The area from SE Asia (Indochina and the Malay peninsula) to New Guinea

called Malasia by plant geographers (van Steenis, 1950) is the core of the flora of the Indomalayan region. Most of the elements of this flora are of local origin, and have moved into SE Asia and India.
On a broad generalization, the vegetation of the Indomalayan region is associated to climatic factors, especially amount and distribution of rainfall, and secondarily to edaphic factors. The main elements, in order of importance, are i) the rainforest; ii) the monsoon forests; iii) sayannas, and iv) highland vegetation; the last is reduced to a few areas in New Guinea and Burma.
Since Schimper (1903) the rain forest have been considered as the main component of the vegetation of SE Asia. They extend from the Western Ghats to Assam, Burma, southern Malaya, Sumatra to the northern part to of New Guinea; also the Oceanic islands and a large part of Philippines.
The rain forests all over the Indomalayan region have been severely disturbed or destroyed, the action of man being very ancient (Rambo, 1979) but has intensified in the last century due to timber extraction or agricultural expansion (Whitemore, 1975). The rainforests of the Indomalayan area are in terms of number, the most important source of cultivated plants in the region, and its destruction is the most serious threat to genetic resources in the Old World.
The monsoon forest covers a large part of India; the Deccan peninsula and the Gangetic plain and parts of Burma and Indochina, northern Malaysia, western Java and the Lesser Sunda islands. In some ways, the monsoon forests have been more affected by the action of man than the rainforests, especially as they have less power of recovery, and some of the savannas

in Indochina and Thailand may be the result of the combination of edaphic factors, vegetation and the action of man, the later mainly by burning. The monsoon forest may have a special role in plant domestication; Burkill (1951) has placed the origin of yam cultivation in areas of monsoon forest, due to the adaptation of these species to alternate season.

On the origin of the flora of the Indomalayan region, the most accepted view is that Asian elements extended through former land connections to the great Sunda Islands (Goods, 1964). However, A. C. Smith (1970) has proposed a different explanation. The center of Angiosperm evolution, according to this hypothesis, was in Malasia, and from the Angiosperm spread towards Asia, Africa, and the Pacific islands, as the continents split. Smith supports his view on the high number of species found in Malasia, and on the presence of the most primitive taxa amon flowering plants: Degeneria, Tropodendron, Eupomatia and others.

The Malasian center of plant diversity as defined by von Steenis (195), includes the Malay peninsula south of the Kra strait, Philippine, the Sunda islands and New Guinea. This area contains more than 25.000 species of flowering plants, that is 10% of the world flora; 40% of the genera are endemic.

3.2.1 Plants forms

The diversity in plant forms in this area is, for domestication, more important than than the number of species. Trees with different kinds of fruits or nuts; vines with tuberous stems; grasses with large seeds; herbs with pungent principles, and others; offer a wide range of domestication materials. The following groups merit special attention: i) trees with edible fruits are abundant in the Indomalayan forest, some with arils and husks of appealing colors and forms (Corner, 1964). Fruit gathering by transhumant tribes in the forest has led to the selection of superior trees in Durio, Nephelium, Mangifera and other genera, and to their accidental multiplication as their seeds are scattered in the forest; ii) trees and shrubs are utilized in SE Asia for the tender twigs, shoots and leaves, which are eaten cooked or fresh, like in Gnetum, Sauropus, or for the flowers like Sesbania; iii) nuts are important as food and for oil, used in differente ways: Canarium, Terminalia, Aleurites; iv) the Monocots are of special importance as food sources, for the tubers or corms, like Dioscorea, Colocasia and other Aroids, or for the essential oil contained in tubers: Zingiber, or in the seeds: Elettaria; v) sugar cane, the most efficient plant in sugar formation; iv) palms provide oil and food: Cocos; sago: Metroxylon; sugar: Nipa; fibers: Raphia and many other uses; vii) grain seeds (cereals) include rice and Coix.

The abundance and diversity of natural plant products in the Indomalayan region could, in one way, promote the easy domestication of many species. On the other, their abundance in natural conditions could be taken as a factor which did not push man to cultivate or domesticate wild plants.

In SE Asia the primitive agriculturist used only a very small fraction of the natural vegetation it the domesticated plants form a reduced number of the total of plants whose properties are known to the agriculturists of the region.

4. MAN AND CROPS IN SE ASIA.

4.1 Peopling

The presence of man or his ancestors, is very ancient in the Indomalayan region. Rests of an early hominid, 2.000,000 years old, were found in Java, and of Homo erectus, estimated at 600,000 years, in Java and continental Asia. The earliest true human rests come from Sarawak, date at 39.600 BC, which is the oldest record in the world (Rambo, 1979). It was generally assumed that the early human occupancy in the region resulted of the continuos migration of people from Central Asia, which moved first to SE Asia, then to the Great Sunda islands and eventually all over the Pacific, in a West-East direction (Shapiro, 1964). This simple pattern is now questioned (Bellwood, 1978), as it is assumed that the first occupants were Australoids, which spread in the late Pliocene or Holocene to SE Asia, through land connections in the Sahul and Sunda shelves. The remnants of these populations are now scattered in parts of India, Andaman islands, Malaya, Melanesia, Philippines and New Guinea. A second group, Mongoloid, moved many centuries later from SE Asia to Malaysia, Philippines and Indonesia, swamped over the Australasians, although at present some mixed populations show introgression with the former. The Mongoloids were hunters, gatherers or fishers, and there is no proof they brought domesticated plants and animals, exept the dog.

Some areas within the region merit special consideration in terms of human settlement.

4.1.1 New Guinea

Human occupancy in the highlands is proved at a level dated 19-26,000 BP, and it was quite complex (Keleny, 1962). In spite of such early settlement, the oldest agricultural traces date from 6000 BP (Bellwood, 1978). There are some indications that this process was an autochtonous development (Yen, 1980).

4.1.2 SE China - Indochina

The Haobinhian culture spread from Southern China to Northern Sumatra from 3000 BP to 4000 BP, and is known in isolated sites of Thailand, Vietnam, Malaya and Sumatra. The relation between this culture and the development of early agriculture in SE Asia, will be discussed later. The Bankao culture developed in Thailand, 6.000 - 5.000 BP, and in some of its pottery appear embedded rests of rice, presumably wild. The same crop and at more or less the same time, appears in the Lungshanoid culture in the lower Yangtzee valley. The relationship, if any, between the two cultures in relation to rice, is open to question. At present, the trend is to consider that rice was domesticated in SE Asia and moved north to China (Chang, 1977). Bellwood (1978) states that the assumption widely admitted before, that SE Asia was a "cultural province of China" could not be accepted anymore.

4.1.3 India

For its size, India is the most complex area in the world geographically, racially and culturally (Coon, 1965). Although the prehistory of India is poorly known, carbon-14 dates (Vishnu-Mittre, 1974) give the impression that its agriculture is rather recent in the tropical areas of the subcontinent.

4.1.4 Polynesia

The peopling of Indonesia is rather recent, starting Indonesia to Tonga or Marquesas, from which in many centuries the Polynesian triangle: Hawaii - New Zealand - Pascua was settled. Most of the domestic plants were taken from the West, possibly from Micronesia.

4.2 The Indomalayan region as one of the hearths of world agriculture

4.2.1 Introduction

The Indomalayan region concretely the SE of Asia and adjacent areas of India. was proposed by C. Sauer (1952) as the hearth of agriculture in the Old World. When this proposition was published, the prevalent hypothesis, still alive in some biological quarters, was that agriculture originated in the Near East as part of the Neolithic revolution, and from there spread on the rest of the Old World. Childe (1964), one of the main proponents, dismissed the possibility that agriculture had independently developed in Peru, Mexico or Ethiopia, on the lack of enough evidence. This hypothesis has a wide acceptance among biologists (Darlington, 1969, Burkill, 1953). However, some serious objections were raised to the hypothesis advocatin the Near East as the only center of origin of agriculture. First, plants domesticated in E. and SE Asia were in the majority of different species and genera than those domesticated in SW Asia; second, these crops require different management systems, which could not be transplanted from the Near East; third, in SE Asia and toher areas, it is possible to trace, even now, all the steps in domestication, as shown by the present practices in food gathering as well as in the archeological evidence. Fourth, in SE Asia, as in the Near East, Mexico, Peru or West Africa, there were some events which are concomitant to the invention of agriculture, such as the discovery of metallurgy, ceramics, weaving, animal domestication. It may be added that most of the species domesticated in SE Asia have special uses, most of which are unkwnown outside the area.

In Sauer's approach, agriculture in SE Asia started with the utilization of vegetative propagated crops (vegeculture). However, it is more likely that in the early stages man domesticated all kinds of crops, regardless of their reproductive systems. Among the primitive people of Malaya (Rambo, 1979) or Borneo (Beccari, 1904) there is, for instance, a system of fruit trees selection and propagation by seed.

According to Barrau (1970) who has done the most complete studies on native crops in Polynesia, "The Indian-oceanic region has an assamblage of conditions very different than the ones that are characteristic of the part of the world where the "neolithic revolution" ocurred. I don't like the term "revolution" as applied to matters of cultural evolution, but even so, I am convinced that one of the several "revolutions" took place outside the Fertile Crescent, probably a long time before the domestication of wheat and barley. In the Indomalayan region, especially in its western part, plants were domesticated very early, and in their husbandry the initial development also ocurred there".

4.2.2 Archeobotanical evidence

The archeological evidence on plant domestication in SE Asia has to be extremely poor. As may be expected for an area of high rainfall and temperature with a predominance of acid soils, only the hardest plant tissues, such as seed covers and stems may resist deterioration, and only in protected sites, like caves. Leaves, fleshy stems and fruits, dissapear completely. The distribution of plant remains is therefore extremely erratic in terms of areas and taxa represented. To this poorness of materials, has to be added the problems of identification. Ancient materials have to be compared with present day plants, on morphological and anatomic characters, to arrive at a tentative identification. But the next problem is to define if the plant remains could be adscribed to wild, gathered or cultivated plants. Indirect evidence, such as the presence of tools or other artifacts for food preparation are of not much help, since they may have been used either for cultivated or wild materials. The rice imprints found in pottery in India and Thailand, resulting of the use of rice chaffs as temper to the clay, provide very valuable records, especially if the imprinted material could be identified as coming from wild or cultivated plants. Vishnu-Mittre (1974) reports for India several cases which it was possible to date and identify such rests and imprints.

Dating by the usual procedure of Carbon-14, clay luminiscence and pottery styles, may give a sequential order to plant rests. Such order is, of course, limited to the locality, since the time, length and stages of domestication, even in the same species, may vary according to the site and the species.

The archeological dating for India (Vishnu-Mittre, 1974) shows a rather incomplete and scattered information. The earliest findings in the Deccan and lower Ganges, are for rice 4300 BP; sorghum, 3370 BP, wheat, 4500 BP.

The most controversial information comes from northern Thailand (Gorman, 1969, 1977; Harlan & de Wet, 1973; Higham, 1979; Solheim, 1967, 1971, 1972; Yen, 1977, 1982). In several caves were found plant remains of Terminalia, Canarium, Castanopsis and Areca, pulses, cucurbits, rice and other, at different levels and is some cases together with bronze artifacts, stone tools, ceramics and animal bones. The remains are identified as belonging to the Hoabinhian culture, and dated 7600 - 11,000 BP. The bronze artifacts suggest and advanced stage in technical development. The plant materials reveal that man was using a wide array of species.

Rests of wild plants found with artifacts in tombs, caves and other sites of ancient human occupation, may be signus of trends towards domestication. From SE Asia no stronger evidence may be expected, within the present archeological methods, for an early change from gathering to agriculture. Even Reed (1977) which is quite critical of some interpretations of these findings admits "the strong possibility that an advanced culture, including agriculture and bronze melting, existed in northeastern Thailand nearly 6000 years ago".

4.3 Plant domestication

The Indomalayan region has special features to study plant domestication. One is the large number of diverse crops that originate in the region; other is the presence of human groups still in the food-gathering stage, in the Andaman islands, Malaysia, Philippines, etc. (Coon, 1965), or practicing incipient agriculture of neolithic characteristics, such as some tribes in the New Guinea highlands (Bulmer & Bulmer, 1964). Some of the approaches on domestication by geographers (Sauer, 1952; Conklin, 1957; Spencer, 1966) although weak in bilogical aspects, are the most comprehensive. Conklin (1957) has defined the kinds of domesticated plants on a rather flexible series of definitions, based on his experience in Philippines. 1. Domesticates: any plants that are artifically propagated rather than depending on natural reproduction; 1a. Cultivates are domesticates which require some special treatment between planting and harvesting, but which do not require artificial propagation to survive, while 1b. cultigens are fully dependant on man for survival.. 2. Semidomesticates are plants which are often preserved or protected, divided in two categories: 2a. first degreee domesticate, wild plants especially preserved and protected when clearing land, because of their utility, and 2b. second degree domesticate are plants which are destroyed only when the forest is burned but otherwise are never intentionally destroyed, as they are sources of food or other useful products. 3. non-domesticates, plants which are neither protected nor planted. As was noted by Spencer (1966) these terms may not be satisfactory to botanists, but they reflect a careful degree of realtionship between man and plants.

Spencer (1966) bases his theoretical approach to domestication on his experience in SE Asia assuming, first, that vegetative crops were the first to be domesticated, as suggested by Sauer (1952). The domestication sites were optimum for plant growth, and the people who made the first domestication had access to different food sources; they were not starving and had the time to observe and experiment. Domestication is also a very old process, which starts in the primitive knowledge of plant gatherers, and not necessarily with food plants. It may not have occurred in areas of high concentration of plants diversity, but in its borders. A similar observation has been done for tropical America. As the areas in which man started domestication are of rich and diverse vegetation, the number of potential domesticates is higher in certain areas, and the experience gained in domesticating a wild plant may be applied to others. As man moved to new habitats he tried to domesticate other plants, and by carrying his domesticates he may have induced, by crossing, a wider range of diversity. Seed crops were domesticated afterwards, annuals first, in several places and at different times. In SE Asia seed crops, especially rice, replaced slowly the root and tuber crops, such as Colocasia, Cystorperma, Dioscorea.

Rice domestication was the turning point in the development of agriculture in the Indomalayan region. As Harris (1974) has suggested, it could be a simple operation: rice growing naturally in taro patches was collected by primitive man, who learned how to plant it in the same places; the complicated system of paddy cultivation came later. Chang (1976, 1977) favors the hypothesis that rice was domesticated in the area extending from NE India to the Pacific, somewhere between Thailand and S. China. The improvement of cultural practices, including paddy systems, was possibly developed in the Yellow-Han river basin, and later spread to SE Asia.

For the Indomalayan region, Burkill (1953) applied the same order of domestication that was established for SE Asia. "After the adoption of (i) cereals and (ii) pulses, (iii) short lived greens, it is by no means unreasonable to think that man would grow (iv) oil seeds, such as the genus Brassica furnishes. But when he found it possible to live on the produce of one locality in a static way he would proceed to (v) what an agriculturist understands as "roots", then (vi) herbaceous fruits, (vii) fibers and dye plants and long afterwards (viii) woody plants, chiefly fruit trees and (ix) various industrial plants. A large measure of urban development had to occur before the entry of group ix". Such a logical and complete succession of domestication has very few supporters now.

4.3.1 Transdomestication in India

Beside the domestication of numerous native species, India has a special role in crop transdomestication. This concept is explained by Hymowitz (1972) as "the movement by man of a wild species from its indigenous area to another region where it is subsequently domesticated". It could be argued that the species does not have to be completely wild, but may be in a stage of incipient domestication. To apply a term often used by Burkill (1953) in India several important crops were "nobilized". Among them sorghum (Burkill, 1953), Eleusine (Mehra, 1963); guar (Hymowitz, 1972); ricinus (Narain, 1974; pigeon pea (De, 1974); okra (Joshi, Gadwal & Hardas, 1974); probably cotton and sesame. Even now, an African crop, Guizotia abyssinica, is receiving more attention in India than elsewhere. The long cultural tradition in plant husbandry and the needs to increase food, fiber and oil production, were the main factors in plant improvement in India. The movement of wild or semiwild plants from Africa to India, ocurred at different times; in Central India, rests of sorghum have been dated at 65000 BP (Vishnu-Mittre, 1974), while Hymowitz suggests that guar was taken sometime between the 9 - 13th centuries AD.

It also should be mentioned that India had a similar role with SE Asia cultigens as secondary center of variability. Thus it is the largest center of rice diversity, of the triploids Musa for the AAB and ABB cultivars, and also of the hybrid Saccharum, the North Indian canes.

4.3.2 The situation in Philippines

Due to the richness of its flora, Philippines seems to offer possibilities for new domestications. Wester (1924) gives a long catalogue of edible plants, many still uncultivated, and Quisumbing (1965) has emphasized this potentiality, especially in ornamentals. The domestication has been helped by the attention given by national and foreing scientist to the breeding of some native crops like abaca (Musa textilitis), or to the introduction into cultivation of some wild plants, like alingaro (Elaeagnus philippensis), mabolo (Diospyros philippensis), adlai (Coix lachryma-jobi), or the timber and medicinal species (Brown, 1951-1958). It is also well knwon that local tribes have an extensive knowledge of the properties of many plants, far more that they cultivate (Conklin, 1957; Spencer, 1966). But in Philippines, as in Malaysia, the destruction of the natural vegetation is threatening the survival of many species of potential utilization and domestication.

4.4. Regional concentration of germplasm

Within a large area such as SE Asia, there are some minor areas or "microcenters", with high concentration of germplasm. This is due mainly to human action through local domestications and introductions from other places. As human action is older and more intensive in the western part of the region: India to Indonesia, it is not surprising to see a gradual decrease in germplasm diversity from wet to east. The geography of the area and its vegetation, tend to strenghen this pattern of distribution: the continental masses and large islands with a rich vegetation are in the western section, while in the east there only islands, most of these of small size. However, there are exceptions to this trend, and Barrau (9170) cites three crops: Artocarpus altilis, Cystosperma chamissonis and Musa troglodytarum, that although originate in the western part of the region, show a wider variability, in terms of number and diversity of cultivars, in Polynesia. Pometia pinnata shows a similar trend, but this is a case of cultural selection, since the fruits in Malaysia, for instance, measure only 2 cm in diameter (Burkill, 1935) while in Santa Cruz islands they reach 5 cm (Yen, 1974). It may be that in Santa Cruz, as "every tree is under observation", superior mutants were detected.

There are several cases of germplasm concentration in the region difficult to explain. One is Psophocarpus tetragonolobus in New Guinea. Although at present, it is in this island where the widest diversity is found (Khan, 1975) it may be possible that, since the rest of the genus is African and the crop was introduced to Malaysia, an intensive cultivation in New Guinea and the preservation of any variant (a practice common to primitive agriculturists) led to an extraordinary concentration of germplasm. The fact that sweet potatoes and tobacco, which are introductions to New Guinea, show a marked diversity, may support this explanation.

In bananas, outside the main area of diversity in Malaysia-Indonesia, in India there is a concentration of triploids of the "plantain" type, of foremost importance (Simmonds, 1962). In sugar cane, Northern India shows also a concentration of cultivars of hybrid origin:the barberi / sinensis group.Rice is perhaps the best example of germplasm concentration in different areas: SE China, India, Indonesia.

These microcenters are of especial importance for plant exploration and conservation. The concentration of primitive cultivars in them, is afected now by the introduction of new cultivars.

4.5 Crop expansion and contraction

Crops domesticated in the "nuclear area" of the Indomalayan region: India-Indonesia, were limited in their spread northwards by the climatic conditions in central China, towards the west by the Thar desert and the Himalayas, but to the east they reached the limits of Polynesia. The agriculture of the oceanic islands is based on materials and systems introduced from the "nuclear area" (Yen, 1973, 1980). Expansion towards SW Asia and eventually to Africa, was more difficult. Burkill (1953) proposes the "Sabean lane" as a route of crop expansion from India to East Africa and the Fertile Crescent, through the southern border of the Arabian peninsula, assuming it had a wetter climate than now. Another possible route is through Mesopotamia to Syria, and *Colocasia esculenta* may have reached the Mediterranean around 100 AD, following this route.

Through maritime connections between Indonesia and East African and Madagascar, some Malayan crops and their names, were moved around 500 AD, including bananas, sugar cane, yams, mangoes and other.

There are also clear examples of crop decline. *Dioscorea alata* being an outstanding one (Burkill, 1951). This crop expanded from Indochina into India, Africa and Oceania, and then declined when it was replaced by other yams, sweet potatoes or cassava. But the crops that have decreased more are dyes and fibers, replaced by synthetic products. In this category could be included also medicinal, gums and resin plants, like gambir, which are still exploited from wild plants. With the change of habits, even areca tends to decrease in importance.

4.6 Plant introduction

Crop plants have been moved into the Indomalayan region since the beginning of agriculture. The earliest introductions from SE Asia or Central China, were of limited adaptability. African crops, as mentioned before, moved in prehistoric times into India, where they were "nobilized". But the larger and more important introductions came in historical times. They could be divided roughly into two periods: the first corresponds to the discovery of the routes to India and the New World by the Spaniards and Portuguese which resulted in the largest plant interchange in history, in which American crops, such as maize, cassava, peppers, tobacco, cacao, cotton, cucurbits, and many others were tried and adapted in SE Asia. They came through three main routes: from Brasil to West Africa to India and Amboina; from Mexico to Philippines, and from Peru to Marquesas. Most of them were food plants, as they were intended to be used during the expeditions and later planted in the new lands that were intended to be permanent settlements.

A second period of active introductions came with the development of the colonial empires of England and Holland in India, Malaysia and Indonesia, from late in the 18th century to the first decades of the 20th century. It was reduced to "industrial" or plantation crops: coffee and oil palm from Africa; rubber, cinchona, sisal and others from tropical America. These introductions had some common characteristics: i) they were collected at random, and like in the case of the rubber seeds obtained by Wickham in the Amazon, the result could have been very different if the site of collection were moved a few kilometers; ii) by the difficulties in transportation, they were of very reduced quantity, and the genetic base very narrow for future improvement; iii) their adaptability was quite high, as the majority did not find serious pests or diseases in their new sites (León, 1963; Pursglove, 1965). Since the development and decline of the colonial plantations, more germplasm of different crops has moved into the Indomalayan region, both for the industrial and the food crops; the result is that in most areas, as Keleny (1962) has shown for New Guinea, the foreing component is as important as the autochtonous.

5. STATUS OF CROP GENETIC RESOURCES IN THE INDOMALAYAN REGION

5.1 Conservation

The importance of the conservation of crops such as rice, sugar cane, bananas, and many others, is a matter of world concern (Frankel, 1970). The problem in the maintenance of the genetic diversity, especially in the factors threatening their survival, are roughly the same than in other regions of the world. But the number and diversity of useful species, their distribution often reduced to small areas and the need to use different systems in their conservation, raise problems of very difficult and expensive solution.

5.1.1 Rainforest deterioration

The Indomalayan rainforests contain the immediate ancestors and wild relatives of many crops. And, aside from this, the rainforest is the source of oil, gutta and other resins, latex, drugs and many other products of present and potential utilization obtained from wild plants. A large share of the tropical ornamentals, some of high economic value, also come from the SE Asian rainforests (Jong, Stone & Soepadmo, 1973; Sastrapradja & Rifai, 1975). These have been one of the earliest habitat of man, who lived in them for many centuries by hunting and gathering, affecting in one way or another the primitive structure of the forest (Rambo, 1979). However, the impact of man during his early occupation of the rain forests, was sporadic and confined to a limited exploitation of a few plants and animals. The primitive forest man was and is not an improvident destructor of wild food plants,as stated by Burkill (1953), but through primitive practices and taboos, maintained and still protects his wild sources of food (Rambo, 1979). The proof is that there are still active groups of plant gatherers in the forests of Malaysia, Mindanao and New Guinea. The clearing of rainforest for agricultural uses and housing by the native population has decreased the extension of the rainforests continuously. But the dependency on local food sources, home gardens (Sastrapradja, 1980) and other systems, has kept alive a large part of the crop diversity, even in Java, with its high density of population. The first large and systematic destruction came with the establishment of plantation crops, both native and introduced, since in this system all the native vegetation is practically eliminated. Under the plantation-crop export system, timber extraction was of secondary importance. Since the 1950's however, the extraction of timber has increased drastically to supply foreing markets, and has been accelerated by the used of improved equipment for cutting, hauling and loading. The Indomalayan rainforests supply at present 20% of the world consumption of hardwoods, and wood exports have increased five times since 1953 to 1968 (Whitemore, 1975). In Philippines, timber and its products are the most valuable export of the country. If this trend continues, and the market perspectives seem to indicate so, by the end of this century only small areas will be left of the large forest tracts in Mindanao, Borneo or Malaya.

The effect of logging in the rainforests is that for every 10% of the trees which are extracted, 35% are left undamaged but 55% are destroyed during the operation (Burgess, 1971 cited in Whitemore, 1975).

There is not much information on how forest clearing or the deterioration resulting from logging, affect the population of useful plants in the Indomalayan region. But in the case of fruit trees some statistical information from Malaysia (Ho, 1971; Whitemore, 1975) apparently confirms the common assumption that fruit trees in wild conditions are scarce. However, Soepadmo (1979) explained that these statistical results are due to the practice in forest inventories of not including trees with a diameter of less than 10 cm, and that the average is of 5 trees per ha. They belong to <u>Artocarpus</u> 1,2 - 6,1 trees per ha in three sites; <u>Baccaurea</u>, 7,0 - 13,0; <u>Durio</u>, 2,2 - 4,2; <u>Garcinia</u>

2,0 - 3,4; Lansium 0,25 - 5,8; Mangifera 0,3 - 4,3; Nephelium 0,25 - 10,0; Xerospermum, 4,4 - 19,6.

The deterioration of the rainforests in SE Asia is the most serious threat to crop genetic resources in the Old World.

Germplasm losses in the monson regions

5.1.2 Monsoon forests

The monsoon areas are among the most densely populated, both in the Indian subcontinent, as in Indochina, Malaysia and Indonesia. There is no much information in germplasm losses, as traditionally these areas are in crop production or other kinds of human occupation. The presence of savannas in patches of variable size in Thailand, Viet Nam, Laos, Kampuchea, on lateritic soils, has been attributed in large part to burning. The importance of these areas in crop genetic resources are of different kind than in the rain forests. The materials to save are mostly around dwellings, and the threat may come if the land use system is changed, with the possible elimination of plants which provide fruits and leaf vegetables around the compounds.

5.1.3 Change in food habits

One of the worst threats to genetic resources in the developing world are the changes in food habits. These are part of the cultural dominance, through commercial propaganda, extension activities and the general trend to adopt the habits of the leading countries. Its main component is often a matter of ignorance on both sides: the groups that want to improve the diet of developing countries, and the local people that atribute superior qualities to foreing foods. A second component is the lack of technology: the ignorance on the practices of crop husbandry; the scarcity of reliable sources of seeds or other propagation stocks, or of materials and systems to handle and prepare the harvested products. In a large part, this sort of cultural imposition comes from the fact that the advanced cultures which dominate at present, are with very few exceptions, countries in which there is a paucity in the number of food plants. Their crop development programs, in selection first and breeding later, have been directed mainly to obtain yielding cultivars, and these in ever decreasing numbers, which can be adapted to mass production and mass consumption. Quality and diversity are of second order.

Among food crops, vegetables are the most affected by cultural changes. In spite of their higher nutritive value, resistance to pests and versatility in their utilization, the native vegetables are losing ground all over the tropics. Only in backward areas or in poor communities, the natives species are holding on, but the recent rise in the cost of insumes like fertilizers, fungicides, and pesticides may help in their survival. In a few cases, like amaranths, the interest of foreing scientists is helping to restore them to their proper place.

On the richness and diversity of the native vegetables in the Indomalayan region, the sources of information are the classic book by Ochse (1931) on Indonesian vegetables, and the most modern and comprehensive of Herklots (1972) for the SE of Asia.

The content, especially in the leafy vegetables, of essential aminoacids, pro-vitamin A and vitamin C, of the tropical species is superior to the temperate zone vegetables. The introduction of the later in local diets, not only does not mean any improvement in nutrition, but implies higher costs and more difficulties in post harvest handling. The following table from Hamilton (1955), shows the food value of 9 native and 10 introduced vegetables in New Guinea.

Botanical Name Food 100 gm. Edible portion	Calories	Protein gm.	Calcium gm.	Iron mgm.	Vitamin A. I.U.	Thiamin mgm,	Ascorbic Acid mgm.
Native							
Saccharum edule	38	4.1	10	-	-	-	21
Archontophoenix sp.	19	1.9	550	-	-	-	14
Panicum palmarum	25	1.6	7	-	-	-	8
Hibiscus abelmoschus	45	5.7	580	approximately		0.15	118
Colocasia esculenta	43	4.1	310	3.0	13.000	0.15	16
Amaranthus spp.	6	3.5	267	3.9	6.090	0.08	80
Portulaca oleracea	21	1.7	103	3.6	2.550	0.03	25
Alsophila sp.	43	5.5	---	-	-	0.15	26
Morus sp.	57	2.9	300	-	-	0.15	49
Introduced							
Lactuca sativa	15	1.2	22	0.5	440	0.04	8
Brassica oleracea	24	1.4	40	1.0	240	0.06	50
Brassica chinensis	14	1.5	186	1.0	2.800	0.08	45
Lycopersicum esculentum	22	0.9	130	0.2	400	0.06	22
Cucumis sativus	2	1.0	5	0.1	0	0.01	2
Daucus carota	9	0.2	12	0.2	6.237	0.02	1
Sechium edule	8	0.2	3	0.1	5	0.05	4
Raphanus sativus	4	0.2	6	0.3	0	0.03	5
Brassica rapa	5	0.1	11	0.1	0	0.07	5
Allium cepa	37	1.0	30	0.4	250	0.03	15

5.1.4 Information erosion

In the same way that germplasm dissapears, the information on the husbandry and utilization of crop plants tends to dissapear. The new generations do not feel the need to have a thorough knowledge of plant names, properties, system of propagation and methods to use the crop products, as the previous generations did. With the cultural changes, the knowledge on primitive crops tends to decrease; most of it is passed orally from one generation to the following, and thus coincident with the losses of germplasm, a very valuable knowledge is often lost forever.

6. OUTLOOK OF ACTIVITIES IN GENETIC RESOURCES

6.1 If it is considered that crop plants have to fill the urgent needs of the region in i) feeding a large and increasing population; ii) providing fibers, fuel and other items for the local industry; iii) maintaining an export market dominated by introduced crops, then the conditions for a conservation policy do not seem to be very favourable. However, in the last decades, some activities in genetic resources have been strengthened or developed. The brightest point is in rice, the most important food crop in the world, in which a strategy of exploring and collecting has been carried on at IRRI, under the leadership of T.T. Chang.

6.2 At national level, the activities in India, Indonesia (Sastrapadja, 1978), Malaysia (Ho, 1971; Jong et al., 1973) and Philippines (Valmayor & Espino, 1975) are aimed at strengthening and expanding the conservation works started by plant introduction services, universities or botanic gardens.

6.3 India is the only country in the region with a national institution fully concerned with genetic resources, the National Bureau of Plant Genetic Resources at ICAR, New Delhi, established in 1976. Work in India begun with the Plant Introduction Office, started at IARI in 1946.

6.4 The establishment under the aegis of IBPGR of a regional cooperative program (IBPGR, 1977) as a result of recommednations of a technical meeting held at Bogor, Indonesia in 1975 (Williams, Lamoureux & Wulijarni-Seoetjipto, 1975) is aimed at placing the responsability of the maintenance of collections on a group of national institutions, who divide among themselves the crops and activities according to priorities assigned in the conference. IBPGR trhough a regional officer located at Bangkok and a newsletter, maintains the coordination of the program.

6.5 The interest of the outside world in the genetic resources of the Indo-malayan region, is focused in crops such as sugarcane, bananas, fruits and spices, which are of foremost importance to other tropical regions as cash crops. In this sense, it is interesting to note that the best collections of some of these crops are outside the region, and also that recent explorations have shown the potential value of new germplasm for their genetic improvment. Also in food crops, there is still very promising germplasm for other parts of the world, mostly at the level of primitive cultivars.

6.6 At the same time, genetic resources in other regions are necessary for the improvement of the introduced food or export crops. The recent efforts to collect oil palm materials in Africa and tropical America, aimed at broadening the genetic bases for further improvement, is a good example that may be repeated in other crops. Some countries have stringent quarantine regulations which are a serious obstacle to plant introduction; they complemented with the establishment of proper quarantine facilities to permit a steady flow of germplasm from other regions. As often happens a crop which originates in the region may offer superior materials outside, so it is not susprising that the best ginger variety in a trial in India came from Brazil (Thomas, 1966).

In resume, the conservation of crop genetic resources in SE Asia will depend on the artificial conservation of its germplasm in living or seed collections, as the possibilities of in situ conservation in the region are remote and risky, probably more than in any other area of the world. A regional network of national institutions may be the most rational or practical approach, the more adapted to the political and economic conditions, but it is an extremely fragile structure if outside help does not support some key institutions, with proper funding and scientific advice.

To create a permanent interest in the preservation and utilization of genetic resources as part of a coherent policy in conservation, requires convincing the public of the importance of these resources for the future development of the countries. In Malaysia, some scientists are developing such approach.
In relation to the other tropical regions, it is necessary to establish a strong exchange of scientific personnel, information and germplasm, which will result in inmediate and mutual benefits.

6.7 Information on current activities in conservation, exploration, documentation, introduction, training and publication on the genetic resources of the Indomalayan region, appear in two periodical publications: Plant Genetic Resources Newsletter, IBPGR/FAO, Rome, and IBPGR Regional Comittee for Southeast Asia Newsletter, R. B. Singh, editor FAO Regional Office Maliwan Mansion Bangkok 2, Thailand. As general background: WILLIAMS, J. T.; LAMOUREUX, C.H. & WULIJARNI-SOETJIPTO, N., ed. 1975. South East Asian plant genetic resources. Bogor, 272 p. Also in IBPGR.

CROP INVENTORY

(not including medicinal and ornamentals)

1. BAMBOO

One of the most remarkable genetic resources of the region are the bamboos. Although bamboos also grow in Africa and tropical America, in no other part of the world they are so intensively and variably used. They supply materials for buildings, furniture, mats, baskets, rafts, hedges, as well as paper pulp, edible seeds and shoots. The same species may be used in different ways.

There are some 50 genera and around 100 spp. of bamboo in the region (Lessard & Chouinard, 1980). The following list includes the most commonly used species.

1.1 Bambusa. Some 75 spp. all in SE Asia, except B. guadua, of South America.

1.1.1 Bambusa arundinacea (Retz) Willd., India - Indonesia.

1.1.2 Bambusa balcoa Roxb.

1.1.3 Bambusa blumeana Schult. F., Philippines.

1.1.4 Bambusa polymorpha Munro, India - Thailand.

1.1.5 Bambusa tulda Roxb., India - Burma.

1.1.6 Bambusa vulgaris Schrod., India - Malaysia.

1.2 Dendrocalamus. 12 species from China to Malaysia, including the tallest bamboos.

1.2.1 Dendrocalamus asper (Schult.) Becker, Malaysia.

1.2.2 Dendrocalamus merrilleneaus Elmer, Philippines.

1.2.3 Dendrocalamus latiflorus Munro, Philippines.

1.2.4 Dendrocalamus strictus (Roxb.) Nees, India - Burma.

1.3 Melocanna. An Indomalayan genus, with 2 species.

1.3.1 Melocanna baccifera Skeels, India

1.4 Ochlandra. Around 12 species from India to Madagascar.

1.4.1 Ochlandra ebracteata India.

1.4.2 Ochlandra scriptoria India.

1.4.3 Ochlandra travancorica India.

1.5 Schizostachyum. Some 25 spp al over SE Asia.

1.5.1 Schizostachyum blumei India.

1.5.2 Schizostachyum lumampapo (Blanco) Merr., Philippines.

2. CEREALS

2.1 Coix — Gramineae

Some five species of the Indomalayan region, of which only one is cultivated.

2.1.1 Coix lachryma-jobi L. ADLAI. Wild and cultivated. India - Philippines - New Guinea; probably domesticated between Burma and Indochina. Cultivars numerous, differing of the wild populations in the thinner receptacle, and showing a high diversity in the size and color of the kernel. This is of high protein content. Adlai cultivation is very ancient, but did not become important due to replacement by rice first and maize later. Cultivated in NE India (Arora, 1977); Philippines (Wester, 1920); New Guinea, introduced to tropical America as cereal and forage. Among the wild populations, var. aquatica is reported to have stems 30 m long (Burkhill, 1935).

2.2 Digitaria

A pantropical genus with some 380 species; a few of them are used as minor cereals, others as grains in Africa.

2.2.1 Digitaria cruciata (Nees) A. Camus, RAISHAN. var. esculenta cultivated in N. India (Singh & Arora, 1972).

2.3 Echinochloa

Some 30 spp. all over the tropics, used as grasses or minor cereals.

2.3.1 Echinochloa crus-galli (L.) Beauv. India - SE Asia. var. frumentacea, a minor cereal, probably selected in India from the wild E. colonum.

2.4 Eleusine

Around nine species, in tropics and subtropics of the two worlds. Only one species used as a minor cereal.

2.4.1 Eleusine coracana (L.) Gaertn. RAGI. An early introduction to India from Africa (Mehra, 1963); an important crop in India, with numerous land races and some 30 advanced cultivars.

2.5 Oryza

A pantropical genus of some 25 species of which 10 are found in the Indomalayan region, only one, rice, in cultivation.

Oryza species in the Indomalayan region (Chang, 1977).

2.5.1 O. granulata Nees & Arn., SE Asia.

2.5.2 O. longiglumis Jansen, 2n:48. New Guinea (discovered in 1953).

2.5.3 O. meyeriana (Zoll. & Moll.) Baill., 2n:24. SE. Asia.

2.5.4 O. minuta J.S. Presl., 2n:48. SE Asia.

2.5.5 O. nivara Sharma & Shastry, 2n:24. S. Asia - Australia.

2.5.6 O. officinalis Wall., 2n:24. S. Asia - S. China - New Guinea.

2.5.7 O. ridlegi Hook. f., 2n:48. SE Asia.

2.5.8 O. rufipogon Griff., 2n:24. S. Asia - SE Asia - S. America.

2.5.9 O. sativa L. 2n:24. SE. Asia (cult. all. trop. & subtrop.)

2.5.10 O. schlechteri Pilger. New Guinea.

According to Chang (1976) "some of the wild species are rapidly becoming extinct".

2.5.9 Oryza sativa L., RICE and its wild relatives: O. rufipogon and O. nivara, are found from the Eastern foothills of the Himalayas to the Mekong valley, the most probable area of rice domestication. Rice, the most important food crop and one of the most ancient, shows one of the widest diversity found in any crop plant. From the point of view of genetic resources, and in comparison to other important crops, it seems to be in a rather favourable situation, due mainly to the collection and maintenance works done at IRRI, Los Baños, Philippines, under the leadership of Dr. T.T. Chang., and at the Indian Rice Institute, Cuttack, India. Other very important collections are kept in China, Japan, USA, etc. Chang (1977) points out that "nearly all the national collections are defficient in minor varieties and especially types of indigenous origen."

Rather few efforts have been made to collect and conserve primitive cultivars, wild races and wild species, and the coverage of genetic material is inadequate. While a number of countries in tropical Asia are collaborating with IRRI on the collection of minor varieties, especially types and primitive cultivars, it is essential that all national centers collect and preserve all segments in the indigenous rice germplasm, much of it existing in remote and less accessible areas".

2.6 Panicum

A genera of 500 species, mostly in the tropics, including some important pasture grasses. Among the minor cereals, the millets, are the two following species:

2.6.1 Panicum milliaceum L. PROSO. It is generally agreed that this species originate in Central Asia; cultivated especially in S. India where some varieties have been selected.

2.6.2 Panicum sumatrense Roth. (P. milliare Lam.) GOUDI. SE Asia, wild and cultivated; in India, where it is widely planted especially in the South, commercial cultivars have been selected.

2.7 Paspalum

250 tropical and subtropical species; one used as minor cereal.

2.7.1. Paspalum scrobiculatum L. KODO. Wild in SE Asia. In India, there are several improved varieties (toxic principles are reported in some primitive cultivars). Highly variable, but not clear varietal differentiation (de Wat et al, 1983).

2.8 Pennisetum

A grass genus with 130 species, of which only the following is used as a minor cereal.

2.8.1 Pennisetum americanum (L.) Leeke (P. typhoides (Burm. f) Stapf & Hubbard). PEARL MILLET. An early introduction from Africa, important especially in NW India; some 15000 genetic stocks at ICRASAT from India (Mengesha, Prasada, Rao & Appa Rao, 1980), and in that country 30 advanced cultivars have been released

(Murty, Upadhyay & Manchanda, 1967). There is also a group of sweet stalk cultivars (Rao et al, 1982)

2.9 Setaria

2.9.1 Setaria italica (L.) Beauv. Introduced probably from Central Asia in very ancient times, cultivated in the Malay peninsula by primitive tribes and in S. India, extremely variable especially in size and shape of panicles; some 10 selected cultivars in India. (de Wet, Oestry-Stidd & Cubero, 1979).

2.10 Sorghum

Sorghum species are estimated at 60, two cultivated= one is an important forage, other a cereal.

2.10.1 Sorghum bicolor (L.) Moench. SORGHUM. An early introduction from Africa to India, many of land races, mutants and hybrids; cultivars selected by in India for the different states, based on time of planting, yield, maturation period, etc. Main races cultivated in India are bicolor, durra, durra-bicolor, guinea-kafir (S. roxburghi); some 80 advanced cultivars. (Rachie, 1965).

2.11 Zea

Zea contains 6 species of American origin.

2.11.1 Zea mays L. MAIZE. The introduction to India and China a few decades after the discovery of America, led to aberrant populations in Assam, due to long isolation. Recently, commercial cultivars have been released in India, Malaysia, Indonesia.

3. COVER CROPS

(including shade trees).

3.1. Albizzia falcataria (L.) Fosberg (A. falcata, A. moluccana). Indonesia (Java) - New Guinea, shade and reforestation, "one of the fastest growing trees in the world" (US Nat. Ac. Sc., 1979).

3.1.2 Albizzia chinensis (Osb.) Merrill, planted as shade tree for coffee and cacao in Indonesia.

3.1.3 Albizzia lebbeck (L.) Benth., Africa - Australia, shade tree.

3.1.4 Albizzia procera (Roxb.) Benth., India - Indonesia.

3.1.5 Albizzia sumatrana Steen., Indonesia; introduced to tropical Africa and America.

3.2 Canavalia gladiata (Jacq.) DC., China - Philippines - India - Australia, also in Africa, in natural stands, often cultivated as cover crop or for its green pods.

3.2.1 Canavalia virosa (Roxb.) Wight & Arn., China - India -Thailand - Australia, wild, cultivated only as cover crop.

3.3 Crotalaria bialata Schrank. (C. alata), this and the following species are widely distributed from India to the Pacific, used as green manure.

3.3.1 Crotalaria linifolia L. f.

3.3.2 Crotalaria mysorensis Roth.

3.3.3 Crotalaria retusa L.

3.4 *Indigofera hirsuta* L., SE Asia, introduced to other tropical areas as a cover crop. Also the next species:

3.4.1 *Indigofera spicata* Forsk. (*I. endecaphylla*).

3.4.2 *Indigofera tinctoria* L. (*I. sumatrana*).

3.5.1 *Mucuna pruriens* (L.) DC., VELVET BEAN. SE Asia, cv. *utilis*, without stinging hairs in the pods, widely cultivated in the region and in the tropics and subtropics, "species" such as *deeringiana*, *cochinchinensis*, *aterrima*, etc, may be synonims.

3.6 *Pueraria phaseoloides* (Roxb.) Benth. (*P. javanica*), TROPICAL KUDZU, SE Asia, wild and cultivated, introduced to the tropics of Asia and America as a fodder plant.

3.7 *Sesbania grandiflora* (L.) Pers. and the following species, both from SE Asia, are widely used as green manure.

3.7.1 *Sesbania sesban* (L.) Merrill.

3.8 *Tephrosia candida* (Roxb.) DC., SE Asia, wild and cultivated as green manure.

4. DYES

4.1 Caesalpinia Caesalpinaceae

a pantropic genus with some 60 spp.

4.1.1 Caesalpinia sappan L., SAPPAN, India - Sri Lanka - Burma - Malaysia, wild and cultivated, the wood yields a red dye.

4.2 Curcuma Zingiberaceae

An Indomalayan genus with around 55 spp.

4.2.1 Curcuma domestica Val. (C. longa), besides its use as condiment, the rhizomes yield a dye, ranging from yellow to blue. India, widely cultivated in several tropical areas.

4.3 Garcinia Guttiferae

Some 200 spp. in the Old World tropics.

4.3.1 Garcinia hanbury Hook. f., GAMBOGE, has a secondary use as a source of yellow dye.

4.4 Marsdenia Asclepiadaceae

A pantropic genus of around 100 spp.

4.4.1 Marsdenia tinctoria R. Br., India - Indonesia, wild and cultivated, a source of indigo dye.

4.5 Morinda Rubiaceae

Around 45 spp. in the Old World tropics, some species gathered or cultivated, for the dyeing materials, contained in the roots.

4.5.1 *Morinda citrifolia* L., India - Polynesia, cultivated.

4.5.2 *Morinda elliptica* Ridl., India - Indochina.

4.5.3 *Morinda coreia* Buch., - Ham., India, wild and cultivated.

4.5.4 *Morinda umbellata* L., India - Australia.

4.6 *Indigofera* Leguminosae

A pantropical genus of aroun 700 spp., several independently domesticated in SE Asia, Africa and Tropical America as dye plants, the color contained in the leaves.

4.6.1 *Indigofera tinctoria* L., (*I. sumatrana*), INDIGO, probably native to SE Asia, formerly cultivated.

5. FIBRES

5.1 Abelmoschus — Malvaceae

A genus of 15 species from tropical Africa to Australia. One species of limited importance as fiber crop.

5.1.1 Abelmoschus ficulneus L., India, wild and cultivated for its bast fibers.

5.2 Boehmeria — Urticaceae

Some 100 tropical and subtropical species, one used for the stem fibers.

5.2.1 Boehmeria nivea (L.) Gaud. RAMIE, The population in SE Asia, called var. "tenacissima", 2n:24, may be of hybrid origin; the chinese populations, var. "nivea", are 2n:28. It has never been a fiber crop of first importance, because of the difficulties in decortication: it is used also widely in the tropics for its leaves and subterranean stem in animal feeding.

5.3 Broussonetia — Moraceae

7 - 8 species from tropical Asia - Oceania, one species used for the stem fibers for paper and other uses.

5.3.1 Broussonetia papyrifera (L.) Vent., Wild in Burma and Thailand, cultivated in E. Asia as a source of material for paper making. In Polynesia, for bark cloth or "tapa".

6.4 Ceiba — Bombacaceae

6.4.1 Ceiba pentandra Goerthn. KAPOK. var indica, from S. India - Polynesia; quite variable in Java and Sumatra, less in Indochina (Zeven, 1969).

7.5 Corchorus Tiliaceae

Some 40 species in the tropics and subtropics, some used for the stem fibers.

7.5.1 Corchorus capsularis L. WHITE JUTE. Cultivated especially in India and Bangladesh, where several improved cultivars have been selected for yield and early or late harvesting.

7.5.2 Corchorus olitorius L. TOSSO JUTE. Several improved cultivars in India and Bangladesh. Of both species of Corchorus, collections are kept at the Jute Agricultural Research Institute, Barrockpne, West Bengal, including genetic stocks, land races and improved cultivars. C. olitorius is also used in the Indomalayan region as a vegetable, the tender tips boiled as spinach.

The industrial uses of Corchorus have declined in the last decades, as synthethic fibers are used more for bags and ropes.

7.6 Crotalaria Leguminosae

A pantropic genus of around 500 spp., used mostly as cover crops or green manure, for the fibers stems: C. juncea and sometimes C. retusa are cultivated.

7.6.1 Crotalaria juncea L. SUNN HEMP. India, only in cultivation; second to jute as a crop fiber in India and Bangladesh, and recently as a source of paper pulp. Three main types: White, Ganjam or Green, and Dewghyddy; introduced to Brazil. In other parts of the tropics used as green manure.

8.7 Eulaliopsis — Gramineae

A grass genus of two species from India - China - Philippines.

8.7.1 Eulaliopsis binata (Retz) Hubbard, SABAI, India; a grass used for paper pulp.

8.8 Fimbristylis — Cuperaceae

A sedge genus of some 300 spp., centered in the Indomalayan region, but of pantropic distribution.

8.8.1 Fimbristylis diphylla Vahl., cultivated in SE Asia for the stems, used as matting material.

8.8.2 Fimbristylis globulosa Kunth, cultivated in Indonesia in paddies, for the stems used as matting material.

8.9 Girardinia — Urticaceae

Some 8 spp., from Africa to the Indomalayan region.

8.9.1 Girardinia heterophylla Dcne., NILGIRI NETTLE, India - Malaysia, cultivated in India, especially var. palmata, and in Sri Lanka, var. zeylanica.

8.10 Gossypium — Malvaceae

The cotton species, around 25, cultivated and wild, are distributed in all continents.

8.10.1 Gossypium arboreum L.

8.10.2 Gossypium herbaceum L.

Cotton is grown all over in the Indomalayan region but only in India reaches a commercial production of world importance. Four species are cultivated: two diploid Old World cottons, G. arboreum which up to 30 years ago represented the 97% of the production, with many land races and improved cultivars.

The annual G. arboreum varieties are grouped in India in two "races" bengalensis and indicum, which derive from the perennial races indicum and burmanicum respectively. The annual G. herbaceum, from the race wightiannum of Western Deccan.

8.10.3 Gossypium barbadense L.

8.10.4 Gossypium hirsutum L.

After some unsuccessful introductions of the New World tetraploid cottons, G. barbadense and G. hirsutum, the second has been established as the most productive species, particularly the Cambodia race. Breeding has been aimed in the last decades to obtain hybrids between arboreum and hirsutum, to select advanced cultivars in these two species and also in barbadense and herbaceum. Santhanam & Hutchinson (1974) give a partial list of the advanced cultivars in the four species. According to them in 1970, the cotton area in India was planted 50% of hirsutum, 29% arboreum, 21% herbaceum, less than 1% barbadense.

Native Gossypium in the region.

8.10.5 G. stocksi Mast., diploid, India - Arabian peninsula.

8.10.6 G. tomentosum Nutt., tetroploid, Hawaii.

8.10.7 "Wild" hirsutum, race taitiense, especially in Marquesas and Tahiti; its origin is still unexplained (Stephens, 1971), but it may have reached Polynesia after the discovery by europeans and turn wild under favourable conditions. In Australia there are 11 diploid species (Fyxell, 1969, 1976), some of them quite scarce. They do not seem to have any affinity with the cultivated species.

Conservation. In India there area large collections of local arboreum and herbaceum, but the impact of the American tetroploid is leading to heavy erosion in both species. The wild species and populations are also being decimated. The total number of genetic stocks, not including duplicates and foreign accessions, are estimated at 3500 hirsutum, 40 barbadense, 500 arboreum; 250 herbaceum (Narayan, Singh & Singh, 1980). The genetic stocks include obsolete cultivars, current cultivars and genetic markers including some cytoplasmic types. Well organized programs in documentation and regeneration and other activities, including introduction, are organized and supervised by a national committee.

8.11 Lepironia — Cyperaceae

Only one species, from Madagascar to China - Polynesia.

8.11.1 Lepironia mucronata Rich. Madagascar - Fiji, cultivated; its wide distribution may be due to human action (Burkhill, 1935). Used to make mats for baling.

8.12 Musa — Musaceae

A Indomalayan genus of some 35 species, of which fibers are obtained from the pseudostem and leaves. In the section Australimusa, 2n:10, one species is cultivated for the fibers.

8.12.1 Musa textilis Neé, ABACA. Philippines, wild and cultivated, some 70 varieties known; the populations known as 'Canton', 'Pacol', and 'Minay' are also possibly hybrids with M. acuminata or other spp. Introduced to Central America; its cultivation have declined steadily.

8.13 Sansevieria — Agavaceae

Around 60 spp., Africa, Madagascar - Arabia - India; several species used for the leaf fibers.

8.13.1 Sansevieria hyacynthoides (L.) Druce (S. zeylanica). India - Sri Lanka, wild and cultivated.

8.13.2 Sansevieria roxburghiana Schult., India, cultivated; introduced to Philippines.

8.14 Scirpodendron — Cyperaceae

8.14.1 Scirpodendron ghaeri (Gaertn) Merr. Sumatra, cultivated for the stems to make mats and hats in Philippines. Grows mainly in tidal swamps.

8.15 Sesbania — Papilionaceae

A pantropical genus of aroun 50 spp. Some are used for the stem fibers, to make fishing nets and ropes.

8.15.1 S. aculeata Pers. JANTAR. India - Thailand. Also for green manure and gum.

8.15.2 S. bispinosa (Jacq.) W. F. Wight. Cultivated in some parts of India. Also used as green manure.

8.16 Sida — Malvaceae

A pantropic genus, with some 200 spp., mostly American. The following species are occasionally used in India.

8.16.1 S. acuta Burm. f.

8.16.2 S. cordifolia Lam.

8.16.3 S. mysorensis Wight & Arn.

8.16.4 S. rhombifolia L.

8.17 Thespesia — Malvaceae

Some 15 spp., of the Old World tropics.

8.17.1 T. lampas Dalz., & Gibs., Indonesia.

8.17.2 T. populnea (L.) Soland. SE Asia - Polynesia.

Thespesia fiber is used as rough cordage, for fishing nets or for caulking boats; these two species have been experimentally cultivated, but their fibers have some undesirable characteristics.

8.18 Urena Malvaceae

The genus comprises six species of pantropical distribution. The following species reaches optimun growth in the South Pacific.

8.18.1 Urena lobata L. India - Polynesia, origins unknown, often used for cordage, the fiber coming mostly from wild plants.

6. FRUITS AND NUTS

In terms of the number of species, the fruits and nuts represent the largest source of germplasm of the Indomalayan region. Their use vary widely, and the same may have different uses; mostly are eaten fresh or canned, while a fex like plantains and breadfruit should be considered more properly as starchy vegetables. The potential of the fruits of the Indomalayan region is of foremost importance for other tropical areas. (Ochse, 1931; Sastrapradja, 1980).

6.1 *Aegle* Rutaceae

An Indomalayan genus, considered by some authorities to contain only one species, by other three.

6.1.1 *Aegle marmelos* Correa, BAEL, India - Sri Lanka, - Burma, introduced to Thailand, Malaysia, Indonesia and torpical areas of the New World. In India an important fruit, with many different populations. (Roy & Singh, 1979).

6.2 *Aceratium* Elaeocarpaceae

6.2.1 *Aceratium oppositifolium* DC. (*Elaeocarpus edulis* T. & B.), Moluccas, cultivated in Java.

6.3 *Acmena* Myrtaceae

A small genus of SE Asia, segregated from *Syzygium*.

6.3.1 *Acmena acuminatissima* (Blume) Merrill & Perry, Burma - Australia.

6.4 *Aglaia* Meliaceae

A large genus, 250 - 300 spp. from China to the South Pacific. Some species yield edible fruits, but they are not in cultivation. The following are the most common:

6.4.1 Aglaia acida Koord. & Val., Java

6.4.2 Aglaia edulis Hiern, India.

6.4.3 Aglaia harmsiana Perk., Philippines.

6.4.4 Aglaia oligantha DC., Philippines.

6.4.5 Aglaia langlassei C.DC., Thailand.

6.5 Alangium — Alangiaceae

From Africa and madagascar to the Indomalayan region, some 17 spp. Several wild species yield edible fruits, as the following:

6.5.1 Alangium javanicum (K. & B.) Wang., Java.

6.5.2 Alangium salvifolium Wang., India - Indochina.

6.6 Anacolosa — Olacaceae

Some 20 spp. the majority in the Indomalayan region.

6.6.1 Anacolosa luzonensis Merr., Philippines, wild and cultivated for its seeds (nuts).

6.7 Antidesma — Stiliginaceae (formerly in Euphorbiaceae).

A large genus, 170 spp., of the Old World tropics and subtropics. Fruits obtained mainly from wild plants.

6.7.1 Antidesma bunius (L.) Spreng., BIGNAY. India - Sri Lanka - Australia (not in Malaysia) - Philippines, wild and cultivated, introduced to the New World tropics and Florida.

6.7.2 Antidesma dallachyanum Gaernt. India - Malaysia.

6.7.3 Antidesma montanum Blume. Malaysia.

6.7.4 Antidesma platyphylla H. Mann., Hawaii, wild and cultivated, introduced to the New World tropics.

6.7.5 Antidesma tomentosum Blume, Malaysia.

6.7.6 Antidesma velutinum Blume. Burma - Malaya.

6.8 Ampelocissus — Vitaceae

A pantropical genus, with some 95 species.

6.8.1 Ampelocissus martini Planch., Philipp. Viet Nam - Malaysia, wild.

6.9 Artocarpus — Moraceae

Some 45 species from the Indomalayan region; additional uses as source of latex, timber, etc. (Jarrett, 1937).

6.9.1 Artocarpus altilis (Parkinson) Fosberg, BREADFRUIT.

Native: New Guinea - Micronesia - Melanesia - Moluccas (?); cultivated: India - SE Asia - Polynesia. Introduced to the African and American tropics. Numerous variants, with seeds in the possible native area, although some seedless types have been reported; seeded and seedlesss in Micronesia, Fijim Tonga, Samoa, while in Polynesia, where it is the most important food, varieties are predominantly seedless. Tahiti seems to have the widest clonal variation, estimated in around 200 clones (Barrau, 1957). The general distribution is quite confusing, due to the lack of complete specimens. The 'camansi', a seeded population from

Philippines, to which some specialists assign a species rank, is considered to be conspecific with A. altilis.

The conservation of this very important crop is threatened by several diseases like "pingelap", some of them lethal to most clonal populations. An attempt has been made to collect them in a place, like Hawaii, free of these diseases. Breadfruit is also important elsewhere: Antilles.

6.9.2 Artocarpus elasticus Reinw. Burma - Lesser Sunda Island, wild and cultivated.

6.9.3 Artocarpus gomezianus Wall. Burma - Indochina - Malaysia - Indonesia - Philippines. India - Sri Lanka: wild and cultivated.

6.9.4 Artocarpus heterophyllus Lam. JACKFRUIT. Wild (?) Western Ghats. India; cultivated in most tropical countries. No information available on its variability.

6.9.5 Artocarpus integer (Thumb.) Merr. CHAMPEDAK. Wild and cultivated: Thailand - New Guinea, introduced to Philippines.

6.9.6 Artocarpus kemando Miq. Wild and cultivated: Malaya - Borneo.

6.9.7 Artocarpus lakoocha Roxb. LAKUCH. Wild and cultivated: India - Burma - Indochina.

6.9.8 Artocarpus nitidus Trécul. The wild population extends from India - S. China - Philippines. Indochina to Borneo; cultivated in Indochina.

6.9.9 Artocarpus odoratissimus Blanco, MARANG. Wild: Borneo, Philippines (?) cultivated in Philippines.

6.9.10 Artocarpus rigidus Blume PERIAN. Wild and cultivated: Burma - Indochina - Bali.

6.9.11 Artocarpus tonkinensis A. Chev. Wild and cultivated: Indochina.

6.10 Averrhoa Averrhoaceae, formerly in Oxalidaceae.

2 spp; most authorities assign them to the Indomalayan region, although some to E. Brasil.

6.10.1 Averrhoa bilimbe L. BILIMBI. Cultivated in all the tropics; several varieties distinguished by the degree of acidity of the fruits.

6.10.2 Averrhoa carambola L. CARAMBOLA. Cultivated in all tropical regions; varieties selected in Thailand, Malaysia, etc. on the colour and acidity of the fruits.

6.11 Baccaurea Euphorbiaceae

Some 80 spp. from India to Polynesia. Contains numerous spp. utilized by the fruits, mostly wild, five of them cultivated (Soejarto, 1965).

6.11.1 Baccaurea dulcis Muell.-Arg., TIUPA. Wild and cultivated: Malaysia - Indonesia, introduced to the American tropics.

6.11.2 Baccaurea griffithi Hook. f., LARAH. Malaysia (probably only gathered, worth of cultivation.

6.11.3 Baccaurea lanceolata Muell.-Arg., GREEN RAMBAI. Malaysia, wild, fruit sold in markets.

6.11.4 Baccaurea malayana King, Malaysia - Indonesia, cultivated in Malaysia.

6.11.5 Baccaurea motleyana Hook. f., RAMBAI. Wild and cultivated in Malaysia - Sumatra, cultivated India, Sri Lanka, Java, Philippines, introduced to the American tropics. A wide variation reported from Malaysia (Allen, 1967).

6.11.6 Baccaurea racemosa (Reinw.) Mull.Arg. Wild and cultivated in Indonesia

6.11.7 Baccaurea sapida Mull. Arg., LATKA, wild and cultivated, India - China - Malaysia, several varieties.

6.12 Barringtonia Barringtoniaceae,

formerly in the Lecythidaceae (Payens, 1967).

Some 120 spp., from East Africa to Polynesia; edible nuts. Other uses as medicinal; poisons, the later due to saponins in the leaves, branches and fruits; young leaves of some wild spp. eaten cooked as vegetables.

6.12.1 Barringtonia edulis Seem. Fiji.

6.12.2 Barringtonia magnifica Lant., Fiji, Solomons.

6.12.3 Barringtonia novae-hibernae Lant. New Guinea - Solomons, cultivated. An important local food.

6.12.4 Barringtonia procera (Miers) Kunth, New Guinea - Solomons.

6.13 Bouea Anacardiaceae

One species highly variable or 2 - 3, of the Indomalayan region.

6.13.1 Bouea burmanica Grift., MAPRANG. India - Burma - Thailand; wild and cultivated.

6.13.2 Bouea macrophylla Griff., GANDARA. Malaysia - Moluccas, wild and cultivated; varieties recognized on sugar content and resin odour.

6.13.3 Bouea microphylla Griff., PLUM-MANGO. Malaysia; cultivated.

6.14 Buchanania Anacardiaceae

Some 25 species, of the Indomalayan region and tropical Australia;

seeds are collected from wild trees and used as nuts.

6.14.1 Buchanania angustifolia Roxb., India.

6.14.2 Buchanania lancifolia Roxb., India.

6.14.3 Buchanania lanzan Spreng., KALOMPANG, India - Indochina - Thailand - Malaysia; seeds are exported as "almondetees".

6.15 Burckella Sapotaceae

A genus of 11 species, ranging from New Guinea to Samoa.

6.15.1 Burckella obovata (Forst. f.) Pierre, New Guinea - Solomons, cultivated and wild; cultivated in Java.

6.16 Canarium Burseraceae

Around 100 spp. from West Africa to Australia and Polynesia; some 40 species are utilized by the seeds (nuts). Others as sources of elemi and dammar.

6.16.1 Canarium album Rauesch. Chinese Olive. Introduced to tropical America Indochina - S. China; cultivated, the fruits are used as olives. In the following species the useful part are the seeds.

6.16.2 Canarium bengalense Roxb. India - Thailand.

6.16.3 Canarium denticulatum Blume, Thailand - Malaysia - Indonesia.

6.16.4 Canarium denticulatum Blume, Andaman - Burma - Indonesia.

6.16.5 Canarium indicum L. (C. moluccanum, C. mehebetene), cultivated New Guinea - Solomon; introduced to Philippines, Indonesia, Melanesia.

6.16.6 Canarium kerri Craib, Indochina - Thailand.

6.16.7 Canarium ovatum Engler, PIUNUT, Philippines, wild and cultivated; introduced to Malaysia, Micronesia, Melanesia, tropical America. An important and potential source of tropical nuts.

6.16.8 Canarium pilosum Benn. (C. grandiflorum) Malaysia - Fiji, wild, cultivated in Fiji?.

6.16.9 Canarium solomonense R.L. Burtt, New Guinea - Solomon, wild and cultivated.

6.16.10 Canarium sublatum Guill., Thailand - Indochina.

6.16.11 Canarium venosum Craib, Thailand.

6.16.12 Canarium vriesianum Engler, Philippines - Celebes.

6.16.13 Canarium vulgare Leenh. (C. commune), JAVA NUT, Malaysia - Moluccas, wild and cultivated: introduced to the American tropics.

6.17 Clausena Rutaceae

A genus of some 30 Asiatic species.

6.17.1 Clausena dentata (Willd.) Roem., INDIAN WAMPEE, India - Sri Lanka - Burma - Thailand - S. China, wild, cult.?

6.17.2 Clausena lansium (Lour.) Skeels, WAMPEE, S. China - Indochine, wild and cultivated; introduced to most countries in SE Asia and to tropical America.

6.18 Cleistocalyx Myrtaceae

A small genus of SE Asia, segregated by some specialists from Syzygium.

6.18.1 *Cleistocalyx operculatus* (Roxb.) Merril & Perry. India - Burma - Malaysia - Indonesia.

6.19 *Cocos nucifera* L. Palmae

The coconut is often included among the fruits for the edible pulp of the seed or nut. However, variety *saccharina* Miquel, found in several places in Melanesia, has an edible mesocarp, which qualifies the coconut as a fruit species (Barrau, 1962).

6.20 *Corynocarpus* Corynocarpaceae

Two species in Australia and New Guinea.

6.20.1 *Corynocarpus australasica* T.C. White, New Guinea, wild. van Steenis (1951) suggests that the nuts of this species, 2.5 cm long, may be edible as are the nuts of other species in Queensland.

6.21 *Cubilia* Sapindaceae

A monotyp genus, from Philippines, Celebes, Moluccas, used for its seeds.

6.21.1 *Cubilia cubili* (Blanco) Adelb. (*C. blancoi*, *C. rumphi*), same distribution, introduced to Indonesia.

6.22 *Carissa* Apocynaceae

A genus with some 35 spp. distributed from tropical Africa to India. In East Africa other spp. are used as fruits.

6.22.1 Carissa carandas L., KARONDA. India, wild and cultivated; naturalized in Java and Timor.

6.23 Castanopsis Fagaceae

Some 120 spp. in tropical and subtropical Asia, used for the nuts. Several species are found in the Himalayas.

6.23.1 Castanopsis argentata (Blume) DC., Java, wild and cultivated.

6.23.2 Castanopsis argyrophylla King, Thailand.

6.23.3 Castanopsis costata A.DC., Malaysia, wild.

6.23.4 Castanopsis diversifolia King, Thailand.

6.23.5 Castanopsis inermis Benth. & Hook., Malaysia - Sumatra, wild, nuts gathered and sold in markets.

6.23.6 Castanopsis javanica (Blume) DC., Java, wild and occasionally cultivated.

6.23.7 Castanopsis malaccensis Gamble (C. hystrix), Malaysia, wild, nuts sold in markets. Introduced to tropical America.

6.23.8 Castanopsis philippiniensis Vid., Philippines, wild.

6.23.9 Castanopsis wallichi King, Malaysia, wild.

6.24 Castanospermum Papilionaceae

A monotypic genus of NE Australia to New Caledonia. The seeds are eaten roasted or cooked.

6.24.1 Castanospermum australe A. Cunn. Australia - New Caledonia, seeds eaten; planted in other areas as ornamental; introduce to tropical America.

6.25 Citrus and its allies Rutaceae

The genus Citrus in the Swingle classification (Reuther et al., 1967) includes some 17 species native to the Indomalayan region (comprising SE China), and in cultivation extending into temperate central China and Japan. The other true citrus fruits: Clymenia, Eremocitrus, Fortunella, Microcitrus and Poncirus, come from the region also, as well as the Citroids: Atalantia, Burkhillanthus, Hesperethusa, Limnocitrus and Pleiospermun; the exception is Citropsis, from West Africa.

The other group of more distant relations, the Balsamocitroideae or hard-shelled citroids: Aegle, Feronia, Feroniella and Swinglea, are native to the region; the rest: Aegilopsis, Afregle and Balsamocitrus, are also from West Africa.

The importance of the Citroid in relation to the true Citrus rests more in their horticultural value than in their breeding. The citroid supply root stocks of great value, like in the case of Swinglea, for their compatibility and resistance to virus and fungal diseases.

The classification of the commercial species of Citrus is still a matter of debate, with two extreme points of view: Swingle's (1948) and Tanaka's (1954), and some intermediate classification: Hodgson (1965).

The intermediate classification is followed in this list.

6.25.1 Citrus amblycarpa (Hassk.) Ochse, DJEROK - LIMO. Java, cultivated

6.25.2 Citrus aurantifolia (Christm. & Panz.) Swingle, INDIAN LIME. Original area unknown, probably India to Java. Tanaka and Hodgson consider

Citrus latifolia Tan. the TAHITI LIME, a sterile triploid as a separate species. Many cultivars, some hybrids like LEMONINES (aurantifolia x limon) and LIMEQUATS (aurantifolia x Fortunella japonica).

6.25.3 Citrus aurantium L. SOUR ORANGE, BIGARADE. S.E. Asia. Many cultivars, mutants or hybrids. Tanaka and Hodgson consider the CHINOTTO as a separate species C. mystifolia Raf.

6.25.4 Citrus celebica Koord., CELEBES PAPEDA. Wild in Celebes and Philippines; cultivated in Philippines. Some cultivars adscribed to this species such as 'Amapong', 'Alemao' and 'Kubayao', are probably hybrids with allied species: C. macroptera or C. hystrix.

6.25.5 Citrus grandis (L.) Osbeck, PUMMELO. Not known in wild condition, but probably from Malaysia to Indonesia, introduced to S. China. The area of higher diversity is Thailand; in Tahiti some monoembryonic types.

6.25.6 Citrus hystrix DC., MAURITIUS PAPEDA. Sri Lanka, Burma - Malaysia - Java - philippines, wild and cultivated.

6.25.7 Citrus indica Tan., INDIAN WILD ORANGE, India (Eastern Himalayas-Assam), wild.

6.25.8 Citrus latipes (Swingle) Tan. KHASI PAPEDA. India (NE Area, wild).

6.25.9 Citrus limon (L.) Bur., LEMON. Origin unknown. It has been suggested that it may be a hybrid between the citron and other citrus C. limetta Risso, LIMETA, and C. limettioides Tan., SWEET LIME, both cultigens, the first apparently related to C. limon, the second to C. aurantifolia.

6.25.10 Citrus macroptera Montr. Thailand - S. China - Philippines - New Caledonia, wild, quite variable.

6.25.11 Citrus medica L., CITRON. India has been suggested as the original area of the citron, a cultigen known since antiquity. In Malaysia are found some cultivars with a rather thin peel.

6.25.12 Citrus micrantha Wester. Philippines, cultivated and wild.

6.25.13 Citrus reticulata Blanco, MANDARIN ORANGE. SE Asia, Philippines introduced to many tropical regions. Tanaka (1954) and Hodgson (1965) consider Citrus nobilis Loureiro, KING ORANGE, from Indochina, as a different species, while Swingle includes it under C. reticulata.

6.25.14 Citrus sinensis (L.) Osbeck, SWEET ORANGE, Indochina, S. China, maybe Burma. Many cultivars known in their area and other originated in Brasil, Europe, U.S.A.

6.26 Crataeva Capparidaceae

A pantropical genus of some 10 spp.

6.26.1 Crataeva speciosa Volk., Polynesia: Caroline islands, wild and cultivated.

6.27 Cynometra Fabaceae

Some 60 spp. in the Old World tropics.

6.27.1 Cynometra cauliflora L., Malaysia, wild and cultivated; introduced to Indonesia and other countries in tropical Asia.

6.28 Dacryodes — Burseraceae

In the Old World tropics, some 50 spp. closely allied to Canarium. The seeds are used as nuts.

6.28.1 Dacryodes expansa (Rid.) H.J. Lam, Borneo.

6.28.2 Dacryodes macrocarpa (King) H.J. Lam, Borneo.

6.28.3 Dacryodes rostrata (Blume) H.J. Lam, (Canarium kadondon), Malaysia.

6.29 Decaspermum — Myrtaceae

Some 30 spp. in the Indomalayan region.

6.30 Dialium — Leguminosae

In tropical Africa - Madagascar to Malaysia, some 40 spp.; one in tropical America.

6.30.1 Dialium indum L., TAMARIND PLUM. Malaysia, wild and cultivated; introduced to Indonesia, Philippines, etc.

6.31 Dillenia — Dillenaceae

Around 60 spp. in the Old World tropics, from the Mascarene islands to Australia. Most of the following species grow wild and fruits are gathered and eaten in different ways (Hoogsland, 1952).

6.31.1 Dillenia indica L. HONDA-PARA, India - S. China - Borneo, cultivated. Planted as ornamental in tropical and subtropical countries.

6.31.2 Dillenia philippinensis Rolfe, KATMON, Philippines, wild and rarely cultivated.

6.32 Dimocarpus Sapindaceae

Five species, distributed from India - Sri Lanka - Philippines - Borneo (Leenhouts, 1971).

6.32.1 Dimocarpus longan Lour. (Nephelium malaiense Griff., Euphoria cinerea Radlk., E. didyma Auct. not Blanco), LONGAN, Sri Lanka - India - S. China - Philippines - Malaysia; probably introduced to Indonesia and New Guinea; introduced to Florida and the American tropics. A highly variable species, divided by Leenhouts (1971) in two subspecies: longana, the true longan, and malaiense, the mata-kuching, each with several varieties.

6.33 Diospyros Ebenaeae

500 spp. of pantropical and subtropical distribution. In the Indomalayan region supply some fine timbers.

6.33.1 Diospyros embryopteris Pers., India - Thailand - Java, wild and cultivated.

6.33.2 Diospyros kaki L., KAKI, N. India - Japan; cultivated in many other tropical and subtropical countries.

6.33.3 Diospyros philippensis (Desr.) Gurke, (D. discolor Willd.), MABOLO, Philippines; introduced to other countries in SE Asia and to tropical America, several cultivars.

6.34 Diplodiscus Tiliaceae

Some seven species, seeds eaten boiled, of the Indomalayan region.

6.34.1 Diplodiscus paniculatus Turez., BALABO, Philippines (Quisumbing, 1965).

6.35 Diploknema — Sapotaceae

Seven species from India to Malaysia.

6.35.1 Diploknema butyraceae (Roxb.) H.J. Lam, is well known in India as a source of oil or butter from its seeds, and the pulp of the fruit is commonly eaten.

6.36 Dovyalis — Flacourtiaceae

Distributed from Africa to SE Asia, some 30 spp. The correct name is Doryalis.

6.36.1 Doryalis hebecarpa (Gard.) Warb., KETEMBILLA, Sri Lanka; cultivated in Philippines, and India; introduced to the American tropics.

6.37 Dracontomelum — Anacardiaceae

Eight species from Philippines - Malaysia to Fiji.

6.37.1 Dracontomelum dao (Blanco) Merrill & Rolfe, DAO, Philippines, wild. Melanesia, cult.?

6.37.2 Dracontomelum edulis (Blanco) Skeels, LAMIO, Philippines, wild. Melanesia, cult.?

6.38 Durio — Bombacaceae

Some 22 spp. of the Indomalayan region, fruits gathered from several wild species.

6.38.1 Durio kutjensis (Hassk.) Becc., KERAN TONGAN, Borneo - Java - wild and cultivated.

6.38.2 Durio zibethinus Murr., DURIAN, Malaysia - New Guinea - Philippines; wild and cultivated; introduced to other regions in tropical Asia and America.

6.39 Elaeagnus Elaeagnaceae

Some 45 spp., in Europa, Asia and North America.

6.39.1 Elaeagnus philipinensis Perr., ALINGARO, Philippines wild and cultivated; introduced to Florida.

6.40 Elaeocarpus Elaeocarpaceae

Some 200 spp. The berries are rather acid or sour, they are cooked or pickled like olives; other are eaten fresh.

6.40.1 Elaeocarpus floribundus Blume (E. serratus), JALPAI, Sri Lanka - India - Java, cultivated.

6.41 Elateriospermum Euphorbiaceae

A monotypic genus, Thailand - Malaysia.

6.41.1 Elateriospermum tapos Blume, Thailand - Malaysia, seeds eaten as nuts, wild.

6.42 Erioglossum Sapindaceae

A monotypic genus, Malaysia - Indonesia.

6.42.1 Erioglossum rubiginosum (Roxb.) Blume (E. edule Bl.), MERTAJAM, Malaysia - Indonesia, wild and cultivated.

6.43 Feronia — Rutaceae

Monotypic, Sri Lanka - India - Indochina.

6.43.1 Feronia limonia (L.) Swingle, INDIAN WOOD APPLE, native in N. India; cultivated India - Indonesia.

6.44 Finschia — Proteaceae

Some 7 spp., from Palau islands - New Guinea - New Hybrids.

6.44.1 Finschia cloroxantha Diels, New Hebrides - Melanesia, a high quality nut, gathered from wild trees, worth domesticating (Barrau, 1973).

6.45 Flacourtia — Flacourtiaceae

Around 15 spp., from South Africa to Fiji.

6.45.1 Flacourtia indica (Burm. f.) Merrill (F. ramantchi) GOVERNOR'S PLUM. Africa - Polynesia, naturalized and cultivated.

6.45.2 Flacourtia inermis Roxb., LOBI LOBI, India - New Britain, only in cultivation, 2 varieties: inermis, spineless and moluccana, with spines.

45.3 Flacourtia jangomas (Lour.) Raeusch., INDIAN PLUM, India - Borneo - Philippines, only in cultivation.

6.45.4 Flacourtia rukam Zoll. & Mor., RUKAN, Malaysia, wild and cultivated.

6.46 Garcinia — Guttiferae

A genus of some 400 spp., from South Africa to SE Asia.

6.46.1 *Garcinia binucao* (Blanco) Choisy, BINOKAU, Philippines, wild, gathered.

6.46.2 *Garcinia cowa* (Roxb. (G. Kydia), India, wild and cultivated.

6.46.3 *Garcinia dulcis* (Roxb.) Kurz, India - Indonesia, Philippines. Wild and cultivated.

6.46.4 *Garcinia mangostana* L., MANGOSTAN, Possibly native in Borneo; cultivated from India to the Pacific islands and in many other regions of the tropics; narrow variability atributed to apomixis.

6.46.5 *Garcinia vidali* Merrill, Philippines, wild and cultivated.

6.46.6 *Garcinia xanthocymas* Hook. f. (*G. tinctoria*), India - Malaya, wild and cultivated; introduced to the American tropics.

Of the many *Garcinia* spp. utilized in the Indomalayan region by their fruits, three are planted outside the region: i) *G. mangostana*, MANGOSTAN, probably the best of all fruits, known only in cultivation, although it is assumed that *G. sylvestris* Boerl., of Borneo, may be its wild counterpart; ii) *G. dulcis*, of which a variety, *pyriformis*, is cultivated; iii) *G. xanthocymus* (*G. tinctoria*). The fruits of the last two species are prepared in jams or eaten fresh. In the same way, the fully mature fruits are eaten in other less known species, such as *G. hombroniana*, *G. cowa*, *G. prainiana* and *G. macrophylla*, while in *G. atroviridis*, *G. binucao* and *G. indica*, they are used for curries and similar dishes. *Garcinia* spp. are also a source of yellow dye, "gamboge", especially from *G. hanbury*, or for the oil of the seeds, like *G. cowa*.

6.47 Gnetum — Gnetaceae

Pantropical distribution, chiefly in the Indomalayan region; 30 spp.

6.47.1 Gnetum gnemon L., GENEMO. Assam - Philippines - Fiji, in Sumatra and Java only in cultivation. Quite variable.

6.47.2 Gnetum indicum (Lour.) Merrill, KOUAT, Philippines - S. China - Malaysia. Cultivated

6.48 Grewia — Tiliaceae

Around 150 spp., from Africa to Australia.

6.48.1 Grewia asiatica L., PHALSA, India, introduced to many tropical countries.

6.49 Inocarpus — Fabaceae

Four spp., New Guinea - Polynesia; seeds large, eaten cooked or roasted.

6.49.1 Inocarpus fagiferus (Parkinson) Fosberg, (I. edulis), OTAHITI CHESNUT. Malaysia - Polynesia, wild and cultivated, especially important in the Oceanic Islands, introduced to tropical America.

6.50 Jossinia — Myrtaceae

Around 30 spp., from Africa to the Pacific.

6.50.1 Jossinia arnehiana (C.B. Rob.) Merrill, (Syzygium arnehianum), Philippines, wild.

6.51 Juglans — Juglandaceae

A pantropical genus which extends to temperate areas. The following species from the mountains of Indochina are the most common.

6.51.1 Juglans ducloxiana Dode, Indochina, wild and cultivated.

6.51.2 Juglans sinensis Dode, S. China - Indochina, wild and cultivated.

6.52 Lansium Meliaceae

Some 6 spp. of the Indomalayan region.

6.52.1 Lansium domesticum Correa, LANSON, Malaysia (wild) - Thailand - Viet Nam. Introduced to other countries in Asia and to tropical America. Quite variable, some strains apomictic.

6.53 Litchi Sapindaceae

One species, wild and cultivated, from Central China to Indochina.

6.53.1 Litchi chinensis, LYCHEE, SE China - Indochina, wild and cultivated; introduced to most of the tropical countries. Three subspecies are distinguished by Leenhouts (1973); javanensis, Java, only in cultivation; philippinensis, wild in Philippines, introduced to tropical America; chinensis, or mountain lychee, wild and cultivated in China and Indochina. The three subspecies do not seem to intergrade.

6.54 Maba Ebenaceae

Very close to Diospyros, used also for its timber.

6.54.1 Maba major Forst., TONGA, cultivated.

6.55 Macadamia Proteaceae

Around 10 spp. in Madagascar, Celebes, Australia.

6.55.1 Macadamia hildebrandii Steen., Celebes, wild. According to Sleumer (1955) the CELEBES NUT is as palatable as the other species of

Macadamia and probably better adapted to tropical conditions.

6.55.2 Macadamia integrifolia Maiden & Betche, "smooth shell" MACADAMIA, Australia (Queensland) is the most important in cultivation, introduced to many tropical countries, many selected clones.

6.55.3 Macadamia tetraphylla L. Johnson, "rough shell" MACADAMIA, used mainly as a rootstock for the former, but also producing good quality nuts.

6.56 Madhuca Sapotaceae

Some 85 spp., especially concentrated in Indochina - Malaysia. Several species yield edible fruits, but only M. obovatifolia is comparable to other sapotaceous fruits. They yield also oil from the seeds, guttapercha, and the flowers of M. indica Gmel. (M. lati folia) and of M. longifolia Machr. are used in India ("maua flower") for their high sugar content.

6.56.1 Madhuca indica Gmel., (M. latifolia), MOHWA, India, widely cultivated.

6.56.2 Madhuca leeri (Theysm. & Binn.) Merrill, Malaysia - Moluccas - Philippines, wild.

6.57 Mangifera Anarcardiaceae

Around 60 spp., centered in the Indomalayan region, of which 16 are used as fruits.

6.57.1 Mangifera altissima Blanco, PAHUTAN, Philippines, unripe fruits used for pickles, wild and cultivated.

6.57.2 Mangifera caesia Jack, Philippines - Malaysia - Indonesia, wild and cultivated.

6.57.3 Mangifera caloneura Kurz, Thailand, wild and cultivated.

6.57.4 Mangifera cochinchinensis Engler, Indochina (Viet Nam, Kampuchea), wild and cultivated.

6.57.5 Mangifera duperreana Pierre, Viet Nam, wild and cultivated.

6.57.6 Mangifera foetida Lour., BACHANG, Burma - Indochina - Thailand - Indonesia - New Guinea, wild and cultivated, several varieties in cultivation; introduced to the American tropics.

6.57.7 Mangifera indica L. MANGO, wild in most of India - Burma - Thailand - Malaysia - Indonesia - Andamans islands, also cultivated; introduced to the tropics and subtropics of Africa and America. Some 1000 "varieties" in India, seedlings or grafted. In India predominate the monoembrionic races, while in Malaysia and Philippines are more common the nucellar lines. Outside the native region, mango cultivars have been selected, especially in Florida, for size and color, and are quite superior to the original populations. The other species closer to M. indica are M. sylvatica, M. caloneura, M. zeylanica, and other. M. indica is possibly an allopolyploid, for the high number of chromosomes, 2n = 40, of satellites and secondary constricted chromosomes and other cythological characteristics (Mukherjee, 1949), 1950, 1953; Singh, 1960).

6.57.8 Mangifera kemanga Blume, KEMANG, Malaysia, occasionally cultivated and wild.

6.57.9 Mangifera lagenifera Griff., LANJUT, Thailand - Malaysia - Indonesia, wild and cultivated.

6.57.10 Mangifera longipes Griff., Philippines - Malaysia - Indonesia, wild and gathered.

6.57.11 Mangifera oblongifolia Hook. f. Thailand - Indochina - Malaysia, wild, reports on cultivation rather doubtful; fruit gathered and consumed in Viet Nam.

6.57.12 Mangifera odorata Griff., KWINI, Philippines - Indochina - Malaysia - Indonesia, wild and often cultivated, especially in areas too wet for M. indica; introduced to the American tropics.

6.57.13 Mangifera pentandra Hook. f. Malaysia, wild and occasionally cultivated.

6.57.14 Mangifera siamensis Warbg., Thailand, wild and "perhaps cultivated".

6.57.15 Mangifera similis Blume. Indonesia.

6.57.16 Mangifera zeylanica Hook, f. Sri Lanka, wild and cultivated.

6.58 Manilkara Sapotaceae

A pantropical genus, with some 70 spp.

6.58.1 Manilkara hexandra Roxb., KHIRNI, India, wild and cultivated.

6.58.2 Manilkara kauki (L.) Dubard, wild in Thailand, Indonesia - Philippines occasionally cultivated, especially in Java; used to graft Manilkara sp.

6.59 Memecylon Melastomaceae

Some 300 spp. from Africa to Polynesia.

6.59.1 Memecylon coeruleum Jack, India - Malaysia - Philippines, gathered

6.59.2 Memecylon edule Roxb. India - Indonesia (Sumatra), gathered

6.60 Mimusops Sapotaceae

Around 60 spp. mainly in Africa, extends to the Pacific islands.

6.60.1 Mimusops elengi L., MAULSARI, wild and cultivated in India; introduced to Philippines, etc.

6.60.2 Mimusops parvifolia R. Br., Philippines, wild, rarely cultivated.

6.61 Microcos Tiliaceae

An Indomalayan genus with some 50 spp.

6.61.1 Microcos stylocarpus (Warb.) Burret, KAMAULING, Philippines, wild, gathered.

6.62 Musa Musaceae

a) Section EUMUSA (Simmonds, 1962).

6.62.1 Musa acuminata Colla, origin and evident diversity in Malaysia - Indonesia; diploid, wild and cultivated, divided by Simmonds (1962) in several subspecies:

i. banksii, wild, Philippines - New Guinea - Queensland - Samra.

ii. burmannica, wild, S. India - Burma.

iii. microcarpa, wild, Malaysia - Indonesia (Borneo).

iv. siamea, wild, Indochina - N. Malaysia.

<u>NATURAL DISTRIBUTION</u>. 1. Eumusa. 1a. <u>Musa acuminata</u> is centered in the Indochina - Malaysia area, extending to northen Sumatra and Borneo (probably is not native to Java), south China, Philippines - New Guinea - Australia - Samoa. 1b. <u>Musa balbisiana</u> is centered in India and extends to Philippines and New Guinea; it is probably not native in Thailand and in a large part of Indonesia. 1c. The wild diploids: <u>M. cheesmani</u> Simmonds, <u>M. flaviflora</u> Simmonds, <u>M. itinerans</u> Cheesman, <u>M. sikkinensis</u> Kurz, are concentrated in the NE corner of India, Burma and northern Thailand. <u>M. schizocarpa</u> Simmonds, in New Guinea, in an isolated distribution. 2. Australimusa extends from Celebes to Marquesas, importance increases from Fiji eastwards.

<u>CONSERVATION</u>. The situation of genetic resources in <u>Musa</u> is rather different than in other major crops. 1. The development of commercial production occurs outside the area of genetical diversity, and the collections assambled for breeding purposes are affected by difficulties in germplasm transportation (both seeds or vegetative material) and quarantine. Also the plantation system does not encourage the maintenance of somatic mutations, therefore ourtailing secondary diversity. 2. There have been very few collecting expeditions to the region= Simmonds: 1954; Allen and Ochse: 1959; and more recently some sponsored by IBPGR= Indonesia, (Valmayor, 1979); Malaysia Thailand (Valmayor, 1979a); Molucca (Nasution, 1982). Important areas still to collect are Burma and Viet Nam. 3. There are many difficulties in the identification of materials, as they are based mainly on common names (Simmonds, 1959; Allen, 1965). The descriptive work on varieties covers only specific areas:

Philippines (Teodor, 1915; Quisumbing, 1919); Sri Lanka (Chandraratna & Nanayakara, 1951); India (Dutta, 1952; Jacob, 1952). 4. The collections have been established by private companies or restricted programs. No effort has been done to duplicate them; losses due to diseases are common. Information, even lists of the collections, have not been published. The main collections are in Honduras, 510 accessions; Jamaica, 120; Indonesia, 120; Malaysia, 110; Papua - New Guinea, 100; Philippines, 70; India, 50. The germplasm situation of bananas was reviewed by an IBPGR panel (IBPGR, 1978a), which made recommendations on exploration, maintenance and documentation.

6.62.2 Musa balbisiana Colla, origen and center of diversity in India, wild in India - Burma; cultivated in all countries of SE Asia, and the tropics of Africa and America.

Hybrids of acuminata (A) x balbisiana (B) constitute the majority of the cultivated bananas and plantains: i) diploid, AB, 'Ney-poovan'; ii) triploids of AAB genome, most of the "plantains"; iii) triploids of ABB genome, 'Bluggoe'; iv) tetroploid, ABBB, 'Tiparot'.

b) Section Australimusa

6.62.3 Musa trogloditarum L., diploid.

6.62.4 Musa fehi Bert., diploid.

6.62.5 Musa aiori Sagot, diploid.

These species, called the "Fehi" bananas, include wild and cultivated populations, apparently originating in New Guinea,but more economically important in Plynesia (McDaniels, 1947).

6.62.6 Musa discolor Horaninow, Loyalty islands, cultivated.

6.63. Nephelium Sapindaceae

Some 30 spp. from Burma to Malaysia and Philippines.

6.63.1 Nephelium eripetalum Miqu., Malaysia - Indonesia (Sumatra), wild and cultivated.

6.63.2 Nepehelium glabrum Noranhoa, Malaysia, wild, fruits gathered.

6.63.3 Nephelium lappaceum L., RAMBUTAN, possibly native to Malaysia, introduced to Indonesia, Africa and tropical America; many varieties known in cultivation.

6.63.4 Nephelium mutabile Blume, PULASAN, wild and cultivated in Philippines;

introduced to Malaysia, Indonesia and the American tropics; many different varieties.

6.64 Otophora — Sapindaceae

Around 30 spp., from Philippines to Indochina and Malaysia.

6.64.1 Otophora alata Blume, BUMBING-CHINA, Indonesia, wild and cultivated (Java).

6.64.2 Otophora cambodiana Pierre, CHAMMALIANG Thailand, wild and cultivated.

6.64.3 Otophora fruticosa Blume, Philippines, wild, gathered for the seeds.

6.65 Palaquium — Sapotaceae

Some 120 spp. from Formosa, SE Asia to the Solomon islands; important as a source of gutta. The four species produce edible fruits, but only one is cultivated for that purpose.

6.65.1 Palaquium burckei H. J. Lam, Malaysia.

6.65.2 Palaquium macrocarpum Burck, Malaysia.

6.65.3 Palaquium philippinense (Perry) C.B. Rob., ALAKO, Philippines, wild and cultivated.

6.65.4 Palaquium rostratum (Miqu.) Burck, Malaysia - Indonesia.

6.66 Pandanus — Pandanaceae

Some 600 spp. in the tropics of Africa to Oceania; used mainly for mats, but the following have edible fruits or seeds, eaten fresh or cooked. The pulp is high in provitamin A.

6.69.1 Phyllanthus acidus (L.) Skeels (P. distichus, Cicca acida) OTAHEITI BERRY, area of origen unknown, although it has been reported as wild in Philippines; cultivated from India - Polynesia, introduced to tropical Africa and America.

6.69.2 Phyllanthus emblica L. (Emblica officinalis), MYROBALAN, India - Timor; introduced to other tropical regions, apparently quite variable.

6.70 Pometia Sapindaceae

Five species in the Indomalayan region.

6.70.1 Pometia pinnata J.R. & G. Forst., BANGKONG, India - Polynesia, wild and cultivated; varieties in Polynesia selected for larger fruits, superior to the SE Asian types.

6.71 Rhodomyrtus Myrtaceae

Six species, SE Asia to Australia.

6.71.1 Rhodomyrtus tomentosa (W. Ait.) Hassk., India - Malaysia, wild and cultivated; introduced to the American tropics.

7.72 Rubus Rosaceae

220 species, mostly in Eurasia and North America, frequent in the tropics in the highlands.

6.72.1 Rubus albescens Roxb., MYSORE RASPBERRY, cultivated in India - Sri Lanka - Malaysia - Indonesia; introduced to tropical America.

6.72.2 Rubus rosaefolius Sm., SE Asia, cultivated, introduced to tropical America, Europe. In the mountains of India, Philippines and Indonesia several wild species are reported to have fruits of good quality. Among them R. copelandi Merrill, R. ellipticus Sm., R. elmeri Fock., R. fraxinifolius Poir., R. moluccanus L., R. niveus Thunb., R. pectinellus Maxim, R. rolfei Vidal.

6.73 Salacia Hippocrataceae

A tropical genus of around 100 spp., some utilized, not cultivated, for their fruit.

6.73.1 Salacia macrophylla Blume (S. flavescens), India - Thailand - Malaysia Java.

6.73.2 Salacia grandiflora Karz, Malaysia.

6.74. Sandoricum Meliaceae

Around six species, from Mauritius to Indonesia.

6.74.1 Sandoricum koetkape (Burm., f.) Merrill, (Sandoricum indicum), SENTUL, Philippines - Malaysia - Indochina, wild and cultivated, introduced to other tropical regions in Asia and to tropical America.

6.75 Salacca Palmae

A palm genus of six species from India to Indonesia, some with sweet or sour fruits.

6.75.1 Salacca zalacca (Gaerth.) Voss. (S. edulis)., Malaysia - Indonesia, widely cultivated, superior varieties in Bali.

6.76 Semecarpus — Anacardiaceae

Around 40 spp. in the Indomalayan region. Two wild Philippinean spp. used for the peduncle or "apples", like the cashew.

6.76.1 Semecarpus cuneiformis Blanco, Philippines.

6.76.2 Semecarpus gigantifolia Vidal, Philippines.

6.77 Sonneratia — Sonneratiaceae

A genus of six spp. of mangroves in SE Asia; fruits are gathered.

6.77.1 Sonneratia acida L. f.

6.77.2 Sonneratia caseolaris (L. f.) Engl.

6.78 Spondias — Anacardiaceae

A pantropical genus of six species, two in the Indomalayan region.

6.78.1 Spondias cytherea Sonn., OTAHEITI APPLE, area of origin unknown, probably Polynesia; widely cultivated in all tropical regions.

6.78.2 Spondias pinnata (L.) Kurz, LIBAS, India - Philippines - Moluccas, cultivated and wild.

6.79 Stelechocarpus — Annonaceae

Around 4 spp. in Malaysia with edible fruits.

6.79.1 Stelechocarpus burahol (Blume) Hook. f. & Thomas, KEPEL, Indonesia (Java - Borneo); introduced to other parts of SE Asia, tropical America, Florida.

6.80 Sterculia Sterculiaceae

A widely spread genus of tropical trees; seeds used as nuts or to extract oil.

6.80.1 Sterculia foetida L., Africa - Australia, incipient cultivation.

6.80.2 Sterculia oblongata R. Br., Philippines, wild, nuts of good quality.

6.80.3 Sterculia monosperma Vent., South China, cultivated in Java.

6.80.4 Sterculia shillinglawi F. Müell., Solomon islands, cultivated (Yen, 1974).

6.80.5 Sterculia novae-hibernae Laut., New Gyinea - Solomon islands, cultivated.

6.81 Syzygium Myrtaceae

An Old World genus with some 140 spp., (sometimes included in Eugenia).

6.81.1 Syzygium acqueum (Burm. f.) Alston, JAMBUAYER, wild and cultivated S. India - Malaysia; introduced to other countries in SE Asia and to tropical America.

6.81.2 Syzygium bankense (Hassk.) Merry & Perry, Indonesia, wild and cultivated in Java.

6.81.3 Sizygium calubcob (C.A. Rob) Merrill, KALAKUB, Philippines, wild and rarely cultivated.

6.81.4 Syzygium claviflorum (Roxb.) Wall., KARA, India - Philippines - Malaysia, wild and rarely cultivated.

6.81.5 Syzygium cummini (L.) Skeels, JAMBOLAN, wild and cultivated India - Malaysia - Philippines; introduced to tropical and subtropical countries in Africa and America; several varieties, seedless types known in Java and Philippines.

6.81.6 Syzygium currani (C.A. Rob.) Merrill, LIPOTE, wild and cultivated in Philippines, fruits acid used for jellies.

6.81.7 Sizygium jambos (L.) Alston, ROSE APPLE, an ancient cultigen known from India to Malaysia; introduced as fruit and ornamental to the tropics of Africa and America; polyembrionic.

6.81.8 Syzygium javanicum Miq., MALAY APPLE, India - Indonesia, widely and sparsely cultivated in the Old and New World tropics; several varieties.

6.81.9 Syzygium manaquil Blanco, Philippines, wild, fruits with good flavour.

6.81.10 Syzygium malaccense (L.) Merry & Perry, MALAY APPLE, native area unknown, cultivated all over the wet areas of the Indomalayan region; introduced to tropical Africa and America.

6.81.11 Syzygium mappaceum (Korth.) Mans.,India - Indochina - Borneo, wild and cultivated.

6.81.12 Syzygium polyanthum (Wight) Walp., SALAM, Malaysia; cultivated in Java.

6.81.13 Syzygium polycephalum (Miq.) Merry & Perry, Malaysia - Indonesia, wild and cultivated.

6,81.14 Syzygium samarangense (Blanco) Merry & Perry, MAKOPA, Thailand - Philippines, wild and cultivated, several varieties.

6.82 Terminalia Combretaceae

A pantropical genus with 250 spp.; some fruits are used for dyening and tanning (myrobalans), other for their seeds (nuts).

6.82.1 Terminalia catappa L. INDIAN ALMOND, Native from Malaysia - Polynesia, cultivated in almost all the tropical countries as shade tree.

6.82.2 Terminalia edulis Blanco, DALINSA, Philippines - Indonesia (Celebes), the fruits used as olives.

6.82.3 Terminalia kaernbachi Warb., OKARI NUT, New Guinea - Moluccas - Solomons, cultivated introduced to Florida.

6.83 Tetrastigma Vitaceae

Some 90 spp. in SE Asia.

6.83.1 Tetrastigma harmandi Planch., cultivated in Philippines

6.84 Uvaria Annonaceae

150 spp., from Africa - Madagascar to Australia, several spp. utilized for the fruits.

6.84.1 Uvaria ruffa Blume, Philippines - Malaysia, wild, cultivated in Philippines.

6.85 Vaccinium Ericaceae

Some 400 spp. of the mountains in tropical America, Asia, Oceania; many species gathered for their fruits.

6.86 Xerospermum Sapindaceae

Some eight species in SE Asia - Indonesia, closely allied to Nephelium.

6.86.1 Xerospermum naranhianum (Blume) Blume, wild and cultivated in Indonesia.

6.87 Ziziphus Rhamnaceae

A pantropic genus of dry and semidry areas, with around 40 spp.

6.87.1 *Ziziphus jujuba* Lam., JUJUBE, India - China - Indonesia, wild (in India) and cultivated; introduced to most of the other tropical areas.

7. GRAIN LEGUMES Leguminosae/Fabaceae

7.1 Cajanus

2 species, one probably Indian, the other in Africa.

7.1.1 Cajanus cajan (L.) Millsps., PIGEON PEA

India is the richest area in the world in the old land races, grouped in: a) "ashar", or var. bicolor, mostly perennials, the yellow flower with purple streaks, dark colored pods with 4-5 seeds. b) "tur", var. flavus, annuals, flower yellow, pod greenish with 2-3 seeds. A wide polymorphism in shape and height of the plants in the two groups. From India also advanced cultivars and genetic stocks.

The relation between Cajanus and Atylosia is not yet completely established. De (1974) suggests, on morphological and cytogenetical evidence, that they cannot be separated. If so, the numerous species of Atylosia, to which India is the center of diversity, should be included in the genetic resources of C. cajan. Oza (1973) and van der Maesen (1980) have accumulated enough evidence to support the Indian origin of C. cajan, and to explain its biological relation to Atylosia.

7.2 Cicer

This genus originates outside the Indomalayan region; however, one species has a long history of cultivation in India.

7.2.1 Cicer arietinum L., GRAM.

As the most important pulse crop in the subcontinent, selection has been done in different states for yield, resistance, packing characteristics, etc. Several advanced cultivars have been released

(Kachrdo & Alif, 1970) and new mutants have been established. Although Cicer arietinum has been adscribed to the "Indian center", it is more likely an early introduction from West Asia, through Iran - Afganistan - Pakistan or through Arabia. In India, the large seeded type, "kabula", seems to be a more recent introduction than then small seeded "Desi" type. The crop species may originate from C. reticulatum L., which grows wild in SE Anatolia (Auchland & Singh, 1977). In North India are found some wild species of Cicer, apparently not related to C. arietinum.

7.3 Cyamopsis

3-4 species from Africa. C. tetragonoloba was probably an early introduction to India (Hymnowitz, 1972).

7.3.1 Cyamopsis tetragonoloba (L.) Taub., GUAR

The largest number of land races are found in India, selected for fodder, as vegetable or for the gum in the seeds. Some advanced cultivars (Sing & Mita, 1970).

7.4 Glycine

A genus with numerous species from tropical Africa to China and Manchuria, mostly used as fodder.

7.4.1 Glycine max (L.) Merr., SOY BEAN

On the soybean in SE Asia, Burkill (1935) writes: "Man has brought the plant southwards, and among the cultivated races has found some to grow under conditions much more tropical than the wild plant supports, but none which are absolutely tropical". In India are found old land races with flattened seeds. In Viet Nam, Thailand and Malasia, is used mostly as a green legume. New cultivars in Thailand and Indonesia are the result of hybridization with introductions from USA, Australia and East Asia, selected mainly for oil content.

7.5 Lathyrus

Some 130 spp., mainly from temperate areas. One grown in India.

7.5.1 Lathyrus sativus L., KHESARI.

According to de Candolle (1883), L. sativus is native from the Caucassus to N. India. Cultivated at present in India as a poor man's legume, all over the country. Many land races and a few improved cultivars. Seed poisoning, lathyrism, restricts a wider use.

7.6 Psophocarpus tetragonolobus (L.) DC.

See under Root and Tubers.

7.7 Vigna

Some 100-150 species in Africa and Asia. According to Jain and Mehra (1980) six species are cultivated in Asia, especially in India. One of them, Vigna angularis (Willd.) Ohur & Ohashi, is an extratropical species, with its center of diversity in Japan, and in the Indomalayan region is cultivated in small amount only in N. India.

7.7.1 Vigna aconitifolia (Jacq.) Marechal, MOTH, MAT.

Wild populations in Sri Lanka - India; cultivated as a pulse crop only in India, also for fodder. Many land races and a few modern cultivars (Kachroo, 1970).

7.7.2 Vigna mungo (L.) Hepper, URD, BLACK GRAM.

Cultivated originally only in India; many land races and selected cultivars.

7.7.3 Vigna radiata (L.) Wilcz. MUNG, GREEN GRAM.

The most important native pulse crop in India; wild populations, many land races and improved varieties (Kachroo, 1970).

The status of germplasm resources in the last four crops, is presented by Singh (1973) for India.

7.7.4 Vigna trilobata (L.) Verd., PILLIPESARA

Cultivated mainly as a fodder crop in S. India.

7.7.5 Vigna umbellata (Thunb.) Ohwi & Ohashi, RICE BEAN.

India; quite variable, with many land races and a few selections. Widely grown in other tropical regions as a cover crop. It has been reported under different names: Phaseolus calcaratus Roxb., P. riccardianus Wall., P. pubescens Blume, etc.

7.7.6 Vigna unguiculata (L.) Walp. COWPEA

An early introduction from Africa to India, with three groups of varieties, probably of local origin: i) unguiculata, the common cowpea; ii) cylindrica or catjang (fodder, green pods and of minimum importance as pulse (Steele & Mehra, 1980); iii) sesquipedalis, or "asparagus bean", probably by mutation in cylindrica. Of the three groups and intermediates, many land races are known. In India some 680 lines are maintained at NBGR, and several improved varieties have been released for seed, vegetable or fodder production (Smithson, Redden & Rawal, 1980).

8. GUTTA PERCHA

Several trees, especially in the Sapotaceae, furnish a resin which was used in the industry, and which has been replaced for the largest part of the commercial consumption, by synthethic products. However, small quantities are exported, a good part of them from cultivated plants.

8.1 Ganua — Sapotaceae

Some 6 spp in Malaysia.

8.1.1 Ganua motleyana Pierre, Malaysia - Sumatra - Borneo, yields a low quality gutta.

8.1.2 Ganua pallida H.J. Lam, Malaysia - Sumatra, is a source of second class gutta.

8.2 Palaquium — Sapotaceae

An Indomalayan genus with around 65 spp.

8.2.1 Palaquium gutta (Hook. fr.) Baill. Sapotaceae, GUTTA, Malaysia - Borneo, now only in cultivation in Java; is the best source of gutta.

8.2.2 Palaquium leicarpum Boerlage, HANGKANG, Borneo - Celebes, produces an inferior kind of gutta, sometimes exported from Borneo.

8.2.3 Palaquium maingayi King & Gamble, Malaysia.

8.2.4 Palaquium obovatum (Griff.) Engl., India - Philippines - Borneo, a source of good quality gutta.

8.3 Payena Sapotaceae

Some 10 spp. in Philippines - Indonesia

8.3.1 Payena leeri (Teysm. & Binn.) Kurz. Philippines - Burma

Malaysia, cultivated in Java.

9. INSECTICIDES

9.1 <u>Derris</u> Papilionaceae

Some 50 spp. in the Old World tropics, in some species the roots contain an insecticidal substance, rotenone.

9.1.1 <u>Derris elliptica</u> (Roxb.) Benth., Philippines - Indochina - Burma - Malaysia - Indonesia - New Guinea, probably originating in Thailand. Several clones in cultivation, selected in Malaysia and Indonesia.

9.1.2 <u>Derris malaccensis</u> Prain, Malaysia - Borneo, cultivated experimentally only. Other spp. reported with some rotenone content, not cultivated: <u>D. elegans</u> Benth., Malaysia - Borneo; <u>D. scandens</u> Benth, Thailand - Australia; <u>D. thyrsiflora</u> Benth., Thailand - Malaysia.

10. MASTICATORIES

10.1 Areca — Palmae

A palm genus of some 20 spp., from India to Polynesia.

10.1.1 Areca catechu L. BETEL PALM India - S. China - Philippines - Fiji. Nuts used with Piper betle leaves and lime, as a masticatory for its stimulant properties. Many varieties known, especially in India, where it is an important crop.

10.2 Piper — Piperaceae

A pantropical genus with some 700 spp., some used as spices, medicine, etc.

10.2.1 Piper betel L., India - Malaysia - Philippines, used for its leaves which are added to slices of Areca catechu nuts and lime, to prepare a masticatory.

10.2.2 Piper methysticum Forster, KAVA, New Guinea - Frech Polynesia. Roots, dry and pulverized, or fresh and mashed, yield an intoxicating beverage.

10.3 Uncaria — Rubiaceae

Some 35 spp. in the Old World tropics.

10.3.1 Uncaria gambier (Hunter) Roxb., GAMBIR, wild and cultivated India - Malaysia - Indonesia (Borneo), leaves used to prepare a masticatory with betel,; is also an important source of tanning material.

11. OIL CROPS

11.1 Aleurites — Euphorbiaceae

A genus of six species of SE Asia and S. China. The following three species are utilized by the oil contained in the seeds.

11.1.1 Aleurites moluccana Willd. CANDLE NUT TREE, Native to Malaysia (?), from where it spread to India and the Pacific, oil of low commercial value.

11.1.2 Aleurites montana (Lour.) E.H. Wilson, TUNG, China (South of 25°N), Viet Nam, Laos, Burma, wild and cultivated; introduced to Malaysia, Indonesia, Malaui, Brasil, Florida, etc., extremely variable, hybrids with A. tardi.

11.1.3 Aleurites trisperma Blanco, BANUCALAG, Philippines, wild and cultivated.

11.2 Camellia — Theaceae

Around 8 spp. in the tropics and subtropics of SE Asia; tea, ornamentals.

11.2.1 Camellia oleifera Abel., according to Sealy (1958) cultivated in Indochina to extract "tea oil".

11.3 Cananga — Annonaceae

Three species from India to Australia.

11.3.1 Cananga odorata (Lam.) Hook f., YLANG-YLANG, India - Burma - Philipines - Polynesia, wild and cultivated for the flowers, source of an essencial oil; introduced to most tropical areas as ornamental and for the fragance of the flowers.

11.4 Cocos Palmacea

A monotypic genus, originating in SE Asia,which spread probably by natural agents in prehistoric times to the Pacific coast of Central America.

Cocos nucifera L., COCONUT, is possibly the most useful plant of the Indomalayan - Pacific region, as a source of oil, or fruits, vegetable, beverage, building materials, ornamental. Not known in wild state. According to Harries (1978), two main groups of populations: the basic population a) Niu-kafa has long, angular, thick-husked fruits; b) Niu-vai selected by man from the former, has fruits more or less spherical, whit a thin husk and a large amount of liquid endosperm. The population cultivated in Asia and Oceania result of the introgression of the two main types, plus the effect of isolation and cultural selection.

Conservation: A special committee sponsored by IBPGR (1978) has indicated the inadequacy of the existing collections as representatives of the species diversity and as a base for breeding programs. It has also urged to collect more germplasm, especially in Oceania. National or regional collections are kept in India (56 stocks), Sri Lanka, Philippines; Indonesia. Other collections in the region are in the Brithish Solomon Islands, Fiji, Popua-New Guinea et Port Moresby, and Malaysia, at Kuala Lampur. Outside the region, the two most important are in Jamaica and Ivory Coast. The collection at the experiment station of IRHO at Port Bouet, Ivory Coast, includer some 45 stocks; it has duplicate collections in French Oceania. The problem in establishing large regional or world wide collections, is limited by a) quarantine regulations, as most diseases have a regional distribution; b) The size of seeds and c) the large space required to maintain proper samples of the populations. Tissue culture may be helpful in solving some of these problems. Coconut diversity is mainly the result of long isolation, which led to the development of distinct populations. The isolation is due to a large extent to the natural spread into isolated islands or continental areas, not only in the SE Asian region, from India to Polynesia, but also in the Pacific coast of Central America and West Africa. These popylations are recognized with varietal names: 'San Ramon','Rennele', 'Tahiti', and divided in "tall" and "dwarf" types. The last are mutants from Malaya and Philippines, of considerable value in breeding. The problems of saving the genetic diversity threatened by diseases and other factors of genetic erosion, are of special concern to breeders, and their efforts are aimed towards the collecting and exchange of germplasm. Here is an opinion "Breeders felt that a great deal reamins to be done as regards establishing and/or expanding genetic resources. There exists a great genetic variability in Southeast Asia, which needs to be explored and collected using IBPGR approved descriptors. Collections are already established in many countries, but introduction and exchange have not been vigorously purpused. While interest for introduction and/or exchange is common, existing quarantine regulations render progress rather difficult. Seedgardens are established in various countries using different seed production techniques. Some gardens are planted mainly with local materials and others use introduced ones. Seedgardens in some countries are in the process of producing PB 121... Despite efforts to promote cooperation on matters related to breeding research, in general, at this stage, the level of cooperation is rather minimal. It is apparent that there is a fairly good amount of technological breakthrough which could be exploited through international cooperation among coconut producing countries". (Baliñgasa, E.N. FAO Year. Prog. Rep. Coconut Res. 1979, p.2-3).

11.5 Cymbopogon Gramineae

A genus of some 60 spp., most of them of the savannas if Africa; in SE Asia several species are utilized for the essential oil of the leaves; clonal multiplication is the rule.

11.5.1 Cymbopogon citratus (DC.) Stapf, LEMON GRASS, known only in cultivation, originating probably in Malaysia. Few clones, introduced to India, Africa, tropical America.

11.5.2 Cymbopogon flexuosus (Nees) W. Wats., MALABAR GRASS, India, cultivated in Indonesia, Viet Nam, etc., one of the sources of "lemon grass oil".

11.5.3 Cymbopogon martini (Roxb.) W. Wats., PALMAROSA GRASS, India. A variety, 'Motia,' introduced to Indonesia, is the most important source. Other variety, 'Sofia', is not cultivated any more.

11.5.4 Cymbopogon nardus (L.) Rendle, CITRONELLA GRASS, possibly originated in Sri Lanka; cultivated in SE Asia, Central America, etc. C. confertiflorus, a wild species in Sri Lanka, is its closest ally.

11.5.5 Cymbopogon winteranus Jowitt, JAVA CITRONELLE, Sri Lanka, cultivated especially in Java, by some authors included under C. nardus.

11.6 Madhuca Sapotaceae

Several species of this genus are utilized for the fruits and the oil contained in the seeds.

11.6.1 Madhuca indica Gmel. (M. latifolia), MOWRA, Indica, cultivated.

11.6.2 Madhuca longifolia (L.) Macbr., India - Sri Lanka.

11.7 Michelia Annonaceae

25 spp. in China - SE Asia.

11.7.1 Michelia champaca L., India, oil in flowers, extracted to be used in perfumery.

11.7.2 Michelia alba DC., Philippines, Java, cultivated, same use.

11.8 Mesua Guttiferae

Three species in SE Asia.

11.8.1 Mesua ferrea L. India, the oil in the flowers is extracted for perfume.

11.9 Pogostemon — Labiatae

An Indomalayan genus of 35 spp., several used for the essential oils contained in the leaves.

11.9.1 Pogostemon cablin (Blanco) Benth., PATCHOULI, India - Philippines, Malaysia - Indonesia, cultivated.

11.9.2 Pogostemon heyneanus Benth., INDIAN PATCHOULI, India - Philippines - Malaysia - Indochina, cultivated. In these two species, clonal cultivars have been established.

11.9.3 Pogostemon hortense Backer, cultivated in Java, probably a variant of one of the species mentioned above.

11.10 Shorea, ILLIPE NUTS — Diptereocarpaceae

A SE Asian genus of around 150 spp., very valuable as timber trees, and also used for the seeds which contain fat used in Europe in the confectionery industry, cosmetics, etc., are exported in large quantities from Borneo especially. Shorea nut production has been considered as an agricultural operation, as a complementary product to timber (Anderson, 1975). Some 11 species are the main source of illipe nuts. The most important are the following:

11.10.1 Shorea macrophylla (De Vr.) Ashton, Borneo, wild and cultivated as a timber tree, is the most important species in the export supply of nuts.

11.10.2 Shorea pinanga Scheff., Borneo, wild and cultivated.

11.10.3 Shorea stenoptera Burck, Borneo, wild and cultivated.

11.11 Vernonia — Compositae

A pantropical genus of around 650 spp.

11.11.1 Vernonia antihelminthica Willd., India - Burma; for its seeds containing fatty acids has received some attention in the USA.

11.12 Vetiveria — Gramineae

A grass genus of eight species, all in SE Asia.

11.12.1 Vetiveria zizanioides (L.) Nash, VETIVER, India, cultivated in Indonesia, tropical Africa, etc. for the oil contained in the roots.

12. PASTURES

The Asiatic tropics are an unimportant source of cultivated pastures, in both grasses and legumes. No one of them has the worldwide importance of the African spps., such as Digitaria, Panicum and other, or like the American species of Paspalum. However, considerable effort is done in India to intensify the use of the native grasses in the improvement of pasture lands. In grasses, hardly one third of the species in India is considered to have some value as forage plants (Bor, 1960). The most important among the tropical species are concentrated in the Western Ghats.

In legumes, there is also a high number of species of potential use (Mehra & Magoon, 1974), but few of them are intensively utilized.

A. Grasses — Gramineae

12A.1. Apluda mutica L., BHANJURA, India - Malaysia - Australia.

12A.2. Botriochloa pertusa (L.) A. Camus, JAREWA, Used as a fodder grass in central India and Sri Lanka.

12A.3 Dichanthium annulatum (Forsk.) Stapf., GORIA, India, introduced to North America.

12A.4 Eriochloa procera (Retz.) C.A. Hubb., Sri Lanka.

12A.5 Ischaemum timorense Kunth, India - Timor. RATTAN GRASS, introduced to tropical America; quite variable, perhaps only a variant of I. indicum.

12A.6 Iseilema laxum Hack., MUSEL, considered as one of the best fodder grasses in India and Sri Lanka.

12A.7 Panicum antidotale Retz., according to Whyte (1964), native of NE India, is planted in tropical areas of America.

B Legumes

12B.1 Alysicarpus vaginalis (L.) DC. India - Philippines - Malaysia - Indonesia, introduced to tropical America, its cultivation is practically abandoned.

12B.2 Desmodium sandwicense F. Meyer, Hawaii and other Pacific islands, in cultivation trial in Australia and elsewhere. It seems to be an early introduction from South America.

12B.3 Macrotyloma uniflorum (Lam.) Verdc. (Dolichos biflorus), HORSE GRAM, especially important as a fodder crop; several land races and a few "improved cultivars".

12B.4 Melilotus indica (L.) All., SENJI, India, wild and cultivated; introduced to USA.

13. RATTANS

The continuous exploitation of rattan for furniture is based almost completely on the wild stands, and only four species are in cultivation. This has led to a depletion in natural stands, particularly in certain species and to urgent needs of conservation (Dransfield, 1981). The richest genera are Calamus, 370 spp. Daemonorops, 115 spp., India - New Guinea; Korthalsia, 29 spp., Burma - New Guinea; Platocomia, 16 spp. India - Borneo (IDRC, 1980).

13.1 Calamus caesium Blume, wild in Malaysia - Borneo, where it is also cultivated.

13.2 Calamus manan Miqu., Malaysia - Borneo, cultivated.

13.3 Calamus minahassae Warb., Celebes, cultivated.

13.4 Calamus trachycoleus Becc., Borneo, cultivated.

14. ROOTS AND TUBERS

(Ochse, 1931; Herklots, 1972; Sastradradja et al, 1981a)

14.1 Alocasia — Araceae

An Asian genus of 36 spp., several cultivated for the edible corms.

14.1.1 Alocasia cucullata Schott, India - Sri Lanka,

14.1.2 Alocasia macrorhiza (L.) G. Don. (A. indica), GIANT TARO, India - Polynesia, many clones, especially in Samoa.

14.2 Amorphophallus — Araceae

90 species in S. Asia to Polynesia; 3 species cultivated

14.2.1 Amorphophallus campanulatus (Roxb.) Blume. India - Polynesia, native area unknown; its cultivation decreasing due to low yields and difficulties to prepare as food.

14.2.2 Amorphophallus harmandi Engl. & Gehr., Indochina.

14.2.3 Amorphophallus rivieri Dur., Philippines - Indochina.

Coleus parviflorus Benth., RATALA, India; cultivated also in Indonesia, is probably and old introduction from Africa (Burkill, 1935).

14.3 Colocasia — Araceae

Eight species in SE Asia, one widely cultivated.

14.3.1 Colocasia esculenta (L.) Schott & Endl. (C. antiquorum), TARO, India - Polynesia; many clones probably hundreds, in cultivation. Two cytological groups, one with 2n=28 predominates in India, Japan, Polynesia; other with 2n=42, in India, New Zealand and Philippines; introduced early to Egypt and the Mediterranean islands,and after the Discovery to Africa and the New World.

14.4 Cordyline — Agavaceae

In Asia, Oceania and Australia, 15 spp. some ornamental, other used for leaf fibers, one for the edible roots.

14.4.1 Cordyline terminalis (L.) Kunth, SE Asia - Australia - Hawaii; cultivated in the Cook islands, for the roots which have a high sugar content.

14.5 Curcuma — Zingiberaceae

An Indomalayan genus of around 55 spp., some used as spices, the following for the starchy roots.

14.1 Curcuma aeruginosa Roxb. Burma; cultived in Indonesia, for the starch obtained from the rhizomes.

14.2 Curcuma angustifolia Borxb., EAST INDIAN ARROWROOT, India, cultivated; the fleshy roots yield a special kind of starch. Other spp. in India: C. aromatica Salisb., C. leurcorhiza Roxb., C. montana Roscoe, C. rubescens Roxb., and in Viet Nam: C. pierreana Gagn., are also used for the same purpose; most of the product in obtained from wild plants.

14.6 Cyrtosperma — Araceae

In the tropics of Asia and Oceania around 11 species.

14.6.1 *Cyrtosperma chamissonis* (Schott) Merrill (*C. edule*, *C. merkusi*), GIANT SWAMP TARO, possibly native to Indonesia; cultivated in Philippines, New Guinea, Polynesia, of special importance in certain islands of Micronesia, where several varieties are known (Barrau, 1961; Plucknett, 1967; Thompson, 1982).

14.7 *Dioscorea* Dioscoreaceae

A large genus of some 600 spp., mostly in the tropics, with species domesticated independently in Africa, Asia and America.

14.7.1 *Dioscorea alata* L., GREATER YAM. According to Burkill (1951) this species originated where its closest allies, *D. hamiltoni* and *D. persimilis*, still grow wild: the area between Burma and Indochina where the three big rivers, Irrawady, Salween and Mekong, rum parallel (20°- 25°N). Alexander and Coursey (1969) tend to support this assumption, while Martin(1976) suggest that *D. alata* may originate somewhere in the region between Burma and New Guinea, perhaps domesticated in different places. The higher variability is found in Indochina - Indonesia - New Guinea. The number of cultivars may vary between 200 - 300. The genetic erosion in this species is probably higher than in other yams, as it is replaced in cultivation by other *Dioscorea* or other tuber crops (Burkill, 1951). Several attempts have been done to classify the interspecific variability (Martin & Rhodes, 1977). Ploidy: 2n=40,60 or 80 (Abraham *et al*, 1976).

14.7.2 Dioscorea bulbifera L., India - Polynesia, wild and cultivated; also in East Africa, the two domestication centers apparently independent (Martin, 1974). The Asiatic types have rounded bulbils and are less acrid than the African. The cultivars have been classified by Burkill (1951) in var. suavior, whith dark brown, warted bulbils, and var. sativa, with smooth bulbils.

14.7.3 Dioscorea cummingii Burkill, Philippines, wild and cultivated, perhaps also in Polynesia.

14.7.4 Dioscorea esculenta (Lour.) Burkill, LESSER YAM, wild populations in Thailand - Indochina; cultivated in all the region and introduced to Africa and tropical America. Highest diversity in Indonesia - New Guinea, with spineless types frequent (Martin, 1978).

14.7.5 Dioscorea glabra Roxb., Andaman islands, Malaysia, gathered from the wild.

14.7.6 Dioscorea hispida Dennst., India - New Ireland, wild and cultivated, "the chief famine food in tropical Asia" (Burkill, 1951). Many cultivars, especially in Java (Ochse, 1931).

14.7.7 Dioscorea luzonensis Schauer, Philippines, gathered.

14.7.8 Dioscorea nummularia Lam., Malaysia - Tahiti, not cultivated in Java - Sumatra - New Caledonia; a relict crop, which is dissapearing (León, 1977).

14.7.9 Dioscorea orbiculata Hook. f., Malaysia, gathered.

14.7.10 Dioscorea pentaphylla L., India - S. China - POlynesia, wild India - Malaysia, many clones, aberrant types in Philippines and New Guinea. Burkill (1951) has grouped the cultivars in 5 "varieties": malaica, *papuana*, *javanica*, *palmata* and *sacerdotalis*, the last being superior in quality.

14.7.11 *Dioscorea puber* Blume, India - Moluccas. In India the tubers are gathered.

Ipomoea batatas (L.) Lam. SWEET POTATOE. Convolvulaceae.

There is at present all sort of evidence demonstrating the American origin of the sweet potatoe. Its introduction into SE Asia followed three lines: first, in prehistoric times from northern South America to eastern Polynesia: second, from the Antilles to Europe and then to China, after the Conquest; a third line was a direct transfer from Mexico to Philippines (Yen, 1982a).

In Polynesia and Melanesia, the sweet potatoes shows a remarkable diversity. In its long history, somatic mutations, hybridization and genetic drift in several small populations, have produced special types. Yen (1974) collected extensively in Polynesia and Melanesia, as well in Philippines and some areas of continental Asia. These collections are partially mantained at the sweet potato germplasm banks in Japan and India.

The collection and preservation of sweet potatoe germplasm have been planned by an IBPGR panel (1981).

14.8 Merremia Convolvulaceae

A pantropical genus with around 70 spp.

14.8.1 Merremia mammosa (Lour.) Hallier f. Indonesia, wild and cultivated for its tuberous roots (Sastrapradja, 1981a)

14.9 Moghania Papilionaceae

20 spp. in tropical Asia, often called Flemingia.

14.9.1 Moghania vestita (Benth.) O. Ktze. (Flemingia vestita), cultivated in India (Assam) for the fleshy roots.

14.10 Psophocarpus Papilionaceae

An African genus with 5 spp., one widely cultivated in the region, where it shows its higher diversity.

14.10.1 Psophocarpus tetragonolobus (L.) DC., WINGED BEAN. An important tuber crop in Burma. In New Guinea a large number of cultivars. Also used as a vegetable: tender leaves, pods, flowers (references under Vegetables).

14.11 Pueraria Leguminosae

An E - SE Asian genus of 15 spp., from Japan to Polynesia, often utilized for the stem fibers.

14.11.1 Pueraria triloba (Lour.) Makino (P. thunbergiana, P. lobata), INDIAN KUDZU, Philippines - India - Polynesia, planted for the fleshy roots, of good protein value.

14.12 Tacca Taccacaceae

Around 15 spp. from tropical Africa to Polynesia.

14.12.1 Tacca leontopetaloides (L.) O. Ktze. (T. pinnatifida), Thailand - Polynesia, used for the cooked tubers or for starch; its culture is declining. Apparently the same species grows in West Africa.

14.13 Vigna Leguminosae

A pantropic genus of around 50 spp., used as pulses and forage; one species cultivated for the fleshy roots.

14.13.1 Vigna vexillata (L.) A. Rich., cultivated, India, where it is known as V. capensis (Chandel, Arora & Joshi, 1972).

15. SAGO-SUGAR PALMS

In the Malasian area there are two special and intensive uses of palms. One is for starch or "sago", obtained from the tissues of the core of the trunk; special techniques have been developed for its extraction and preparation. Other is for sugar, prepared from the liquid, "toddy", obtained by cutting or crushing the stems of the inflorescenses; the juice is drunk fresh or fermented, "tuba", and is also a source of vinegar. Often the same species is used for both purposes and for other uses, such as for building material and fibers (Barrau, 1959; Friedbergh, 1977).

15.1 Arenga. A Caryotoid genus of SE Asia with 17 spp., mostly in Indomalaysia.

15.1.1 Arenga pinnata (Wurmb.) Merrill, SUGAR PALM, India - Indonesia - Philippines, cultivated and wild, used for sugar, toddy, sago.

15.2 Borassus Belongs to the Borassoid group; 7 species in the tropics of Africa to Malaysia.

15.2.1 Borassus flabelliger L., PALMYRA PALM, India - Sri Lanka - Indonesia, sugar (Romera, 1968; Lubeigt, 1977).

15.2.2 Borassus sundaica Becc., Indonesia, sugar.

15.3 Caryota A Caryotoid genus of around 12 species of SE Asia, often introduced to other areas as ornamentals.

15.3.1 Caryota aequatorialis Rid., Malaysia.

15.3.2 Caryota cumingi Lodd., Philippines, sago.

15.3.3 Caryota mitis Lour., Burma - Malaysia, sago.

15.3.4 Caryota urens L., India - Sri Lanka - Burma - Thailand.

15.4 Cocos. A monotypic genus in the Coccoid group; India to Indonesia; spread naturally to Central America in pre-historic times.

15.4.1 Cocos nucifera L., all over the region, toddy.

15.5 Corypha. In the Coryphoid group; 6 species in SE Asia, often planted elsewhere as ornamentals.

15.5.1 Corypha elata Roxb., BURI, India, toddy, tuba, sago.

15.6 Metroxylon. A Lepidocaryoid genus, with 8 spp., from Thailand to New Guinea.

15.6.1 Metroxylon rumphi (Willd.) Martius, SAGO PALM, Malaysia - New Guinea and adjacent islands, wild and cultivated, especially in the last area.

15.6.2 Metroxylon sagu Rottb., SAGO PALM, Malaysia - New Guinea, often considered as the spineless form of M. rumphi, wild and cultivated. The importance of this resource has been evaluated in several recent publications (Tan, 1977; Ruddle et al, 1978; Koolin, 1979; Stanton & Flach, 1980). The utilization of Metroxylon does not go beyond the Malasian area; although it has been introduced to Polynesia, it is there seldom utilized.

15.7 Nypa. A monotypic genus the only in the Nypoid palms; Philippines to Indonesia.

15.7.1 Nypa fruticans Warmb., or Thunb., NIPA PALM, India - Philippines - Australia; cultivated or gathered from wild stands in coastal areas, "nipales" in Philippines; toddy, sugar (once in industrial scale in Philippines); seeds eaten especially in New Guinea and Philippines.

16. SPICES AND CONDIMENTS

16.1 Alpinia — Zingiberaceae

An Indomalasian genus of around 225 spp., some utilized also as medicinal plants for the esential oils contained in tubers, seeds and other parts of the plant.

16.1.2 Alpinia conchigera Griff., Indochina, tubers used as spice.

16.1.3 Alpinia galanga (L.) Willd., GREATER GALANGA, India, cultivated and wild; Malaysia - Indonesia, cultivated.

16.2 Amomum — Zingiberaceae

Some 100 spp. in the Indomalayan region; used for their seeds, somethimes as substitute for cardamom.

16.2.1 Amomum aculeatum Roxb., India - Indonesia, cultivated.

16.2.2 Amomum aromaticum Roxb., BENGAL CARDAMOM, India, cultivated and wild.

16.2.3 Amomum compactum Soland. (A. kupulaga), ROUND CARDAMOM, Indonesia, cultivated.

16.2.4 Amomum dealbatum Roxb. (A. maximum), India: wild and cultivated, Indonesia: cultivated.

16.2.5 Amomum echinosphaera K. Schum., Indochina: wild and cultivated.

16.2.6 Amomum krevank Pierre, CAMBODIAN CARDAMOM, Thailand - Viet Nam: cultivated.

16.2.7 Amomum repens Sonn., Indochina, cultivated.

16.2.8 Amomum subulatum Roxb., GREATER CARDAMOM, India: wild and cultivated, Indonesia: cultivated.

16.2.9 Amomum tomrey Gagn., TOMREY, Indochina, cultivated.

16.2.10 Amomum walang (Blume) Val., Indonesia: cultivated.

16.2.11 Amomum xanthoides Wall., Burma - Indochina, wild and cultivated.

16.3 Anethum Umbelliferae

Two species in S. Asia, one used as condiment.

16.3.1 Anethum sowa Roxb., India, cultivated.

16.4 Boesenbergia Zingiberaceae

Some 30 spp., Himalayan - Sikim - Malaysia.

16.4.1 Boesenbergia pandurata (Ridl.) Holttum, Malaysia, cultivated for the rhizomes used to flavour foods.

16.5 Capsicum spp. Solanaceae

Introduced to India early in the 16th century, the Capsicum peppers were readily adopted. Some of the Indian cultivars show a marked resistence to foliar diseases, which is not found in the native populations of the New World.

16.6 Cattimbium Zingiberaceae

16.6.1 Cattimbium malaccensis (Burm. f.) Holttum, India - Indonesia, wild, and cultivated; used for the seeds and flowers which contain and essential oil.

16.7 <u>Cinnamomum</u> Lauraceae

Around 80 spp., from S. China to Indonesia (Moluccas), used especially for the essential oil in the bark.

16.7.1 <u>Cinnamomum aromaticum</u> Nees (<u>C. cassia</u>), CASSIA, S. China - Indochina, wild and cultivated; used often to replace cinnamon.

16.7.2 <u>Cinnamomum burmanni</u> Blume. PANDAG CASSIA, Indonesia: wild and cultivated, Malysia: cultivated.

16.7.3 <u>Cinnamomum tamala</u> (Buch. Ham.) Nees & Oberm. INDIAN BARK, India: wild and cultivated.

16.7.4 <u>Cinnamomum verum</u> J.S. Presl (<u>C. zeylanicum</u>), CINNAMOM, wild and cultivated India - Sri Lanka - Burma, cultivated in most parts of SE Asia and the tropics of Africa and the New World for the bark (spice) and the essential oil. (See also under <u>Oil plants</u>).

16.8 <u>Coleus</u> Lamiaceae

A pantropic genus with some 150 spp., many of them cultivated as ornamentals.

16.8.1 <u>Coleus amboinicus</u> (Lour., INDIAN BORAGE, native area unkwnown; cultivated from India to Indonesia; leaves used as condiment.

16.9 <u>Curcuma</u> Zingiberaceae

An Indomalayan genus of 55 spp., used as sources of dye, essential oils or starch, mostly from the tubers.

16.9.1 Curcuma amada Roxb., AMADA, India: cultivated, used as flavoring.

16.9.2 Curcuma domestica Val. (C. longa), TURMERIC, India: wild and cultivated; in SE Asia and other tropical regions, cultivated for the tubers, used as condiment and dyes to foods.

16.9.3 Curcuma zedoaria (Berg.) Roscoe, ZEDOARY, India: wild and cultivated; in SE Asia, cultivated; quite variable.

16.10 Elettaria Zingiberaceae

A monotypic genus of the Indomalayan region.

16.10.1 Elettaria cardamomum (L.) Maton, CARDAMOM, India - Sri Lanka; cultivated in the rest of the region; introduced to Central America. Four main cultivars, grouped in two "varieties": var. major includes 'Ceylon' or big cardamom, with some wild (?) populations in Sri Lanka; var minuscula includes 'Malabar', 'Mysore' and 'Mangalore', the first two providing most of the commercial product (Samarawira, 1972).

16.11 Globba Zingiberaceae

80 spp. in the Indomalayan region.

16.11.1 Globba parviflora Presl., Philippines, tubers used as flavouring.

16.12 Illicium Winteraceae

A genus of some 20 spp., of discontinuous distribution: Eastern North America and SE Asia.

16.12.1 Illicium verum Hook. f., STAR ANISE. S. China - Indochina, wild and cultivated for the seeds used for flavouring curries.

16.13 Kaempferia Zingiberaceae

Some 55 spp. in Africa and SE Asia, including many ornamentals.

16.13.1 Kaempferia galanga L., India - Philippines - Malaysia - Indonesia; wild and cultivated.

16.14 Languas Zingiberaceae

16.14.1 Languas pyramidata (Blume) Merrill, Philippines, rhizomes used as condiment.

16.15 Murraya Rutaceae

16.15.1 Murraya koeniggi (L.) Spreng., CURRY LEAF, India - Indonesia: wild and cultivated, leaves used to flavour foods. Other Rutaceae, like Todalia asiatica (L.) Lam. are used with the same purpose.

16.16 Myristica Myristicaceae

In SE Asia to Melanesia, 85 spp., used for the seeds (nutmeg) and the aril (mace).

16.16.1 Myristica argentea Warb., NEW GUINEA NUTMEG, New Guinea, cultivated, yields seed oil and arils: "Macassar mace".

16.16.2 Myristica fatua Houtt., Moluccas, Java, cultivated.

16.16.3 Myristica fragrans Houtt., NUGMEG, Moluccas: Ambon, Banda: wild (and cultivated); introduced to SE Asia, tropical Africa and America. During the Dutch occupation of Indonesia, the production was restricted to a few islands (Amboina, Ternate) and the trees in other islands were destroyed. In this way the Dutch kept the monopoly of nutmeg and mace, at the expense of wiping off the natural diversity of the species. The contemporary descriptions of La Perouse (1785) and McCarteny tell the systems used: destruction of standing trees, periodic removing of the bark, etc., and the results obtained. However, the Frech expeditions first and then the English, obtained seeds and established plantings in their colonies in Africa and Asia.

16.16.4 Myristica malabarica Lam. India. The aril, "Bombay mace", was an adulterant of the true nutmeg.

16.16.5 Myristica succedanea Reinw., Moluccas. "The nuts are quite aromatic and the tree was formerly cultivated to a small extent by the inhabitants of Northern Moluccas, probably mostly for their own use. They made little profit for the trees did not produce great quantity of fruit and the nuts are smaller than those of M. fragrans. The Dutch political administrators ordered all the trees to be cut down so as to keep the true nutmeg pure. Even if M. fragrans and succedanea did hybridize spontaneously in nature, the chance that succedanea would threaten the trade in the commercial product must have been remote. Such vandalism in exterminating an interesting and useful species is to be deplored, but fortunately H. J. Lam in 1926 found wild material of this species on Gunong Mala-Mala in Tidore, which goes to show that their diabolical acts did not altogether succeeed". (Sinclair, 1968).

Other spp. of Myristica have been exploited sporadically as substitutes; some of the wild species seem to have fruits with oil content as high as the cultivated species (Sinclair, 1968).

16.17. Piper Piperaceae

A pantropical genus of some 700 species, which contain essential oils in the seeds, leaves and stems; used as spices, stimulants or medicine.

16.17.1 Piper cubeba L. f. CUBEB, India - Indonesia (Moluccas), widely cultivated in the region, mainly for medicinal purposes; as spice is of secondary importance.

16.17.2 Piper longum L., LONG PEPPER, India - Indonesia, wild and cultivated especially in S. India, where several clones are known.

16.17.3 Piper nigrum L. BLACK PEPPER, India; land races and advanced cultivars= numerous clones and some hybrids. Main collections= India (Pepper Res. Sta., Panniyur, Kerala and Regional Sta., Calicut); Indonesia; Brasil. Availability of materials rather restricted.

16.17.4 Piper ornatum N.E. Br., CELEBES PEPPER, Moluccas, wild and cultivated.

16.17.5 Piper retrofractum Vahl, JAVANESE PEPPER, in incipient cultivation in Indonesia.

16.18 Syzygium Myrtaceae

A SE Asian genus of 140 spp., often included in Eugenia.

16.18.1 Syzigium aromaticum (L.) Merr. & Perry (Eugenia caryophyllata), cultivated in SE Asia, Tanzania, etc. Wild populations in Moluccas and Irian (New Guinea). Variants under cultivation are atributed by

17. STIMULANTS

Camellia — Camelliaceae

Around 80 spp. in the tropics and subtropics of E and SE Asia. Some are well known ornamentals, other are used as beverages for the caffein content of their leaves.

17.1 Camellia irrawadiensis P. K. Barua, WILSON'S CAMELLIA, Burma, wild, cultivated by local tribes according to Singh (1980). According to Wood & Barua (1958) and Roberts et al. (1958), the population known as "Forest's camellia" and named by Sealy C. taliensis, are hybrids between irrawadiensis and sinensis, and yield an acceptable quality of tea.

17.1.2 Camellia kissi Wall., India, leaves used to prepare a kind of tea.

17.1.3 Camellia sinensis (L.) O. Ktze., TEA. The natural habitat of C. sinensis is still to be found, possibly between Assam-Burma-Southeast China. The so called "wild teas" are very likely spontaneous populations. C. sinensis is a very polymorphic species, and three phenotypically different groups of hybrids are generally accepted, and some specialists assign to two of them a specific rank, a) sinensis, "small leaved" or "china" tea, India, China - Japan; b) assamica, "large leaved" tea; c) cambodia, or subsp. lasiocalyx. As most modern cultivars are clones, it is expected a wide diversity, however, "the popularity of a few superior clones (is) resulting in the narrowing of the genetic base of populations" (Sing, I.D., 1980).

Begbaruah (1971) has called the attention on the need to maintain tea germplasm; the largest collection is at Tocklai, India, including cultivated clones, "wild teas", genetic stocks used to obtain biclonal and policlonal cultivars, and allied species of _Camellia_, _Gordonia_, _Eurya_ and other close genera (Singh, 1970).

17.2 _Coffea_ Rubiaceae

Around 40 species, mainly in Africa.

17.2.1 _Coffea bengalensis_ Roxb., India, according to Narasimhaswamy & Vishveshwara (1963), it was cultivated in North India before _C. arabica_ was introduced, and is still planted in Assam.

6.34.1 Diplodiscus paniculatus Turez., BALABO, Philippines (Quisumbing, 1965).

6.35 Diploknema — Sapotaceae

Seven species from India to Malaysia.

6.35.1 Diploknema butyraceae (Roxb.) H.J. Lam, is well known in India as a source of oil or butter from its seeds, and the pulp of the fruit is commonly eaten.

6.36 Dovyalis — Flacourtiaceae

Distributed from Africa to SE Asia, some 30 spp. The correct name is Doryalis.

6.36.1 Doryalis hebecarpa (Gard.) Warb., KETEMBILLA, Sri Lanka; cultivated in Philippines, and India; introduced to the American tropics.

6.37 Dracontomelum — Anacardiaceae

Eight species from Philippines - Malaysia to Fiji.

6.37.1 Dracontomelum dao (Blanco) Merrill & Rolfe, DAO, Philippines, wild. Melanesia, cult.?

6.37.2 Dracontomelum edulis (Blanco) Skeels, LAMIO, Philippines, wild. Melanesia, cult.?

6.38 Durio — Bombacaceae

Some 22 spp. of the Indomalayan region, fruits gathered from several wild species.

6.38.1 Durio kutjensis (Hassk.) Becc., KERAN TONGAN, Borneo - Java - wild and cultivated.

6.38.2 Durio zibethinus Murr., DURIAN, Malaysia - New Guinea - Philippines; wild and cultivated; introduced to other regions in tropical Asia and America.

6.39 Elaeagnus Elaeagnaceae

Some 45 spp., in Europa, Asia and North America.

6.39.1 Elaeagnus philipinensis Perr., ALINGARO, Philippines wild and cultivated; introduced to Florida.

6.40 Elaeocarpus Elaeocarpaceae

Some 200 spp. The berries are rather acid or sour, they are cooked or pickled like olives; other are eaten fresh.

6.40.1 Elaeocarpus floribundus Blume (E. serratus), JALPAI, Sri Lanka - India - Java, cultivated.

6.41 Elateriospermum Euphorbiaceae

A monotypic genus, Thailand - Malaysia.

6.41.1 Elateriospermum tapos Blume, Thailand - Malaysia, seeds eaten as nuts, wild.

6.42 Erioglossum Sapindaceae

A monotypic genus, Malaysia - Indonesia.

6.42.1 Erioglossum rubiginosum (Roxb.) Blume (E. edule Bl.), MERTAJAM, Malaysia - Indonesia, wild and cultivated.

6.43 Feronia Rutaceae

Monotypic, Sri Lanka - India - Indochina.

6.43.1 Feronia limonia (L.) Swingle, INDIAN WOOD APPLE, native in N. India; cultivated India - Indonesia.

6.44 Finschia Proteaceae

Some 7 spp., from Palau islands - New Guinea - New Hybrids.

6.44.1 Finschia cloroxantha Diels, New Hebrides - Melanesia, a high quality nut, gathered from wild trees, worth domesticating (Barrau, 1973).

6.45 Flacourtia Flacourtiaceae

Around 15 spp., from South Africa to Fiji.

6.45.1 Flacourtia indica (Burm. f.) Merrill (F. ramantchi) GOVERNOR'S PLUM. Africa - Polynesia, naturalized and cultivated.

6.45.2 Flacourtia inermis Roxb., LOBI LOBI, India - New Britain, only in cultivation, 2 varieties: inermis, spineless and moluccana, with spines.

45.3 Flacourtia jangomas (Lour.) Raeusch., INDIAN PLUM, India - Borneo - Philippines, only in cultivation.

6.45.4 Flacourtia rukam Zoll. & Mor., RUKAN, Malaysia, wild and cultivated.

6.46 Garcinia Guttiferae

A genus of some 400 spp., from South Africa to SE Asia.

6.46.1 Garcinia binucao (Blanco) Choisy, BINOKAU, Philippines, wild, gathered.

6.46.2 Garcinia cowa (Roxb. (G. Kydia), India, wild and cultivated.

6.46.3 Garcinia dulcis (Roxb.) Kurz, India - Indonesia, Philippines. Wild and cultivated.

6.46.4 Garcinia mangostana L., MANGOSTAN, Possibly native in Borneo; cultivated from India to the Pacific islands and in many other regions of the tropics; narrow variability atributed to apomixis.

6.46.5 Garcinia vidali Merrill, Philippines, wild and cultivated.

6.46.6 Garcinia xanthocymas Hook. f. (G. tinctoria),India - Malaya, wild and cultivated; introduced to the American tropics.

Of the many Garcinia spp. utilized in the Indomalayan region by their fruits, three are planted outside the region: i) G. mangostana, MANGOSTAN,probably the best of all fruits, known only in cultivation, although it is assumed that G. sylvestris Boerl., of Borneo, may be its wild counterpart; ii) G. dulcis, of which a variety, pyriformis, is cultivated; iii) G. xanthocymus (G. tinctoria). The fruits of the last two species are prepared in jams or eaten fresh. In the same way, the fully mature fruits are eaten in other less known species, such as G. hombroniana, G. cowa, G. prainiana and G. macrophylla, while in G. atroviridis, G. binucao and G. indica, they are used for curries and similar dishes. Garcinia spp. are also a source of yellow dye, "gamboge", especially from G. hanbury, or for the oil of the seeds, like G. cowa.

6.47 Gnetum — Gnetaceae

Pantropical distribution, chiefly in the Indomalayan region; 30 spp.

6.47.1 Gnetum gnemon L., GENEMO. Assam - Philippines - Fiji, in Sumatra and Java only in cultivation. Quite variable.

6.47.2 Gnetum indicum (Lour.) Merrill, KOUAT, Philippines - S. China - Malaysia. Cultivated

6.48 Grewia — Tiliaceae

Around 150 spp., from Africa to Australia.

6.48.1 Grewia asiatica L., PHALSA, India, introduced to many tropical countries.

6.49 Inocarpus — Fabaceae

Four spp., New Guinea - Polynesia; seeds large, eaten cooked or roasted.

6.49.1 Inocarpus fagiferus (Parkinson) Fosberg, (I. edulis), OTAHITI CHESNUT. Malaysia - Polynesia, wild and cultivated, especially important in the Oceanic Islands, introduced to tropical America.

6.50 Jossinia — Myrtaceae

Around 30 spp., from Africa to the Pacific.

6.50.1 Jossinia arnehiana (C.B. Rob.) Merrill, (Syzygium arnehianum), Philippines, wild.

6.51 Juglans — Juglandaceae

A pantropical genus which extends to temperate areas. The following species from the mountains of Indochina are the most common.

6.51.1 Juglans ducloxiana Dode, Indochina, wild and cultivated.

6.51.2 Juglans sinensis Dode, S. China - Indochina, wild and cultivated.

6.52 Lansium — Meliaceae

Some 6 spp. of the Indomalayan region.

6.52.1 Lansium domesticum Correa, LANSON, Malaysia (wild) - Thailand - Viet Nam. Introduced to other countries in Asia and to tropical America. Quite variable, some strains apomictic.

6.53 Litchi — Sapindaceae

One species, wild and cultivated, from Central China to Indochina.

6.53.1 Litchi chinensis, LYCHEE, SE China - Indochina, wild and cultivated; introduced to most of the tropical countries. Three subspecies are distinguished by Leenhouts (1973); javanensis, Java, only in cultivation; philippinensis, wild in Philippines, introduced to tropical America; chinensis, or mountain lychee, wild and cultivated in China and Indochina. The three subspecies do not seem to intergrade.

6.54 Maba — Ebenaceae

Very close to Diospyros, used also for its timber.

6.54.1 Maba major Forst., TONGA, cultivated.

6.55 Macadamia — Proteaceae

Around 10 spp. in Madagascar, Celebes, Australia.

6.55.1 Macadamia hildebrandii Steen., Celebes, wild. According to Sleumer (1955) the CELEBES NUT is as palatable as the other species of

Macadamia and probably better adapted to tropical conditions.

6.55.2 Macadamia integrifolia Maiden & Betche, "smooth shell" MACADAMIA, Australia (Queensland) is the most important in cultivation, introduced to many tropical countries, many selected clones.

6.55.3 Macadamia tetraphylla L. Johnson, "rough shell" MACADAMIA, used mainly as a rootstock for the former, but also producing good quality nuts.

6.56 Madhuca — Sapotaceae

Some 85 spp., especially concentrated in Indochina - Malaysia. Several species yield edible fruits, but only M. obovatifolia is comparable to other sapotaceous fruits. They yield also oil from the seeds, guttapercha, and the flowers of M. indica Gmel. (M. lati folia) and of M. longifolia Machr. are used in India ("maua flower") for their high sugar content.

6.56.1 Madhuca indica Gmel., (M. latifolia), MOHWA, India, widely cultivated.

6.56.2 Madhuca leeri (Theysm. & Binn.) Merrill, Malaysia - Moluccas - Philippines, wild.

6.57 Mangifera — Anarcardiaceae

Around 60 spp., centered in the Indomalayan region, of which 16 are used as fruits.

6.57.1 Mangifera altissima Blanco, PAHUTAN, Philippines, unripe fruits used for pickles, wild and cultivated.

6.57.2 Mangifera caesia Jack, Philippines - Malaysia - Indonesia, wild and cultivated.

6.57.3 Mangifera caloneura Kurz, Thailand, wild and cultivated.

6.57.4 Mangifera cochinchinensis Engler, Indochina (Viet Nam, Kampuchea), wild and cultivated.

6.57.5 Mangifera duperreana Pierre, Viet Nam, wild and cultivated.

6.57.6 Mangifera foetida Lour., BACHANG, Burma - Indochina - Thailand - Indonesia - New Guinea, wild and cultivated, several varieties in cultivation; introduced to the American tropics.

6.57.7 Mangifera indica L. MANGO, wild in most of India - Burma - Thailand - Malaysia - Indonesia - Andamans islands, also cultivated; introduced to the tropics and subtropics of Africa and America. Some 1000 "varieties" in India, seedlings or grafted. In India predominate the monoembrionic races, while in Malaysia and Philippines are more common the nucellar lines. Outside the native region, mango cultivars have been selected, especially in Florida, for size and color, and are quite superior to the original populations. The other species closer to M. indica are M. sylvatica, M. caloneura, M. zeylanica, and other. M. indica is possibly an allopolyploid, for the high number of chromosomes, $2n = 40$, of satellites and secondary constricted chromosomes and other cythological characteristics (Mukherjee, 1949), 1950, 1953; Singh, 1960).

6.57.8 Mangifera kemanga Blume, KEMANG, Malaysia, occasionally cultivated and wild.

6.57.9 Mangifera lagenifera Griff., LANJUT, Thailand - Malaysia - Indonesia, wild and cultivated.

6.57.10 Mangifera longipes Griff., Philippines - Malaysia - Indonesia, wild and gathered.

6.57.11 Mangifera oblongifolia Hook. f. Thailand - Indochina - Malaysia, wild, reports on cultivation rather doubtful; fruit gathered and consumed in Viet Nam.

6.57.12 Mangifera odorata Griff., KWINI, Philippines - Indochina - Malaysia - Indonesia, wild and often cultivated, especially in areas too wet for M. indica; introduced to the American tropics.

6.57.13 Mangifera pentandra Hook. f. Malaysia, wild and occasionally cultivated.

6.57.14 Mangifera siamensis Warbg., Thailand, wild and "perhaps cultivated".

6.57.15 Mangifera similis Blume. Indonesia.

6.57.16 Mangifera zeylanica Hook, f. Sri Lanka, wild and cultivated.

6.58 Manilkara — Sapotaceae

A pantropical genus, with some 70 spp.

6.58.1 Manilkara hexandra Roxb., KHIRNI, India, wild and cultivated.

6.58.2 Manilkara kauki (L.) Dubard, wild in Thailand, Indonesia - Philippines occasionally cultivated, especially in Java; used to graft Manilkara sp.

6.59 Memecylon — Melastomaceae

Some 300 spp. from Africa to Polynesia.

6.59.1 Memecylon coeruleum Jack, India - Malaysia - Philippines, gathered

6.59.2 Memecylon edule Roxb. India - Indonesia (Sumatra), gathered

6.60 Mimusops Sapotaceae

Around 60 spp. mainly in Africa, extends to the Pacific islands.

6.60.1 Mimusops elengi L., MAULSARI, wild and cultivated in India; introduced to Philippines, etc.

6.60.2 Mimusops parvifolia R. Br., Philippines, wild, rarely cultivated.

6.61 Microcos Tiliaceae

An Indomalayan genus with some 50 spp.

6.61.1 Microcos stylocarpus (Warb.) Burret, KAMAULING, Philippines, wild, gathered.

6.62 Musa Musaceae

a) Section EUMUSA (Simmonds, 1962).

6.62.1 Musa acuminata Colla, origin and evident diversity in Malaysia - Indonesia; diploid, wild and cultivated, divided by Simmonds (1962) in several subspecies:

i. banksii, wild, Philippines - New Guinea - Queensland - Samra.

ii. burmannica, wild, S. India - Burma.

iii. microcarpa, wild, Malaysia - Indonesia (Borneo).

iv. siamea, wild, Indochina - N. Malaysia.

NATURAL DISTRIBUTION. 1. Eumusa. 1a. Musa acuminata is centered in the Indochina - Malaysia area, extending to northen Sumatra and Borneo (probably is not native to Java), south China, Philippines - New Guinea - Australia - Samoa. 1b. Musa balbisiana is centered in India and extends to Philippines and New Guinea; it is probably not native in Thailand and in a large part of Indonesia. 1c. The wild diploids: M. cheesmani Simmonds, M. flaviflora Simmonds, M. itinerans Cheesman, M. sikkinensis Kurz, are concentrated in the NE corner of India, Burma and northern Thailand. M. schizocarpa Simmonds, in New Guinea, in an isolated distribution. 2. Australimusa extends from Celebes to Marquesas, importance increases from Fiji eastwards.

CONSERVATION. The situation of genetic resources in Musa is rather different than in other major crops. 1. The development of commercial production occurs outside the area of genetical diversity, and the collections assambled for breeding purposes are affected by difficulties in germplasm transportation (both seeds or vegetative material) and quarantine. Also the plantation system does not encourage the maintenance of somatic mutations, therefore ourtailing secondary diversity. 2. There have been very few collecting expeditions to the region= Simmonds: 1954; Allen and Ochse: 1959; and more recently some sponsored by IBPGR= Indonesia, (Valmayor, 1979); Malaysia Thailand (Valmayor, 1979a); Molucca (Nasution, 1982). Important areas still to collect are Burma and Viet Nam. 3. There are many difficulties in the identification of materials, as they are based mainly on common names (Simmonds, 1959; Allen, 1965). The descriptive work on varieties covers only specific areas:

Philippines (Teodor, 1915; Quisumbing, 1919); Sri Lanka (Chandraratna & Nanayakara, 1951); India (Dutta, 1952; Jacob, 1952). 4. The collections have been established by private companies or restricted programs. No effort has been done to duplicate them; losses due to diseases are common. Information, even lists of the collections, have not been published. The main collections are in Honduras, 510 accessions; Jamaica, 120; Indonesia, 120; Malaysia, 110; Papua - New Guinea, 100; Philippines, 70; India, 50. The germplasm situation of bananas was reviewed by an IBPGR panel (IBPGR, 1978a), which made recommendations on exploration, maintenance and documentation.

6.62.2 Musa balbisiana Colla, origen and center of diversity in India, wild in India - Burma; cultivated in all countries of SE Asia, and the tropics of Africa and America.

Hybrids of acuminata (A) x balbisiana (B) constitute the majority of the cultivated bananas and plantains: i) diploid, AB, 'Ney-poovan'; ii) triploids of AAB genome, most of the "plantains"; iii) triploids of ABB genome, 'Bluggoe'; iv) tetroploid, ABBB, 'Tiparot'.

b) Section Australimusa

6.62.3 Musa trogloditarum L., diploid.

6.62.4 Musa fehi Bert., diploid.

6.62.5 Musa aiori Sagot, diploid.

These species, called the "Fehi" bananas, include wild and cultivated populations, apparently originating in New Guinea,but more economically important in Plynesia (McDaniels, 1947).

6.62.6 Musa discolor Horaninow, Loyalty islands, cultivated.

6.63. Nephelium — Sapindaceae

Some 30 spp. from Burma to Malaysia and Philippines.

6.63.1 Nephelium eripetalum Miqu., Malaysia - Indonesia (Sumatra), wild and cultivated.

6.63.2 Nepehelium glabrum Noranhoa, Malaysia, wild, fruits gathered.

6.63.3 Nephelium lappaceum L., RAMBUTAN, possibly native to Malaysia, introduced to Indonesia, Africa and tropical America; many varieties known in cultivation.

6.63.4 Nephelium mutabile Blume, PULASAN, wild and cultivated in Philippines;

introduced to Malaysia, Indonesia and the American tropics; many different varieties.

6.64 Otophora — Sapindaceae

Around 30 spp., from Philippines to Indochina and Malaysia.

6.64.1 Otophora alata Blume, BUMBING-CHINA, Indonesia, wild and cultivated (Java).

6.64.2 Otophora cambodiana Pierre, CHAMMALIANG Thailand, wild and cultivated.

6.64.3 Otophora fruticosa Blume, Philippines, wild, gathered for the seeds.

6.65 Palaquium — Sapotaceae

Some 120 spp. from Formosa, SE Asia to the Solomon islands; important as a source of gutta. The four species produce edible fruits, but only one is cultivated for that purpose.

6.65.1 Palaquium burckei H. J. Lam, Malaysia.

6.65.2 Palaquium macrocarpum Burck, Malaysia.

6.65.3 Palaquium philippinense (Perry) C.B. Rob., ALAKO, Philippines, wild and cultivated.

6.65.4 Palaquium rostratum (Miqu.) Burck, Malaysia - Indonesia.

6.66 Pandanus — Pandanaceae

Some 600 spp. in the tropics of Africa to Oceania; used mainly for mats, but the following have edible fruits or seeds, eaten fresh or cooked. The pulp is high in provitamin A.

6.66.1 Pandanus andamanensium Kurz, Andaman islands, wild; fruits eaten cooked.

6.66.2 Pandanus brosimos Merrill & Perry, New Guinea, wild.

6.66.3 Pandanus conoideus Lam. New Guinea, Moluccas, wild, pulp eaten.

6.66.4 Pandanus dubius Spreng., Solomon islands, wild and cultivated.

6.66.5 Pandanus bouletti Carr., Malaysia, wild, fresh fruits eaten.

6.66.6 Pandanus julianetti Martius, New Guinea.

6.66.7 Pandanus leram Jones, Nicobar islands, cooked as bread fruit.

6.66.8 Pandanus tectorius Sol., of pan-Pacific distribution, in many cultivars and varieties; the pulp is eaten fresh or cooked, and in Polynesia is eaten also the base of the fruits, seeds and the heart of the termina bud (Barrau, 1962).

6.67 Paranephelium — Sapindaceae

Some four species in SE Asia.

6.67.1 Paranephelium longifolium Lec., LUMYAI-PA, Thailand, wild and cultivated

6.68 Parkia — Mimosaceae

In tropical Africa and Asia, around 20 species.

6.68.2 Parkia intermedia Hassk., Java, cultivated.

6.68.3 Parkia speciosa Hassk., Malaysia, wild and cultivated.

6.69 Phyllanthus — Euphorbiaceae

A complex genus of some 500 spp. in the tropics and subtropics.

6.69.1 Phyllanthus acidus (L.) Skeels (P. distichus, Cicca acida) OTAHEITI BERRY, area of origen unknown, although it has been reported as wild in Philippines; cultivated from India - Polynesia, introduced to tropical Africa and America.

6.69.2 Phyllanthus emblica L. (Emblica officinalis),MYROBALAN, India - Timor; introduced to other tropical regions, apparently quite variable.

6.70 Pometia — Sapindaceae

Five species in the Indomalayan region.

6.70.1 Pometia pinnata J.R. & G. Forst., BANGKONG, India - Polynesia, wild and cultivated; varieties in Polynesia selected for larger fruits, superior to the SE Asian types.

6.71 Rhodomyrtus — Myrtaceae

Six species, SE Asia to Australia.

6.71.1 Rhodomyrtus tomentosa (W. Ait.) Hassk., India - Malaysia, wild and cultivated; introduced to the American tropics.

7.72 Rubus — Rosaceae

220 species, mostly in Eurasia and North America, frequent in the tropics in the highlands.

6.72.1 Rubus albescens Roxb., MYSORE RASPBERRY, cultivated in India - Sri Lanka - Malaysia - Indonesia; introduced to tropical America.

6.72.2 Rubus rosaefolius Sm., SE Asia, cultivated, introduced to tropical America, Europe. In the mountains of India, Philippines and Indonesia several wild species are reported to have fruits of good quality. Among them R. copelandi Merrill, R. ellipticus Sm., R. elmeri Fock., R. fraxinifolius Poir., R. moluccanus L., R. niveus Thunb., R. pectinellus Maxim, R. rolfei Vidal.

6.73 Salacia Hippocrataceae

A tropical genus of around 100 spp., some utilized, not cultivated, for their fruit.

6.73.1 Salacia macrophylla Blume (S. flavescens), India - Thailand - Malaysia Java.

6.73.2 Salacia grandiflora Karz, Malaysia.

6.74. Sandoricum Meliaceae

Around six species, from Mauritius to Indonesia.

6.74.1 Sandoricum koetkape (Burm., f.) Merrill, (Sandoricum indicum), SENTUL, Philippines - Malaysia - Indochina, wild and cultivated, introduced to other tropical regions in Asia and to tropical America.

6.75 Salacca Palmae

A palm genus of six species from India to Indonesia, some with sweet or sour fruits.

6.75.1 Salacca zalacca (Gaerth.) Voss. (S. edulis)., Malaysia - Indonesia, widely cultivated, superior varieties in Bali.

6.76 Semecarpus Anacardiaceae

Around 40 spp. in the Indomalayan region. Two wild Philippinean spp. used for the peduncle or "apples", like the cashew.

6.76.1 Semecarpus cuneiformis Blanco, Philippines.

6.76.2 Semecarpus gigantifolia Vidal, Philippines.

6.77 Sonneratia Sonneratiaceae

A genus of six spp. of mangroves in SE Asia; fruits are gathered.

6.77.1 Sonneratia acida L. f.

6.77.2 Sonneratia caseolaris (L. f.) Engl.

6.78 Spondias Anacardiaceae

A pantropical genus of six species, two in the Indomalayan region.

6.78.1 Spondias cytherea Sonn., OTAHEITI APPLE, area of origin unknown, probably Polynesia; widely cultivated in all tropical regions.

6.78.2 Spondias pinnata (L.) Kurz, LIBAS, India - Philippines - Moluccas, cultivated and wild.

6.79 Stelechocarpus Annonaceae

Around 4 spp. in Malaysia with edible fruits.

6.79.1 Stelechocarpus burahol (Blume) Hook. f. & Thomas, KEPEL, Indonesia (Java - Borneo); introduced to other parts of SE Asia, tropical America, Florida.

6.80 Sterculia — Sterculiaceae

A widely spread genus of tropical trees; seeds used as nuts or to extract oil.

6.80.1 Sterculia foetida L., Africa - Australia, incipient cultivation.

6.80.2 Sterculia oblongata R. Br., Philippines, wild, nuts of good quality.

6.80.3 Sterculia monosperma Vent., South China, cultivated in Java.

6.80.4 Sterculia shillinglawi F. Müell., Solomon islands, cultivated (Yen, 1974).

6.80.5 Sterculia novae-hibernae Laut., New Gyinea - Solomon islands, cultivated.

6.81 Syzygium — Myrtaceae

An Old World genus with some 140 spp., (sometimes included in Eugenia).

6.81.1 Syzygium acqueum (Burm. f.) Alston, JAMBUAYER, wild and cultivated S. India - Malaysia; introduced to other countries in SE Asia and to tropical America.

6.81.2 Syzygium bankense (Hassk.) Merry & Perry, Indonesia, wild and cultivated in Java.

6.81.3 Sizygium calubcob (C.A. Rob) Merrill, KALAKUB, Philippines, wild and rarely cultivated.

6.81.4 Syzygium claviflorum (Roxb.) Wall., KARA, India - Philippines - Malaysia, wild and rarely cultivated.

6.81.5 Syzygium cummini (L.) Skeels, JAMBOLAN, wild and cultivated India - Malaysia - Philippines; introduced to tropical and subtropical countries in Africa and America; several varieties, seedless types known in Java and Philippines.

6.81.6 Syzygium currani (C.A. Rob.) Merrill, LIPOTE, wild and cultivated in Philippines, fruits acid used for jellies.

6.81.7 Sizygium jambos (L.) Alston, ROSE APPLE, an ancient cultigen known from India to Malaysia; introduced as fruit and ornamental to the tropics of Africa and America; polyembrionic.

6.81.8 Syzygium javanicum Miq., MALAY APPLE, India - Indonesia, widely and sparsely cultivated in the Old and New World tropics; several varieties.

6.81.9 Syzygium manaquil Blanco, Philippines, wild, fruits with good flavour.

6.81.10 Syzygium malaccense (L.) Merry & Perry, MALAY APPLE, native area unknown, cultivated all over the wet areas of the Indomalayan region; introduced to tropical Africa and America.

6.81.11 Syzygium mappaceum (Korth.) Mans.,India - Indochina - Borneo, wild and cultivated.

6.81.12 Syzygium polyanthum (Wight) Walp., SALAM, Malaysia; cultivated in Java.

6.81.13 Syzygium polycephalum (Miq.) Merry & Perry, Malaysia - Indonesia, wild and cultivated.

6,81.14 Syzygium samarangense (Blanco) Merry & Perry, MAKOPA, Thailand - Philippines, wild and cultivated, several varieties.

6.82 Terminalia Combretaceae

A pantropical genus with 250 spp.; some fruits are used for dyening and tanning (myrobalans), other for their seeds (nuts).

6.82.1 Terminalia catappa L. INDIAN ALMOND, Native from Malaysia - Polynesia, cultivated in almost all the tropical countries as shade tree.

6.82.2 Terminalia edulis Blanco, DALINSA, Philippines - Indonesia (Celebes), the fruits used as olives.

6.82.3 Terminalia kaernbachi Warb., OKARI NUT, New Guinea - Moluccas - Solomons, cultivated introduced to Florida.

6.83 Tetrastigma Vitaceae

Some 90 spp. in SE Asia.

6.83.1 Tetrastigma harmandi Planch., cultivated in Philippines

6.84 Uvaria Annonaceae

150 spp., from Africa - Madagascar to Australia, several spp. utilized for the fruits.

6.84.1 Uvaria ruffa Blume, Philippines - Malaysia, wild, cultivated in Philippines.

6.85 Vaccinium Ericaceae

Some 400 spp. of the mountains in tropical America, Asia, Oceania; many species gathered for their fruits.

6.86 Xerospermum Sapindaceae

Some eight species in SE Asia - Indonesia, closely allied to Nephelium.

6.86.1 Xerospermum naranhianum (Blume) Blume, wild and cultivated in Indonesia.

6.87 Ziziphus Rhamnaceae

A pantropic genus of dry and semidry areas, with around 40 spp.

6.87.1 Ziziphus jujuba Lam., JUJUBE, India - China - Indonesia, wild (in India) and cultivated; introduced to most of the other tropical areas.

7. GRAIN LEGUMES Leguminosae/Fabaceae

7.1 Cajanus

2 species, one probably Indian, the other in Africa.

7.1.1 Cajanus cajan (L.) Millsps., PIGEON PEA

India is the richest area in the world in the old land races, grouped in: a) "ashar", or var. bicolor, mostly perennials, the yellow flower with purple streaks, dark colored pods with 4-5 seeds. b) "tur", var. flavus, annuals, flower yellow, pod greenish with 2-3 seeds. A wide polymorphism in shape and height of the plants in the two groups. From India also advanced cultivars and genetic stocks.

The relation between Cajanus and Atylosia is not yet completely established. De (1974) suggests, on morphological and cytogenetical evidence, that they cannot be separated. If so, the numerous species of Atylosia, to which India is the center of diversity, should be included in the genetic resources of C. cajan. Oza (1973) and van der Maesen (1980) have accumulated enough evidence to support the Indian origin of C. cajan, and to explain its biological relation to Atylosia.

7.2 Cicer

This genus originates outside the Indomalayan region; however, one species has a long history of cultivation in India.

7.2.1 Cicer arietinum L., GRAM.

As the most important pulse crop in the subcontinent, selection has been done in different states for yield, resistance, packing characteristics, etc. Several advanced cultivars have been released

(Kachrdo & Alif, 1970) and new mutants have been established. Although *Cicer arietinum* has been adscribed to the "Indian center", it is more likely an early introduction from West Asia, through Iran - Afganistan - Pakistan or through Arabia. In India, the large seeded type, "kabula", seems to be a more recent introduction than then small seeded "Desi" type. The crop species may originate from *C. reticulatum* L., which grows wild in SE Anatolia (Auchland & Singh, 1977). In North India are found some wild species of *Cicer*, apparently not related to *C. arietinum*.

7.3 *Cyamopsis*

3-4 species from Africa. *C. tetragonoloba* was probably an early introduction to India (Hymnowitz, 1972).

7.3.1 *Cyamopsis tetragonoloba* (L.) Taub., GUAR

The largest number of land races are found in India, selected for fodder, as vegetable or for the gum in the seeds. Some advanced cultivars (Sing & Mita, 1970).

7.4 *Glycine*

A genus with numerous species from tropical Africa to China and Manchuria, mostly used as fodder.

7.4.1 *Glycine max* (L.) Merr., SOY BEAN

On the soybean in SE Asia, Burkill (1935) writes: "Man has brought the plant southwards, and among the cultivated races has found some to grow under conditions much more tropical than the wild plant supports, but none which are absolutely tropical". In India are found old land races with flattened seeds. In Viet Nam, Thailand and Malasia, is used mostly as a green legume. New cultivars in Thailand and Indonesia are the result of hybridization with introductions from USA, Australia and East Asia, selected mainly for oil content.

7.5 Lathyrus

Some 130 spp., mainly from temperate areas. One grown in India.

7.5.1 Lathyrus sativus L., KHESARI.

According to de Candolle (1883), L. sativus is native from the Caucassus to N. India. Cultivated at present in India as a poor man's legume, all over the country. Many land races and a few improved cultivars. Seed poisoning, lathyrism, restricts a wider use.

7.6 Psophocarpus tetragonolobus (L.) DC.

See under Root and Tubers.

7.7 Vigna

Some 100-150 species in Africa and Asia. According to Jain and Mehra (1980) six species are cultivated in Asia, especially in India. One of them, Vigna angularis (Willd.) Ohur & Ohashi, is an extra-tropical species, with its center of diversity in Japan, and in the Indomalayan region is cultivated in small amount only in N. India.

7.7.1 Vigna aconitifolia (Jacq.) Marechal, MOTH, MAT.

Wild populations in Sri Lanka - India; cultivated as a pulse crop only in India, also for fodder. Many land races and a few modern cultivars (Kachroo, 1970).

7.7.2 Vigna mungo (L.) Hepper, URD, BLACK GRAM.

Cultivated originally only in India; many land races and selected cultivars.

7.7.3 Vigna radiata (L.) Wilcz. MUNG, GREEN GRAM.

The most important native pulse crop in India; wild populations, many land races and improved varieties (Kachroo, 1970).

The status of germplasm resources in the last four crops, is presented by Singh (1973) for India.

7.7.4 Vigna trilobata (L.) Verd., PILLIPESARA

Cultivated mainly as a fodder crop in S. India.

7.7.5 Vigna umbellata (Thunb.) Ohwi & Ohashi, RICE BEAN.

India; quite variable, with many land races and a few selections. Widely grown in other tropical regions as a cover crop. It has been reported under different names: Phaseolus calcaratus Roxb., P. riccardianus Wall., P. pubescens Blume, etc.

7.7.6 Vigna unguiculata (L.) Walp. COWPEA

An early introduction from Africa to India, with three groups of varieties, probably of local origin: i) unguiculata, the common cowpea; ii) cylindrica or catjang (fodder, green pods and of minimum importance as pulse (Steele & Mehra, 1980); iii) sesquipedalis, or "asparagus bean", probably by mutation in cylindrica. Of the three groups and intermediates, many land races are known. In India some 680 lines are maintained at NBGR, and several improved varieties have been released for seed, vegetable or fodder production (Smithson, Redden & Rawal, 1980).

8. GUTTA PERCHA

Several trees, especially in the Sapotaceae, furnish a resin which was used in the industry, and which has been replaced for the largest part of the commercial consumption, by synthethic products. However, small quantities are exported, a good part of them from cultivated plants.

8.1 Ganua Sapotaceae

Some 6 spp in Malaysia.

8.1.1 Ganua motleyana Pierre, Malaysia - Sumatra - Borneo, yields a low quality gutta.

8.1.2 Ganua pallida H.J. Lam, Malaysia - Sumatra, is a source of second class gutta.

8.2 Palaquium Sapotaceae

An Indomalayan genus with around 65 spp.

8.2.1 Palaquium gutta (Hook. fr.) Baill. Sapotaceae, GUTTA, Malaysia - Borneo, now only in cultivation in Java; is the best source of gutta.

8.2.2 Palaquium leicarpum Boerlage, HANGKANG, Borneo - Celebes, produces an inferior kind of gutta, sometimes exported from Borneo.

8.2.3 Palaquium maingayi King & Gamble, Malaysia.

8.2.4 Palaquium obovatum (Griff.) Engl., India - Philippines - Borneo, a source of good quality gutta.

8.3 Payena Sapotaceae

Some 10 spp. in Philippines - Indonesia

8.3.1 Payena leeri (Teysm. & Binn.) Kurz. Philippines - Burma

Malaysia, cultivated in Java.

9. INSECTICIDES

9.1 Derris — Papilionaceae

Some 50 spp. in the Old World tropics, in some species the roots contain an insecticidal substance, rotenone.

9.1.1 Derris elliptica (Roxb.) Benth., Philippines - Indochina - Burma - Malaysia - Indonesia - New Guinea, probably originating in Thailand. Several clones in cultivation, selected in Malaysia and Indonesia.

9.1.2 Derris malaccensis Prain, Malaysia - Borneo, cultivated experimentally only. Other spp. reported with some rotenone content, not cultivated: D. elegans Benth., Malaysia - Borneo; D. scandens Benth, Thailand - Australia; D. thyrsiflora Benth., Thailand - Malaysia.

10. MASTICATORIES

10.1 Areca — Palmae

A palm genus of some 20 spp., from India to Polynesia.

10.1.1 Areca catechu L. BETEL PALM India - S. China - Philippines - Fiji. Nuts used with Piper betle leaves and lime, as a masticatory for its stimulant properties. Many varieties known, especially in India, where it is an important crop.

10.2 Piper — Piperaceae

A pantropical genus with some 700 spp., some used as spices, medicine, etc.

10.2.1 Piper betel L., India - Malaysia - Philippines, used for its leaves which are added to slices of Areca catechu nuts and lime, to prepare a masticatory.

10.2.2 Piper methysticum Forster, KAVA, New Guinea - Frech Polynesia. Roots, dry and pulverized, or fresh and mashed, yield an intoxicating beverage.

10.3 Uncaria — Rubiaceae

Some 35 spp. in the Old World tropics.

10.3.1 Uncaria gambier (Hunter) Roxb., GAMBIR, wild and cultivated India - Malaysia - Indonesia (Borneo), leaves used to prepare a masticatory with betel,; is also an important source of tanning material.

11. OIL CROPS

11.1 *Aleurites* Euphorbiaceae

A genus of six species of SE Asia and S. China. The following three species are utilized by the oil contained in the seeds.

11.1.1 *Aleurites moluccana* Willd. CANDLE NUT TREE, Native to Malaysia (?), from where it spread to India and the Pacific, oil of low commercial value.

11.1.2 *Aleurites montana* (Lour.) E.H. Wilson, TUNG, China (South of 25°N), Viet Nam, Laos, Burma, wild and cultivated; introduced to Malaysia, Indonesia, Malaui, Brasil, Florida, etc., extremely variable, hybrids with *A. tardi*.

11.1.3 *Aleurites trisperma* Blanco, BANUCALAG, Philippines, wild and cultivated.

11.2 *Camellia* Theaceae

Around 8 spp. in the tropics and subtropics of SE Asia; tea, ornamentals.

11.2.1 *Camellia oleifera* Abel., according to Sealy (1958) cultivated in Indochina to extract "tea oil".

11.3 *Cananga* Annonaceae

Three species from India to Australia.

11.3.1 *Cananga odorata* (Lam.) Hook f., YLANG-YLANG, India - Burma - Philipines - Polynesia, wild and cultivated for the flowers, source of an essencial oil; introduced to most tropical areas as ornamental and for the fragance of the flowers.

11.4 Cocos Palmacea

A monotypic genus, originating in SE Asia,which spread probably by natural agents in prehistoric times to the Pacific coast of Central America.

Cocos nucifera L., COCONUT, is possibly the most useful plant of the Indomalayan - Pacific region, as a source of oil, or fruits, vegetable, beverage, building materials, ornamental. Not known in wild state. According to Harries (1978), two main groups of populations: the basic population a) Niu-kafa has long, angular, thick-husked fruits; b) Niu-vai selected by man from the former, has fruits more or less spherical, whit a thin husk and a large amount of liquid endosperm. The population cultivated in Asia and Oceania result of the introgression of the two main types, plus the effect of isolation and cultural selection.

Conservation: A special committee sponsored by IBPGR (1978) has indicated the inadequacy of the existing collections as representatives of the species diversity and as a base for breeding programs. It has also urged to collect more germplasm, especially in Oceania. National or regional collections are kept in India (56 stocks), Sri Lanka, Philippines; Indonesia. Other collections in the region are in the Brithish Solomon Islands, Fiji, Popua-New Guinea et Port Moresby, and Malaysia, at Kuala Lampur. Outside the region, the two most important are in Jamaica and Ivory Coast. The collection at the experiment station of IRHO at Port Bouet, Ivory Coast, includer some 45 stocks; it has duplicate collections in French Oceania. The problem in establishing large regional or world wide collections, is limited by a) quarantine regulations, as most diseases have a regional distribution; b) The size of seeds and c) the large space required to maintain proper samples of the populations. Tissue culture may be helpful in solving some of these problems. Coconut diversity is mainly the result of long isolation, which led to the development of distinct populations. The isolation is due to a large extent to the natural spread into isolated islands or continental areas, not only in the SE Asian region, from India to Polynesia, but also in the Pacific coast of Central America and West Africa. These popylations are recognized with varietal names: 'San Ramon','Rennele', 'Tahiti', and divided in "tall" and "dwarf" types. The last are mutants from Malaya and Philippines, of considerable value in breeding. The problems of saving the genetic diversity threatened by diseases and other factors of genetic erosion, are of special concern to breeders, and their efforts are aimed towards the collecting and exchange of germplasm. Here is an opinion "Breeders felt that a great deal reamins to be done as regards establishing and/or expanding genetic resources. There exists a great genetic variability in Southeast Asia, which needs to be explored and collected using IBPGR approved descriptors. Collections are already established in many countries, but introduction and exchange have not been vigorously purpused. While interest for introduction and/or exchange is common, existing quarantine regulations render progress rather difficult. Seedgardens are established in various countries using different seed production techniques. Some gardens are planted mainly with local materials and others use introduced ones. Seedgardens in some countries are in the process of producing PB 121... Despite efforts to promote cooperation on matters related to breeding research, in general, at this stage, the level of cooperation is rather minimal. It is apparent that there is a fairly good amount of technological breakthrough which could be exploited through international cooperation among coconut producing countries". (Baliñgasa, E.N. FAO Year. Prog. Rep. Coconut Res. 1979, p.2-3).

11.5 Cymbopogon — Gramineae

A genus of some 60 spp., most of them of the savannas if Africa; in SE Asia several species are utilized for the essential oil of the leaves; clonal multiplication is the rule.

11.5.1 *Cymbopogon citratus* (DC.) Stapf, LEMON GRASS, known only in cultivation, originating probably in Malaysia. Few clones, introduced to India, Africa, tropical America.

11.5.2 *Cymbopogon flexuosus* (Nees) W. Wats., MALABAR GRASS, India, cultivated in Indonesia, Viet Nam, etc., one of the sources of "lemon grass oil".

11.5.3 *Cymbopogon martini* (Roxb.) W. Wats., PALMAROSA GRASS, India. A variety, 'Motia,' introduced to Indonesia, is the most important source. Other variety, 'Sofia', is not cultivated any more.

11.5.4 Cymbopogon nardus (L.) Rendle, CITRONELLA GRASS, possibly originated in Sri Lanka; cultivated in SE Asia, Central America, etc. C. confertiflorus, a wild species in Sri Lanka, is its closest ally.

11.5.5 Cymbopogon winteranus Jowitt, JAVA CITRONELLE, Sri Lanka, cultivated especially in Java, by some authors included under C. nardus.

11.6 Madhuca — Sapotaceae

Several species of this genus are utilized for the fruits and the oil contained in the seeds.

11.6.1 Madhuca indica Gmel. (M. latifolia), MOWRA, Indica, cultivated.

11.6.2 Madhuca longifolia (L.) Macbr., India - Sri Lanka.

11.7 Michelia — Annonaceae

25 spp. in China - SE Asia.

11.7.1 Michelia champaca L., India, oil in flowers, extracted to be used in perfumery.

11.7.2 Michelia alba DC., Philippines, Java, cultivated, same use.

11.8 Mesua — Guttiferae

Three species in SE Asia.

11.8.1 Mesua ferrea L. India, the oil in the flowers is extracted for perfume.

11.9 Pogostemon — Labiatae

An Indomalayan genus of 35 spp., several used for the essential oils contained in the leaves.

11.9.1 Pogostemon cablin (Blanco) Benth., PATCHOULI, India - Philippines, Malaysia - Indonesia, cultivated.

11.9.2 Pogostemon heyneanus Benth., INDIAN PATCHOULI, India - Philippines - Malaysia - Indochina, cultivated. In these two species, clonal cultivars have been established.

11.9.3 Pogostemon hortense Backer, cultivated in Java, probably a variant of one of the species mentioned above.

11.10 Shorea, ILLIPE NUTS — Diptereocarpaceae

A SE Asian genus of around 150 spp., very valuable as timber trees, and also used for the seeds which contain fat used in Europe in the confectionery industry, cosmetics, etc., are exported in large quantities from Borneo especially. Shorea nut production has been considered as an agricultural operation, as a complementary product to timber (Anderson, 1975). Some 11 species are the main source of illipe nuts. The most important are the following:

11.10.1 Shorea macrophylla (De Vr.) Ashton, Borneo, wild and cultivated as a timber tree, is the most important species in the export supply of nuts.

11.10.2 Shorea pinanga Scheff., Borneo, wild and cultivated.

11.10.3 Shorea stenoptera Burck, Borneo, wild and cultivated.

11.11 *Vernonia* Compositae

A pantropical genus of around 650 spp.

11.11.1 *Vernonia antihelminthica* Willd., India - Burma; for its seeds containing fatty acids has received some attention in the USA.

11.12 *Vetiveria* Gramineae

A grass genus of eight species, all in SE Asia.

11.12.1 *Vetiveria zizanioides* (L.) Nash, VETIVER, India, cultivated in Indonesia, tropical Africa, etc. for the oil contained in the roots.

12. PASTURES

The Asiatic tropics are an unimportant source of cultivated pastures, in both grasses and legumes. No one of them has the worldwide importance of the African spps., such as Digitaria, Panicum and other, or like the American species of Paspalum. However, considerable effort is done in India to intensify the use of the native grasses in the improvement of pasture lands. In grasses, hardly one third of the species in India is considered to have some value as forage plants (Bor, 1960). The most important among the tropical species are concentrated in the Western Ghats.

In legumes, there is also a high number of species of potential use (Mehra & Magoon, 1974), but few of them are intensively utilized.

A. Grasses — Gramineae

12A.1. Apluda mutica L., BHANJURA, India - Malaysia - Australia.

12A.2. Botriochloa pertusa (L.) A. Camus, JAREWA, Used as a fodder grass in central India and Sri Lanka.

12A.3 Dichanthium annulatum (Forsk.) Stapf., GORIA, India, introduced to North America.

12A.4 Eriochloa procera (Retz.) C.A. Hubb., Sri Lanka.

12A.5 Ischaemum timorense Kunth, India - Timor. RATTAN GRASS, introduced to tropical America; quite variable, perhaps only a variant of I. indicum.

12A.6 Iseilema laxum Hack., MUSEL, considered as one of the best fodder grasses in India and Sri Lanka.

12A.7 Panicum antidotale Retz., according to Whyte (1964), native of NE India, is planted in tropical areas of America.

B Legumes

12B.1 Alysicarpus vaginalis (L.) DC. India - Philippines - Malaysia - Indonesia, introduced to tropical America, its cultivation is practically abandoned.

12B.2 Desmodium sandwicense F. Meyer, Hawaii and other Pacific islands, in cultivation trial in Australia and elsewhere. It seems to be an early introduction from South America.

12B.3 Macrotyloma uniflorum (Lam.) Verdc. (Dolichos biflorus), HORSE GRAM, especially important as a fodder crop; several land races and a few "improved cultivars".

12B.4 Melilotus indica (L.) All., SENJI, India, wild and cultivated; introduced to USA.

13. RATTANS

The continuous exploitation of rattan for furniture is based almost completely on the wild stands, and only four species are in cultivation. This has led to a depletion in natural stands, particularly in certain species and to urgent needs of conservation (Dransfield, 1981). The richest genera are Calamus, 370 spp. Daemonorops, 115 spp., India - New Guinea; Korthalsia, 29 spp., Burma - New Guinea; Platocomia, 16 spp. India - Borneo (IDRC, 1980).

13.1 Calamus caesium Blume, wild in Malaysia - Borneo, where it is also cultivated.

13.2 Calamus manan Miqu., Malaysia - Borneo, cultivated.

13.3 Calamus minahassae Warb., Celebes, cultivated.

13.4 Calamus trachycoleus Becc., Borneo, cultivated.

14. ROOTS AND TUBERS

(Ochse, 1931; Herklots, 1972; Sastradradja et al, 1981a)

14.1 Alocasia — Araceae

An Asian genus of 36 spp., several cultivated for the edible corms.

14.1.1 Alocasia cucullata Schott, India - Sri Lanka,

14.1.2 Alocasia macrorhiza (L.) G. Don. (A. indica), GIANT TARO, India - Polynesia, many clones, especially in Samoa.

14.2 Amorphophallus — Araceae

90 species in S. Asia to Polynesia; 3 species cultivated

14.2.1 Amorphophallus campanulatus (Roxb.) Blume. India - Polynesia, native area unknown; its cultivation decreasing due to low yields and difficulties to prepare as food.

14.2.2 Amorphophallus harmandi Engl. & Gehr., Indochina.

14.2.3 Amorphophallus rivieri Dur., Philippines - Indochina.

Coleus parviflorus Benth., RATALA, India; cultivated also in Indonesia, is probably and old introduction from Africa (Burkill, 1935).

14.3 Colocasia — Araceae

Eight species in SE Asia, one widely cultivated.

14.3.1 Colocasia esculenta (L.) Schott & Endl. (C. antiquorum), TARO, India - Polynesia; many clones probably hundreds, in cultivation. Two cytological groups, one with 2n=28 predominates in India, Japan, Polynesia; other with 2n=42, in India, New Zealand and Philippines; introduced early to Egypt and the Mediterranean islands,and after the Discovery to Africa and the New World.

14.4 Cordyline — Agavaceae

In Asia, Oceania and Australia, 15 spp. some ornamental, other used for leaf fibers, one for the edible roots.

14.4.1 Cordyline terminalis (L.) Kunth, SE Asia - Australia - Hawaii; cultivated in the Cook islands, for the roots which have a high sugar content.

14.5 Curcuma — Zingiberaceae

An Indomalayan genus of around 55 spp., some used as spices, the following for the starchy roots.

14.1 Curcuma aeruginosa Roxb. Burma; cultived in Indonesia, for the starch obtained from the rhizomes.

14.2 Curcuma angustifolia Borxb., EAST INDIAN ARROWROOT, India, cultivated; the fleshy roots yield a special kind of starch. Other spp. in India: C. aromatica Salisb., C. leurcorhiza Roxb., C. montana Roscoe, C. rubescens Roxb., and in Viet Nam: C. pierreana Gagn., are also used for the same purpose; most of the product in obtained from wild plants.

14.6 Cyrtosperma — Araceae

In the tropics of Asia and Oceania around 11 species.

14.6.1 Cyrtosperma chamissonis (Schott) Merrill (C. edule, C. merkusi), GIANT SWAMP TARO, possibly native to Indonesia; cultivated in Philippines, New Guinea, Polynesia, of special importance in certain islands of Micronesia, where several varieties are known (Barrau, 1961; Plucknett, 1967; Thompson, 1982).

14.7 Dioscorea — Dioscoreaceae

A large genus of some 600 spp., mostly in the tropics, with species domesticated independently in Africa, Asia and America.

14.7.1 Dioscorea alata L., GREATER YAM. According to Burkill (1951) this species originated where its closest allies, D. hamiltoni and D. persimilis, still grow wild: the area between Burma and Indochina where the three big rivers, Irrawady, Salween and Mekong, rum parallel (20°- 25°N). Alexander and Coursey (1969) tend to support this assumption, while Martin(1976) suggest that D. alata may originate somewhere in the region between Burma and New Guinea, perhaps domesticated in different places. The higher variability is found in Indochina - Indonesia - New Guinea. The number of cultivars may vary between 200 - 300. The genetic erosion in this species is probably higher than in other yams, as it is replaced in cultivation by other Dioscorea or other tuber crops (Burkill, 1951). Several attempts have been done to classify the interspecific variability (Martin & Rhodes, 1977). Ploidy: 2n=40,60 or 80 (Abraham et al, 1976).

14.7.2 Dioscorea bulbifera L., India - Polynesia, wild and cultivated; also in East Africa, the two domestication centers apparently independent (Martin, 1974). The Asiatic types have rounded bulbils and are less acrid than the African. The cultivars have been classified by Burkill (1951) in var. suavior, whith dark brown, warted bulbils, and var. sativa, with smooth bulbils.

14.7.3 Dioscorea cummingii Burkill, Philippines, wild and cultivated, perhaps also in Polynesia.

14.7.4 Dioscorea esculenta (Lour.) Burkill, LESSER YAM, wild populations in Thailand - Indochina; cultivated in all the region and introduced to Africa and tropical America. Highest diversity in Indonesia - New Guinea, with spineless types frequent (Martin, 1978).

14.7.5 Dioscorea glabra Roxb., Andaman islands, Malaysia, gathered from the wild.

14.7.6 Dioscorea hispida Dennst., India - New Ireland, wild and cultivated, "the chief famine food in tropical Asia" (Burkill, 1951). Many cultivars, especially in Java (Ochse, 1931).

14.7.7 Dioscorea luzonensis Schauer, Philippines, gathered.

14.7.8 Dioscorea nummularia Lam., Malaysia - Tahiti, not cultivated in Java - Sumatra - New Caledonia; a relict crop, which is dissapearing (León, 1977).

14.7.9 Dioscorea orbiculata Hook. f., Malaysia, gathered.

14.7.10 Dioscorea pentaphylla L., India - S. China - POlynesia, wild India - Malaysia, many clones, aberrant types in Philippines and New Guinea. Burkill (1951) has grouped the cultivars in 5 "varieties": malaica, papuana, javanica, palmata and sacerdotalis, the last being superior in quality.

14.7.11 Dioscorea puber Blume, India - Moluccas. In India the tubers are gathered.

Ipomoea batatas (L.) Lam. SWEET POTATOE. Convolvulaceae.

There is at present all sort of evidence demonstrating the American origin of the sweet potatoe. Its introduction into SE Asia followed three lines: first, in prehistoric times from northern South America to eastern Polynesia: second, from the Antilles to Europe and then to China, after the Conquest; a third line was a direct transfer from Mexico to Philippines (Yen, 1982a).

In Polynesia and Melanesia, the sweet potatoes shows a remarkable diversity. In its long history, somatic mutations, hybridization and genetic drift in several small populations, have produced special types. Yen (1974) collected extensively in Polynesia and Melanesia, as well in Philippines and some areas of continental Asia. These collections are partially mantained at the sweet potato germplasm banks in Japan and India.

The collection and preservation of sweet potatoe germplasm have been planned by an IBPGR panel (1981).

14.8 Merremia Convolvulaceae

A pantropical genus with around 70 spp.

14.8.1 Merremia mammosa (Lour.) Hallier f. Indonesia, wild and cultivated for its tuberous roots (Sastrapradja, 1981a)

14.9 Moghania Papilionaceae

20 spp. in tropical Asia, often called Flemingia.

14.9.1 Moghania vestita (Benth.) O. Ktze. (Flemingia vestita), cultivated in India (Assam) for the fleshy roots.

14.10 Psophocarpus Papilionaceae

An African genus with 5 spp., one widely cultivated in the region, where it shows its higher diversity.

14.10.1 Psophocarpus tetragonolobus (L.) DC., WINGED BEAN. An important tuber crop in Burma. In New Guinea a large number of cultivars. Also used as a vegetable: tender leaves, pods, flowers (references under Vegetables).

14.11 Pueraria Leguminosae

An E - SE Asian genus of 15 spp., from Japan to Polynesia, often utilized for the stem fibers.

14.11.1 Pueraria triloba (Lour.) Makino (P. thunbergiana, P. lobata), INDIAN KUDZU, Philippines - India - Polynesia, planted for the fleshy roots, of good protein value.

14.12 Tacca Taccacaceae

Around 15 spp. from tropical Africa to Polynesia.

14.12.1 Tacca leontopetaloides (L.) O. Ktze. (T. pinnatifida), Thailand - Polynesia, used for the cooked tubers or for starch; its culture is declining. Apparently the same species grows in West Africa.

14.13 Vigna Leguminosae

A pantropic genus of around 50 spp., used as pulses and forage; one species cultivated for the fleshy roots.

14.13.1 Vigna vexillata (L.) A. Rich., cultivated, India, where it is known as V. capensis (Chandel, Arora & Joshi, 1972).

15. SAGO-SUGAR PALMS

In the Malasian area there are two special and intensive uses of palms. One is for starch or "sago", obtained from the tissues of the core of the trunk; special techniques have been developed for its extraction and preparation. Other is for sugar, prepared from the liquid, "toddy", obtained by cutting or crushing the stems of the inflorescenses; the juice is drunk fresh or fermented, "tuba", and is also a source of vinegar. Often the same species is used for both purposes and for other uses, such as for building material and fibers (Barrau, 1959; Friedbergh, 1977).

15.1 Arenga. A Caryotoid genus of SE Asia with 17 spp., mostly in Indomalaysia.

15.1.1 Arenga pinnata (Wurmb.) Merrill, SUGAR PALM, India - Indonesia - Philippines, cultivated and wild, used for sugar, toddy, sago.

15.2 Borassus Belongs to the Borassoid group; 7 species in the tropics of Africa to Malaysia.

15.2.1 Borassus flabelliger L., PALMYRA PALM, India - Sri Lanka - Indonesia, sugar (Romera, 1968; Lubeigt, 1977).

15.2.2 Borassus sundaica Becc., Indonesia, sugar.

15.3 Caryota A Caryotoid genus of around 12 species of SE Asia, often introduced to other areas as ornamentals.

15.3.1 Caryota aequatorialis Rid., Malaysia.

15.3.2 Caryota cumingi Lodd., Philippines, sago.

15.3.3 Caryota mitis Lour., Burma - Malaysia, sago.

15.3.4 Caryota urens L., India - Sri Lanka - Burma - Thailand.

15.4 Cocos. A monotypic genus in the Coccoid group; India to Indonesia; spread naturally to Central America in pre-historic times.

15.4.1 Cocos nucifera L., all over the region, toddy.

15.5 Corypha. In the Coryphoid group; 6 species in SE Asia, often planted elsewhere as ornamentals.

15.5.1 Corypha elata Roxb., BURI, India, toddy, tuba, sago.

15.6 Metroxylon. A Lepidocaryoid genus, with 8 spp., from Thailand to New Guinea.

15.6.1 Metroxylon rumphi (Willd.) Martius, SAGO PALM, Malaysia - New Guinea and adjacent islands, wild and cultivated, especially in the last area.

15.6.2 Metroxylon sagu Rottb., SAGO PALM, Malaysia - New Guinea, often considered as the spineless form of M. rumphi, wild and cultivated. The importance of this resource has been evaluated in several recent publications (Tan, 1977; Ruddle et al, 1978; Koolin, 1979; Stanton & Flach, 1980). The utilization of Metroxylon does not go beyond the Malasian area; although it has been introduced to Polynesia, it is there seldom utilized.

15.7 *Nypa*. A monotypic genus the only in the Nypoid palms; Philippines to Indonesia.

15.7.1 *Nypa fruticans* Warmb., or Thunb., NIPA PALM, India - Philippines - Australia; cultivated or gathered from wild stands in coastal areas, "nipales" in Philippines; toddy, sugar (once in industrial scale in Philippines); seeds eaten especially in New Guinea and Philippines.

16. SPICES AND CONDIMENTS

16.1 Alpinia — Zingiberaceae

An Indomalasian genus of around 225 spp., some utilized also as medicinal plants for the esential oils contained in tubers, seeds and other parts of the plant.

16.1.2 Alpinia conchigera Griff., Indochina, tubers used as spice.

16.1.3 Alpinia galanga (L.) Willd., GREATER GALANGA, India, cultivated and wild; Malaysia - Indonesia, cultivated.

16.2 Amomum — Zingiberaceae

Some 100 spp. in the Indomalayan region; used for their seeds, somethimes as substitute for cardamom.

16.2.1 Amomum aculeatum Roxb., India - Indonesia, cultivated.

16.2.2 Amomum aromaticum Roxb., BENGAL CARDAMOM, India, cultivated and wild.

16.2.3 Amomum compactum Soland. (A. kupulaga), ROUND CARDAMOM, Indonesia, cultivated.

16.2.4 Amomum dealbatum Roxb. (A. maximum), India: wild and cultivated, Indonesia: cultivated.

16.2.5 Amomum echinosphaera K. Schum., Indochina: wild and cultivated.

16.2.6 Amomum krevank Pierre, CAMBODIAN CARDAMOM, Thailand - Viet Nam: cultivated.

16.2.7 Amomum repens Sonn., Indochina, cultivated.

16.2.8 Amomum subulatum Roxb., GREATER CARDAMOM, India: wild and cultivated, Indonesia: cultivated.

16.2.9 Amomum tomrey Gagn., TOMREY, Indochina, cultivated.

16.2.10 Amomum walang (Blume) Val., Indonesia: cultivated.

16.2.11 Amomum xanthoides Wall., Burma - Indochina, wild and cultivated.

16.3 Anethum Umbelliferae

Two species in S. Asia, one used as condiment.

16.3.1 Anethum sowa Roxb., India, cultivated.

16.4 Boesenbergia Zingiberaceae

Some 30 spp., Himalayan - Sikim - Malaysia.

16.4.1 Boesenbergia pandurata (Ridl.) Holttum, Malaysia, cultivated for the rhizomes used to flavour foods.

16.5 Capsicum spp. Solanaceae

Introduced to India early in the 16th century, the Capsicum peppers were readily adopted. Some of the Indian cultivars show a marked resistence to foliar diseases, which is not found in the native populations of the New World.

16.6 Cattimbium Zingiberaceae

16.6.1 Cattimbium malaccensis (Burm. f.) Holttum, India - Indonesia, wild, and cultivated; used for the seeds and flowers which contain and essential oil.

16.7 Cinnamomum Lauraceae

Around 80 spp., from S. China to Indonesia (Moluccas), used especially for the essential oil in the bark.

16.7.1 Cinnamomum aromaticum Nees (C. cassia), CASSIA, S. China - Indochina, wild and cultivated; used often to replace cinnamon.

16.7.2 Cinnamomum burmanni Blume. PANDAG CASSIA, Indonesia: wild and cultivated, Malysia: cultivated.

16.7.3 Cinnamomum tamala (Buch. Ham.) Nees & Oberm. INDIAN BARK, India: wild and cultivated.

16.7.4 Cinnamomum verum J.S. Presl (C. zeylanicum), CINNAMOM, wild and cultivated India - Sri Lanka - Burma, cultivated in most parts of SE Asia and the tropics of Africa and the New World for the bark (spice) and the essential oil. (See also under Oil plants).

16.8 Coleus Lamiaceae

A pantropic genus with some 150 spp., many of them cultivated as ornamentals.

16.8.1 Coleus amboinicus (Lour., INDIAN BORAGE, native area unkwnown; cultivated from India to Indonesia; leaves used as condiment.

16.9 Curcuma Zingiberaceae

An Indomalayan genus of 55 spp., used as sources of dye, essential oils or starch, mostly from the tubers.

16.9.1 Curcuma amada Roxb., AMADA, India: cultivated, used as flavoring.

16.9.2 Curcuma domestica Val. (C. longa), TURMERIC, India: wild and cultivated; in SE Asia and other tropical regions, cultivated for the tubers, used as condiment and dyes to foods.

16.9.3 Curcuma zedoaria (Berg.) Roscoe, ZEDOARY, India: wild and cultivated; in SE Asia, cultivated; quite variable.

16.10 Elettaria — Zingiberaceae

A monotypic genus of the Indomalayan region.

16.10.1 Elettaria cardamomum (L.) Maton, CARDAMOM, India - Sri Lanka; cultivated in the rest of the region; introduced to Central America. Four main cultivars, grouped in two "varieties": var. major includes 'Ceylon' or big cardamom, with some wild (?) populations in Sri Lanka; var minuscula includes 'Malabar', 'Mysore' and 'Mangalore', the first two providing most of the commercial product (Samarawira, 1972).

16.11 Globba — Zingiberaceae

80 spp. in the Indomalayan region.

16.11.1 Globba parviflora Presl., Philippines, tubers used as flavouring.

16.12 Illicium — Winteraceae

A genus of some 20 spp., of discontinuous distribution: Eastern North America and SE Asia.

16.12.1 Illicium verum Hook. f., STAR ANISE. S. China - Indochina, wild and cultivated for the seeds used for flavouring curries.

16.13 Kaempferia Zingiberaceae

Some 55 spp. in Africa and SE Asia, including many ornamentals.

16.13.1 Kaempferia galanga L., India - Philippines - Malaysia - Indonesia; wild and cultivated.

16.14 Languas Zingiberaceae

16.14.1 Languas pyramidata (Blume) Merrill, Philippines, rhizomes used as condiment.

16.15 Murraya Rutaceae

16.15.1 Murraya koeniggi (L.) Spreng., CURRY LEAF, India - Indonesia: wild and cultivated, leaves used to flavour foods. Other Rutaceae, like Todalia asiatica (L.) Lam. are used with the same purpose.

16.16 Myristica Myristicaceae

In SE Asia to Melanesia, 85 spp., used for the seeds (nutmeg) and the aril (mace).

16.16.1 Myristica argentea Warb., NEW GUINEA NUTMEG, New Guinea, cultivated, yields seed oil and arils: "Macassar mace".

16.16.2 Myristica fatua Houtt., Moluccas, Java, cultivated.

16.16.3 Myristica fragrans Houtt., NUGMEG, Moluccas: Ambon, Banda: wild (and cultivated); introduced to SE Asia, tropical Africa and America. During the Dutch occupation of Indonesia, the production was restricted to a few islands (Amboina, Ternate) and the trees in other islands were destroyed. In this way the Dutch kept the monopoly of nutmeg and mace, at the expense of wiping off the natural diversity of the species. The contemporary descriptions of La Perouse (1785) and McCarteny tell the systems used: destruction of standing trees, periodic removing of the bark, etc., and the results obtained. However, the Frech expeditions first and then the English, obtained seeds and established plantings in their colonies in Africa and Asia.

16.16.4 Myristica malabarica Lam. India. The aril, "Bombay mace", was an adulterant of the true nutmeg.

16.16.5 Myristica succedanea Reinw., Moluccas. "The nuts are quite aromatic and the tree was formerly cultivated to a small extent by the inhabitants of Northern Moluccas, probably mostly for their own use. They made little profit for the trees did not produce great quantity of fruit and the nuts are smaller than those of M. fragrans. The Dutch political administrators ordered all the trees to be cut down so as to keep the true nutmeg pure. Even if M. fragrans and succedanea did hybridize spontaneously in nature, the chance that succedanea would threaten the trade in the commercial product must have been remote. Such vandalism in exterminating an interesting and useful species is to be deplored, but fortunately H. J. Lam in 1926 found wild material of this species on Gunong Mala-Mala in Tidore, which goes to show that their diabolical acts did not altogether succeeed". (Sinclair, 1968).

Other spp. of *Myristica* have been exploited sporadically as substitutes; some of the wild species seem to have fruits with oil content as high as the cultivated species (Sinclair, 1968).

16.17. *Piper* Piperaceae

A pantropical genus of some 700 species, which contain essential oils in the seeds, leaves and stems; used as spices, stimulants or medicine.

16.17.1 *Piper cubeba* L. f. CUBEB, India - Indonesia (Moluccas), widely cultivated in the region, mainly for medicinal purposes; as spice is of secondary importance.

16.17.2 *Piper longum* L., LONG PEPPER, India - Indonesia, wild and cultivated especially in S. India, where several clones are known.

16.17.3 *Piper nigrum* L. BLACK PEPPER, India; land races and advanced cultivars= numerous clones and some hybrids. Main collections= India (Pepper Res. Sta., Panniyur, Kerala and Regional Sta., Calicut); Indonesia; Brasil. Availability of materials rather restricted.

16.17.4 *Piper ornatum* N.E. Br., CELEBES PEPPER, Moluccas, wild and cultivated.

16.17.5 *Piper retrofractum* Vahl, JAVANESE PEPPER, in incipient cultivation in Indonesia.

16.18 *Syzygium* Myrtaceae

A SE Asian genus of 140 spp., often included in Eugenia.

16.18.1 *Syzigium aromaticum* (L.) Merr. & Perry (*Eugenia caryophyllata*), cultivated in SE Asia, Tanzania, etc. Wild populations in Moluccas and Irian (New Guinea). Variants under cultivation are atributed by

17. STIMULANTS

Camellia Camelliaceae

Around 80 spp. in the tropics and subtropics of E and SE Asia. Some are well known ornamentals, other are used as beverages for the caffein content of their leaves.

17.1 Camellia irrawadiensis P. K. Barua, WILSON'S CAMELLIA, Burma, wild, cultivated by local tribes according to Singh (1980). According to Wood & Barua (1958) and Roberts et al. (1958), the population known as "Forest's camellia" and named by Sealy C. taliensis, are hybrids between irrawadiensis and sinensis, and yield an acceptable quality of tea.

17.1.2 Camellia kissi Wall., India, leaves used to prepare a kind of tea.

17.1.3 Camellia sinensis (L.) O. Ktze., TEA. The natural habitat of C. sinensis is still to be found, possibly between Assam-Burma-Southeast China. The so called "wild teas" are very likely spontaneous populations. C. sinensis is a very polymorphic species, and three phenotypically different groups of hybrids are generally accepted, and some specialists assign to two of them a specific rank, a) sinensis, "small leaved" or "china" tea, India, China - Japan; b) assamica, "large leaved" tea; c) cambodia, or subsp. lasiocalyx. As most modern cultivars are clones, it is expected a wide diversity, however, "the popularity of a few superior clones (is) resulting in the narrowing of the genetic base of populations" (Sing, I.D., 1980).

Begbaruah (1971) has called the attention on the need to maintain tea germplasm; the largest collection is at Tocklai, India, including cultivated clones, "wild teas", genetic stocks used to obtain biclonal and policlonal cultivars, and allied species of Camellia, Gordonia, Eurya and other close genera (Singh, 1970).

17.2 Coffea Rubiaceae

Around 40 species, mainly in Africa.

17.2.1 Coffea bengalensis Roxb., India, according to Narasimhaswamy & Vishveshwara (1963), it was cultivated in North India before C. arabica was introduced, and is still planted in Assam.

18. SUGARCANE

The cultivation of sugar cane originated in the indomalayan region, which is still its more important source of germplasm. The so called "Saccharum complex" (Mukherjee, 1957) includes besides Saccharum some very close genera: Mischanthus, Ripidium and Sclerostachya, among which gene exchange is still active, either in the wild populations or in artificial breeding. Outside the "Sachcarum complex" other genera in the Saccharine, such as Mischanthidium, Eccoilopus and other, hybridized with Saccharum. The complex includes some 80 species, of which around a dozen has given true hybrids with Saccharum (Grassl, 1962). It is also known that sugarcane has been crossed to Zea, Bambusa, Sorghum, which are not closely related.

The most important genera and species forming the Saccharum complex, are:

18.1 Saccharum

18.1.1 Saccharum barberi Jeswit, India (North).

18.1.2 Saccharum edule Hassk., Java - New Guinea.

18.1.3 Saccharum officinarum L., the "noble cannes", widely cultivated since prehistoric times, possibly derived from the next species.

18.1.4 Saccharum robustum Brandes & Jeswit, Celebes, Borneo, New Guinea, New Hebrides.

18.1.5 Saccharum sanguineum (Grassl) Grassl, New Guinea.

18.1.6 Saccharum sinense Roxb., often included with S. barberi in one species, but the present trend is to separate them on cytotaxonomic and chemotaxonomic evidence.

18.1.7 Saccharum spontaneum L., N.E.W. Africa, Anatolia, Turkmenistan, Pakistan, India, China, Taiwan, Indochina, Malaya to Celebes, and possibly of recent introduction to New Guinea.

18.2 *Mischanthus*

18.2.1 *Mischanthus floridulus* (Labill.) Warb., East Africa, Indochina, China, Taiwan, Korea, Japan to Java, New Guinea and the Pacific islands.

18.2.2 *Mischanthus rufipilus* (Steud.) Grassl, N. NW. India.

18.2.3 *Mischanthus nepalensis* (Trin.) Hack. N. India.

18.3 *Ripidium*, includes the Asiatic species formerly under *Erianthus*.

18.3.1 *Ripidium arundinaceum* (Retz) Grassl, India, Burma, Celebes, New Guinea.

18.3.2 *Ripidium procerum* (Roxb.) Grassl, India, Burma.

18.3.3 *Ripidium bengalense* (Retz) Grassl, India.

18.3.4 *Ripidium ravennae* (L.) Grassl, Mediterranean - India, and other.

18.4 *Sclerostachya* (species formerly under *Narenga*)

18.4.1 *Sclerostachya fallax* (Balansa) Grassl, India - Indonesia.

18.4.2 *Sclerostachya fusca* (Roxb.) Camus, Indochina.

18.4.3 *Sclerostachya narenga* (Nees) Grassl, India.

18.4.4 *Sclerostachya ridleyi* (Hack.) Camus, Malaya.

Problems of conservation in sugar cane.

Miscanthus is of special interest since it has been proved by Grassl (1967) that it shows extensive introgression with Saccharum, especially in the evolution of S. sinense, S. robustum and S. officinarum. According to Daniels, Smith & Paton (1975) "there is an urgent need to bring more clones of Miscanthus... in the world collection of sugarcane germplasm".

Genetic erosion in the Saccharum complex, especially in S. officinarum is due to several factors. First, the continuous production of new cultivars eliminates other that may have potential value in future breeding; although at gene level the losses may not be very serious, the improvement for different purposes (sugar, fiber, fuel) in many research stations, will determine some genetic losses. Second, clearing of land occupied by species of Saccharum and allied genera, due to agricultural expansion. Third, changes in the consumption habits; cane chewing, for instance, is decreasing, and the availability of cristaline sugar in remote areas affects the survival of the sugar gardens, so rich in different clones. Finally, the world or national collections have suffered inevitably losses due to poor adaptation, diseases, etc.

The gusar cane breeders and geneticists were aware of the problems in genetic consevation before the specialists in other crops. A "germplasm committee" in the ISSCT under the leadership of J. Daniels and others, has been active for many years in the exploration, maintenance and information of sugarcane genetic resources.

Strategy for exploration

Areas. The most promising sources of germplasm of the "Saccharum complex" are 1) the Indonesian islands, including New Guinea; 2) the Indochina peninsula to Malaya; the Indian subcontinent, better explored than the other areas. The approach to collections in these areas has been defined by Berding (1975), as follows: The Indonesian archipielago and neighbouring islands, would have these priorities: a) Papua - New Guinea, b) Irian Jaya (The Indonesial section of New Guinea); c) islands west of New Guinea: Ceram, Buru, Moluccas, Halmahera, Sulawesi (Celebes) and Kalimantan (Borneo); d) islands east of New Guinea: New Britain, New Ireland, Bouganville, Solomon and New Hebrides. Berding and Koike conducted a collection expedition recently to areas b) and c). Their report (Berding & Koike, 1980) contains a methodological approach, discussions on previous work and of their field operations, which is a model of its kind. In reporting their findings they state that "the conservation of Saccharum complex material from Indonesia is imperative", and that "urgency is dictated by the rapid abandonment of cultivated sugar cane from native gardens in Irian Jaya and the need to collect the highly variable robustum material ahead of any widespread habitat disturbance". In Celebes, Moluccas and Borneo, Berding and Koike (1980) consider that urgency in collection is determined by the increased habitat disturbance, due to developments in forestry, agriculture and transmigration projects.

South Asia - Africa. These regions are of special interest for Saccharum spontaneum germplasm. This is the most polymorphic species in the genus and the most widely dispersed. Collections in Coimbatore with some 470 entries

(Mehra & Sethi, 1980), are the most complete and have been studied in their cytology, associated to their geographic distribution by Panje and Baju (1960).

19. VEGETABLES

(Ochse, 1931; Herklots, 1972; Sastrapradja, 1981a)

19.1 Abelmoschus Malvaceae

50 spp. in the tropics of SE Asia to Australia.

19.1.1 Abelmoschus esculentus (L.) Moench., OKRA. Although it is generally accepted that this species originated in Africa, Joshi and Hardas (1976) claim it is of polyphyletic origin, and Boorsum-Wallkes (1966) that it is related to Hibiscus tuberculatus, a wild species of N. India.

19.1.2 Abelmoschus manihot (L.) Medik., SUNSET HIBISCUS, India - Polynesia; apparently derived from a wild population, tetraphyllus, found from India - Australia. Cultivated especially in Celebes, Moluccas, New Guinea to Samoa. Ochse (1931) describes eight types from Indonesia, based mainly in leaf characters; clonal propagation.

19.2 Alleanthus Moraceae

Three species, all in the Indomalayan region.

19.2.1 Alleanthus luzonicus (Blanco) F. Vill., HIMBABAO; leaves and flowers cooked.

19.3 Alternanthera Amaranthaceae

Some 70 spp. in the tropics and subtropics; the following two are used for the leaves.

19.3.1 Alternanthera amoena L., cultivated in India.

19.3.2 Alternanthera triandra Lam., wild and cultivated in Malaysia.

19.4 *Amaranthus* Amaranthaceae

A pantropical genus of some 60 spp., in many species the leaves are used as spinach.

19.4.1 *Amaranthus blitum* L., cultivated in China - Indochina.

19.4.2 *Amaranthus gracilis* Desf., Moluccas, cultivated.

19.4.3 *Amaranthus lividus* L., Indonesia, cultivated.

19.4.4 *Amaranthus mangostanus* L., India, cultivated.

19.4.5 *Amaranthus tricolor* L., (*A. gangeticus*), TAMPALA, India - Indonesia; several cultivars have been selected.

19.5 *Basella* Basellaceae

A monotypic genus of tropical Asia.

19.5.1 *Basella alba* L. (*Basella rubra*), MALABAR SPINACH, wild (?) populations in tropical Africa and Asia; cultivated in all tropical regions. Several varieties, red-fruited (*rubra*); heart-shaped leaves (*cordifolia*); thick leaves (*crassifolia*).

19.6 *Benincasa* Cucurbitaceae

A monotypic genus, with feral populations from India to Java

19.6.1 *Benincasa hispida* (Thunb.) Cogn., WAX GOURD, original area unknown, cultivated India - Polynesia; introduced to the tropics of Africa and America.

19.7 *Brassica* Cruciferae

19.7.1 *Brassica oleracea* L., CAULIFLOWER, in India, local varieties of special genetic characteristics (Swarup & Chaterjee, 1972).

19.8 Canavalia Papilionaceae

A pantropical genus with some 12 spp.

19.8.1 Canavalia gladiata (Jacq.) DC., West India - Oceania, wild and cultivated for its young pods.

19.9 Capparis Capparidaceae

Some 250 species, in tropical and subtropical regions.

19.9.1 Capparis cordifolia Lam., in Polynesia (Guam) and Philippines, cultivated for its flower buds.

19.10 Cardiopteris Icacinaceae

An Indomalayan genus of three species; young leaves eaten fresh or cooked.

19.10.1 Cardiopteris javanica Blume, Java, wild.

19.10.2 Cardiopteris moluccana Blume, Moluccas, wild.

19.11 Centella Umbelliferae

Some 20 spp. from tropical Africa-Asia, often included in Hydrocotyle.

19.11.1 Centella asiatica (L.) Urb., Malaysia - Indonesia, leaves gathered and sold in markets.

19.12 Coccinia Cucurbitaceae

A genus with around 20 spp. in the African - Asiatic tropics.

19.12.1 Coccinia grandis (L.) Voigt (C. cordifolia, C. indica) IVY GOURD, Africa - Indonesia, wild and cultivated for its young fruits and leaves.

19.13 Crataeva Capparidaceae

A pantropical genus with some 10 spp.

19.13.1 Crataeva nurvala Buch. Ham., VARUNA, India, gathered for the tender leaves.

19.14 Cucumis Cucurbitaceae

Four species in tropical Africa and Asia.

19.14.1 Cucumis sativus L., CUCUMBER. The probable ancestor of the cucumber is supposed to be C. hardwicki Royle, which grows in the foothills of the Himalayas. Primitive cultivars from India provide genes for resistance to several diseases (Leppik, 1966). According to De Candolle (1883), the cucumber was cultivated in India 3000 years ago.

19.15 Enhydra Compositae

Nine spp. in the tropics and subtropics of the Old World.

19.15.1 Enhydra fluctuans Lour., India - Indochina - Indonesia. Cultivated for the tips, used as salad or cooked.

19.16 Gnetum Gnetaceae

Some 35 spp. in the tropics, with a higher concentration in SE Asia.

19.16.1 Gnetum gnemon L., BULSO, widely used from cultivated or wild plants, in SE Asia - Indonesia - Melanesia for its leaves, one of the most popular vegetables.

19.17 Hibiscus Malvaceae

A pantropical genus of around 300 spp.

19.17.1 Hibiscus tiliaceus L. a pantropical species, is used and cultivated in Melanesia for the fibrous trunk or branches, which are chewed (Barrau, 1958).

19.18 Houttuynia Saururaceae

A monotypic genus, India to Japan.

19.18.1 Houttuynia cordata Thunb., JAMROA, cultivated in India and Viet Nam for the leaves, used as salad or cooked.

19.19 Ipomoea Convolvulaceae

A pantropical genus of some 400 spp. Several wild species are used as greens; among them, in India, according to Terra (1966): I. alba L. f., I. biloba Forsk.; I. digitata L.,; I. eriocarpa R. Br.,; I. sepiaria L. etc.

19.19.1 Ipomoea aquatica Forsk., (I. reptans),KANK KONG, SE Asia, wild and extensively cultivated for the tips, eaten as spinach.

19.20 Lactuca Compositae

A genus of around 100 spp. mostly in temperate areas

19.20.1 Lactuca indica L., possibly originary of India, cultivated also in Indonesia, has its widest diversity in China.

19.24.1 Momordica charantia L., SE Asia,wild and cultivated; many cultivars grouped in chinensis and muricata, distinguished by the size, color and degree of bitterness of the fruits. (A regional collection at Katsetsart University, Bangkok, Thailand).

19.24.2 Momordica cochinchinensis (Lour.) Spreng., India - Japan - New Guinea; like the previous species, used for the fruits and tips.

19.24.3 Momordica dioica Roxb. (M. subangulata), India - Sri Lanka, possibly Java, wild and cultivated.

19.25 Morinda Rubiaceae

Some 45 spp. in the Old World tropics. Several species are known as a source of dye.

19.25.1 Morinda citrifolia L. India; widely cultivated in the tropics as ornamental; the leaves are "probably the richest leaf source of carotene" (Oomen & Gruben, 1978).

19.26 Moringa Moringaceae

A genus of 3 spp, from the Mediterranean to India.

19.26.1 Moringa oleifera Lam. (M. pterigosperma), HORSE RADISH TREE, India; cultivated in SE Asia and other tropical regions. Tender leaves and poods eaten as vegetables (Ramachandran et al, 1980).

19.27 Mucuna Papilionaceae

Some 25 spp. of pantropical distribution, used also as cover crops.

19.27.1 Mucuna capitata (Roxb.) Wight & Arn., cultivated India - Indonesia, leaves and young pods.

19.27.2 Mucuna cochinchinensis (Lour.) A. Chev. (M. nivea). Indochina, cultivated, same uses as above.

19.28 Neptunia Papilionaceae

Some 10 spp. in the tropics and subtropics.

19.28.1 Neptunia oleracea Lour., Indochina, cultivated for its leaves.

19.29 Oenanthe Umbelliferae

Some 35 spp., mostly in the temperate euro-asiatic region.

19.29.1 Oenanthe javanica DC. (O. stolonifera), Indochina, Philippines - Indochina - Australia, cultivated ?, wild populations quite variable.

19.30 Paracitrullus Cucurbitaceae

A monotypic genus, the species formerly included in Citrullus. Paracitrullus fistulosus (Stokes) Pangalo, TINDA, India known only in cultivation fruits eaten cooked.

19.31 Pisonia Nyctaginaceae

A pantropical genus of 60 spp.

19.31.1 Pisonia alba Span., MALUKO, Malaysia, cultivated for its leaves; the wild populations are called P. sylvestris R. Br.

19.32 Pithecellobium — Papilionaceae

A complex pantropical genus, with some 120 spp.

19.32.1 Pithecellobium jiringa (Jack) Mansf., JERING, Burma - Java, wild and cultivated, seeds eaten young and ripe.

19.32.2 Pithecellobium lobatum Benth., India, used as the previous species.

19.33 Pluchea — Compositae

Some 30 spp. in the tropics and subtropics of the old world.

19.33.1 Pluchea indica (L.) Less. India - Australia. In Indonesia cultivated for the young foliage.

19.34 Polyscias — Araliaceae

A complex genus of some 80 spp. of pantropical distribution, ornamental.

19.34.1 Polyscias fruticosa (L.) Harms, Indonesia, cultivated as ornamental and for its leaves.

19.34.2 Polyscias obtusa (Bl.) Harms, as above.

19.34.3 Polyscias pinnata Forst., New Hebrides, cultivated for its leaves.

19.34.4 Polyscias rumphiana Harms, Java - New Guinea.

19.34.5 Polyscias scutellarium (Burm. f.) Fosb., Malaysia - Polynesia, cultivated especially in Indonesia.

19.35 Pterococcus — Euphorbiaceae

A small genus of two species, one in Africa, the other in Asia.

19.35.1 Pterococcus corniculatus (J.E. Smith) Pax & Hoffm., CHUMBAI, India - Moluccas; cultivated in Indonesia for the leaves.

19.36 Rungia Acanthaceae

A genus of some 50 spp. in Africa - India - Polynesia.

19.36.1 Rungia klassi S. Moore. New Guinea, cultivated for its leaves.

19.37 Saccharum edule Hassk., New Guinea - New Hebrides, cultivated for its inflorescenses, which are eaten cooked. There are also reports (Barrau, 1958) that Erianthus maximus, another tall grass close to Saccharum, is eaten in a similar way in Fiji.

19.38 Sauropus Euphorbiaceae

Some 40 spp. in SE Asia.

19.38.1 Sauropus androgynous (L.) Merrill, Indochina - Indonesia, wild and cultivated, the young leaves eaten as spinach (13.470 units of vitamin A as compared with 3670 in Brassica).

19.39 Sesbania Papilionaceae

A pantropical genus of around 50 spp.

19.39.1 Sesbania grandiflora (L.) Perso., India - Australia; cultivated flowers, young pods, leaves eaten cooked.

19.40 Setaria Gramineae

Around 140 spp., of pantropical distribution.

19.40.1 Setaria palmiflora Stapf., Indonesia - New Guinea, in the last country cultivated for its tender shoots.

19.41 Solanum — Solanaceae

A large genus of some 1400 spp., of wide distribution in temperate and tropical regions.

19.41.1 Solanum melongena L., EGGPLANT, BRINJAL, wild populations in India described, according to Deb (1979) as S. incanum and S. insanum; S. indicum is also closely allied; many primitive and a few improved cultivars in India. Widely cultivated elsewhere.

19.41.2 Solanum nigrum a complex, of many integrading populations, including the typical hexaploids; the leaves and fruits are eaten cooked.

19.41.3 Solanum uporo Dunal, Fiji, cultivated.

19.42 Tetragonia — Tetragoniaceae

Around 50 species in the Southern hemisphere, Africa - Asia - Australia - New Zealand - S. America.

19.42.1 Tetragonia tetragonioides (Pall.) Kuntze (T. expansa), NEW ZEALAND SPINACH, Australia, New Zealand; cultivated in most tropical and subtropical countries.

19.43 Trevesia — Araliaceae

A genus of 10 spp. from Malaysia to Polynesia.

19.43.1 Trevesia sundaica Miq. is cultivated in Indonesia for its leaves and flowers.

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2. TROPICAL AFRICA

TROPICAL AFRICA

1. Geographic delimitation

1.1. The tropical region of Africa is limited to the north by the Sahara, and to the South by the Kalahari-Karro. These two desertic areas run across the tropic lines,and determine a series of transversal vegetation belts, from the Equator to the deserts, and from the Atlantic to the Indian Ocean. However, to the East, the transversal belts are interr-upted by the cordilleras which run North-South along the Rift valley. Only in Southern Sudan, a break in the mountain chains opens a direct connection between Central and Eastern Africa.

1.2 Among the factors that determine the vegetation types in tropical Africa, climate and soils will be briefly considered. The climatic pattern is rather simple: an area of high precipitation is found in the Gulf of Guinea, due to the SW Monsoon, which in some places like the Coast of Dahomey, it reaches up to 4000 mm. From the coastal area of Guinea,the precipitation decreases inland through the Congo basin, to the borders of the Sahara and the Kalahari. In the Sahara, a permanent anticyclone determines almost total aridity (1-40mm). Towards the East of the Congo basin, in some reduced areas of the highlands, between Ethiopia and Transvaal, rainfall increases by convection. However, aridity is the predominant characteristic of the whole of Africa, with the exception of the Guinea coast and the Congo basin. This aridity has increased during the recent geological periods, and it may have had, as will be seen later, an important influence on plant domestication and the development of agriculture.

1.3 The soils of Africa, as shown since the classic work of Shantz & Marbut (1923) and others (D'Hoore, 1964 ; Schokalskaja, 1953), have been associated closely with rainfall patterns and plant distribution. Other factors, as human influence, in practices such as burning and overgrazing, are important in soil determination, while other such as reforestation (Laurie, 1975), tend to improve the condition in the savannas.

2. Vegetation

2.1 The vegetation types in tropical Africa follow a rather simple pattern of transversal belts (East-West), interrumpted by the chain of mountains which runs North-South along the Rift valley. The Northern limit is the Sahara, the Southern the Kalahari desert and the dry lands of the Orange valley. Aubréville et al. (1958) and Bakker (1967) recognize the following vegetation types: a) semidesert, a narrow belt along the Sahara from the Atlantic to the Red Sea, and bordering the Kalahari in South Africa; b) Dry savannas and woodlands, which occuppy a wide belt south of the semidesert in the north, and a large part of East and South Africa; c) Open woodland, a narrow belt South of the dry savanna in Western and Central Africa, and a large extension in the South, west of Lake Nyasa. These two types are included as "woody savannas and open woodland" by Aubréville (1949). They occupy the largest area of any type of vegetation in Africa, especially in Sudan. Acacia and similar trees dominate the drier, while the *Isoberlinia* forests characterize the wetter areas. South of the rainforest they occupy a large extension in which *Brachystegia* and *Jubernardia* predominate, and in several places they interrumpt the "forest-savanna mosaic" and connect directly to the rain forest. d) Forest-savanna mosaic, which in West and Central Africa runs East-West as a narrow belt north of the rain forest, and south of this, as large and disconnected areas. e) Rain forest, extending in West Africa from the upper coast of Guinea to the mountains of Uganda, interrupted only by the Togo-Dahomey gap, in which the rain forest-savanna mosaic reaches the coast of the Gulf of Guinea.

2.2. The flora of the African tropics is by far poorer in species and biotypes than in SE Asia or the Neotropics. There are marked differences in the floristic composition of the rainforests and the open woods. In the latter, among the Dicots, the Leguminosae is the family with the largest number of species, followed by Rubiaceae, Moraceae and other. The Gramineae are very well represented, and man has obtained from them several cereals and many pastures, among the best in the tropics. Although there is a profusion of floras at national or regional level, only the pioneer work of Engler (1908-1925), although incomplete, gives a comprehensive view of the flora and vegetation of the continent.

3. Geographic concentration of germplasm in Africa

3.1 Africa, with the possible exception of Ethiopia, is a continent in which it is very difficult to define centers of germplasm concentration.

Vavilov (1951) established one of his "centers of origin of cultivated plants" in Ethiopia, but forgot the rest of Africa. Chevalier (1938) proposed an African center of crop origin south of the Sahara, and Portères (1950) two "hearths of agriculture": one in East Africa and a second in West Africa. Murdock (1959) came up with a "Sudanian complex" as an agricultural hearth, in the assumption that most of the tropical crops of Africa were domesticated in the Sudan, in the upper valley of the river Niger rather than in West Africa, and ascribed the local invention of agriculture to the Mande culture. These assumptions brought a reply from a diffusionist, J. D. Clark (1962), who held that agriculture permeated from the Near East through Egypt and Nubia into Sudan and the rest of Africa, around 5000 - 2000 BC, based on anthropological arguments. On the other hand, Baker (1962) dismissed Murdock's hypothesis on botanical arguments, showing that most crops assigned to the "Sudan complex" came from other parts of tropical Africa. At the same time, Portères (1962) proposed four primary agricultural hearths: a) Western Africa; b) Nile-Ethiopia; c) Eastern Africa; d) Central Africa. Harlan (1971) considers tropical Africa as "non-center" of agriculture, while Zeven & Zhukovsky (1975) included all the areas South of the Sahara as their "African center" of crop diversity. Harlan, de Wet and Stemmler (1976) "failed to detect a particular center of origin for the indigenous African agriculture" However, they agree that African agriculture "has a number of unique characteristics which appear to be indigenous and are not likely to be derived from the Near East system".

3.2 Crops like coffee, sorghum, yams and many others, are without doubt of African origin, in the sense that were domesticated from wild materials, often still existent. Not much selection has been applied in Africa to them, as pointed by Burkill (1953), and several have been bred or improved outside the continent, like coffee and oil palm. But if plant domestication is an important component in the invention of agriculture (as are tools, planting systems, etc.), it is very difficult to deny that agriculture in Africa is more likely an autochtonous development than a cultural extension of the Near East. This is especially supported when it is considered that many crops, such as coffee, yams, voandzeia, oil palm, do not have equivalents in South Asia (Davies, 1968; Seddon, 1968).

Clark (1976), limiting his analysis to the dry areas and to cereals, has proposed a model of plant domestication based on the change from gathering to cultivation. This was due first to the desiccation of the Sahara which forced pastoralist-gatherers to move southwards around 2000 BC; also to fish dissapearance in the lakes and rivers of the Sahel, and to the losses of cattle due to the appearance of the tse-tse fly around 1000 BC. These factors forced the domestication of millets, sorghum and African rice in the Sahel between 3000-1000 BC and in northern Sudan around 3000 BC. These dates roughly agree with the latest conclusions based on archeological information (McIntosh & McIntosh, 1981). According to this, agriculture in West African was not developed before 1500 BC.

3.3 The lack of old and permanent nuclei of civilization, leading to the development of urban areas and the need to concentrate agricultural production close to them, may explain the lack of definition in centers of germplasm concentrations in Africa. Only Ethiopia offers the image of an incipient center (Harlan, 1969; Kupzow, 1974), but as a hearth of agriculture it cannot be compared with the Near East, Mexico or Peru, with their advanced system of germplasm concentration, and the development of irrigation, soil conservation and food storage facilities, as well as tools and animal domestication. The low population pressure, due in part to diseases, trashumance, dependence on cattle or wildlife for food as well as the tribal system, which tends to disperse populations instead of concentrating them in large rural or urban communities, do not favor the establishement of the conditions necessary for germplasm concentration, in contrast to the Near East or Mesoamerica.

3.3.1. Madagascar. The great island should be considered as separate from Africa in relation to the origin and evolution of its crops. In spite of the richness of its flora, Madagascar has contributed only with very few crops, all of secondary importance (Chevalier, 1948). Dioscorea ovifotsy Perr., which is no longer in cultivation and Dodonaea madagascariensis Radlk., are the most important. On the other hand, some 900 crop species have been introduced, first by the Bantus from Africa, and later on, during historical times, by the Malays. Often, in the last case, the names of crop plants are the same in Indonesia and Madagascar (Haudricourt, 1948).

4. Number of crop species

In number of crops, Africa may be compared with the other tropical areas. The list of Jardin (1967) for food crops is very impressive in the number and spread of native crops. But in contrast to other continents, the difference between wild, protected and cultivated plants is less clear in Africa than elsewhere. Thus "useful" has a different rank in Africa than in tropical America or SE Asia.

4.2 Introduced Crops

It has veen stated several times that in Africa the impact of introduced crops, especially after 1500, was stronger than in any other continent. Only to consider the influence of American crops such as cassava, cacao, peanuts, maize, or Asiatic as bananas, rice, mangos, in the present food or export production of Africa is enough to appreciate the drastic changes in agriculture and nutrition, after their introduction. Darlington (1969) however, sees in the easy production and high yields of introduced crops, a depressive factor in the development of Africa.

5. Status of native crops

The role of plant introduction in African agriculture is well documented for East Africa (Greenway, 1944), South Africa (Godwin, 1937) and West Africa (Irvine, 1952; Mauny, 1953), especially for the food plants. The effect of introductions on the conservation of native crops has been extremely negative. African crops, due to the low pressure of selection that they have been subjected, cannot compete with the introduced crops.

Chevalier (1947) noted how the small cereals, like Digitaria and oil plants: Citrullus, Telfairia, Tetracarpidium canophorum, Polygala butyraceae, have dissapeared in many areas of tropical Africa. Voandzeia and Macrotyloma are also on the way out, replaced by peanuts.

A combination of biological and human factors contribute to the genetic erosion in African crops. African agriculture is a rather recent invention, going probably no farther than a millenium and a half before the Christian era (McIntosh & McIntosh, 1981). This is a rather short period for plant domestication and therefore for the establishment of a good number of cultivars in each crop species, and for the selection of superior types. Besides, African crops did not receive special attention during the European domination. The interest of European scientists was concentrated on plantation crops, either to take out of Africa the basic materials to plant them elsewhere, as coffee or oil palm, or to introduce foreign crops, such as Hevea or peanuts. However, some European scientists did pay attention to the native crops; outstanding among them was August Chevalier (1876-1956), whose knowledge of African crops has not been surpassed.

As in SE Asia and the Amazon, the West African rainforest contains many species in incipient utilization (Dalziel, 1955). But the rainforest has also been depleted of some of its most promising species and destroyed for agricultural use.

Pershaps the most promising materials are the pasture species; the grasses of East-West Africa have not been tested or evaluated in their full potential. To quote an example, Entolasia imbricata, of Uganda, has a crude protein content higher than any other grass (15-30%) and high palatability (Bodgan, 1963).

1. CEREALS

1.1. **Avena**

Some 70 spp. in the temperate areas of the northern hemisphere, with a few in the tropical mountains of Africa.

1.1.1 Avena barbata (A. abyssinica Hochst.) weedy and tolerated populations, harvested for its grains.

1.2 **Brachiaria**

A pantropical genus, close to Panicum.

1.2.1 Brachiaria deflexa Hubbard, wild populations all over Africa and in Yemen; cultivated in the highlands of Guinea, Gambia and Senegal, in very uniform populations. Other Brachiaria are gathered in different parts of Africa (Portères, 1976).

1.3 **Digitaria**

Around 50 spp., in the tropics of America and Africa-Asia.

1.3.1 Digitaria exilis (Kipp.) Stapf, FONIO, cultivated only, in West Africa: Cabo Verde to Lake Chad, in the savanna or open woodland regions, hexaploid of unknown origin; many cultivars, an importan center of diversity in the upper Niger and Segenal, the Fouta-Djalon plateau.

1.3.2 Digitaria iburua Stapf, IBURU, wild and cultivated in restricted and separate areas of Togo, Dahomey, Nigeria, in association with D. exilis. Portères (1976) suggests it may be derived from D. barbinodis Hern.

1.4 Eleusine

Some 10 spp., in the tropics of Africa and Asia.

1.4.1 Eleusine coracana (L.) Gaertn., CORACAN, FINGER MILLET. Wild and cultivated in East and SW Africa, in open woodlands and savanna regions. The populations are divided in two groups: highland, probably derived from E. africana, a tetraploid that crosses freely with E. coracana, and, afro-asiatic populations which were probably introduced to India in prehistorical times, where they were intensively selected (Mehra, 1963).

1.5 Eragrostis

Around 250 spp., especially in the northern regions of the New and the Old Worlds.

1.5.1 Eragrostis teff (Zucc.) Trotter, TEF, cultivation restricted to Ethiopia, where it is the most important food crop. Simmons (1960) suggestes it may be a domestication of E. pilosa. Costanza, de Wet & Harlan (1979) also consider E. pilosa one of the putative ancestors, the other is E. aethiopica, and recognized 35 cultivars grouped in 6 complexus. Other classifications were done by Ciferri and Baldrati (1940) and Ebba (1975).

1.6 Oryza

Around 7 recognized species, some pantropical, but mostly in Asia.

1.6.1 Oryza glaberrima Stapf, AFRICAN RICE, cultivated in the open woods-savanna region form Senegal to Sudan. Around 1500 "varieties" known, including floating types. Main center in the upper Niger, others in Gambia and Guinea. Probably derived from *O. longistaminata* A. Chev. & Rochr., which is found in the same areas and is often gathered. *O. longistaminata* may derive from *O. perennis*, a complex which is found in many tropical areas. Nayar (9173) has proposed that African rices are old introduction of *O. sativa*, but this view has not received much support.

The cultivation of *O. glaberrima* is decreasing all over Africa as the result of the higher yields and availability of planting materials of *O. sativa*. The result is that the cultivated types are dissapearing fast; the weedy races, *O. barthi*, *O. breviligulata* are still common in the fields of African or Asian rices. They ofter some potential value, as such as resistance to *Piricularia*. There is a wide range of variation, due to crosses between cultivated and wild *glaberrima*. As other species in incipient domestication, it is still in active process of evolution (Ogbe & Williams, 1978). A number of primitive cultivars are known, grouped by Portéres in subspecies *humilis* and *glaberrima*. Oka (1974) recognized them as belonging to two ecotypes= deep water and upland. Collections of African rices have not been established, and are difficult to mantain in *O. sativa* banks.

1.7 *Paspalum*

A grass genus with some 250 spp., mostly in the American tropics.

1.7.1 *Paspalum scrobiculatum* L.; the variety *polystachium* is cultivated in West Africa, generally associated with rice.

1.8 Pennisetum

Some 50 spp. in the tropics and subtropics of both worlds.

118.1 Pennisetum americanum (L.) K. Schum. (P. typhoides (Burm. f.) L.C. Rich.; P. spicatum L.), BULRUSH, PEARL MILLET, acomplex diploid with several cultivated races, wild populations (ssp. monodii) and weedy types ("Shibra"). P. americanum was probably domesticated in the Sahel (Chevalier, 1934; Brunken, de Wet & Harlan, 1977), now cultivated in most parts of Africa except in the rainforest or highland regions. Introduced in prehistorical time to India. The numerous races in Africa have received specific status (Portères, 1976), but they are considered now as forming only one species.

Pennisetum americanum is still mantained in thousand of "varieties" cultivated in the dry belt of central Africa. The monodii shows a wide introgression with the cultivated races, while the "shibra", characterized by the shattering of the spikelets are found as weeds in the cultivated fields. Large collections in India, extremely mixed and material should be collected again in Africa.

The following "species" are how considered as races of P. americanum; P. albicenda Stapf & Hubb., P. ancylochaete Stapf & Hubb., Nigeria - Niger, P. cinereum Stapf & Hubb., Senegal - Dahomey, P. echinurus (K. Schum.) Stapf & Hubb. Uganda - Angola, P. gambiense Stapf & Hubb. Senegal - Gambia - Ghana, P. gibbosum Stapf & Hubb., Chad, P. leonis Stapf & Hubb., Sierra Leone - Guinea, P. maiwa Stapf & Hubb., NE Nigeria - Chad, P. malacochoate Stapf & Hubb., Tanzania - Mozambique, P. nigritarum (Schelcht.) Durand & Schinz, Senegal - Chad, P. niloticum and from there spread some 3000 BP to the West and South of Africa and to India. An early domestication is proposed also in central Sudan (Clark & Stemler, 1975).

The wild sorghum races are still predominant all over tropical Africa. The cultivated races are not been actively replaced yet, as there are few breeding programs and as the advanced hybrids do not adapt to the tropical conditions. Most of the land races are grown in the savanna areas, across the continent, extending to South Africa, to Angole and southern Zaire.

2. FIBERS

2.1 Cephalonema — Tiliaceae

A monotypic genus of W. Africa

2.1.1 Cephalonema polyandrum K. Schum., PUNGA, West Africa, mostly from wild plants.

2.2 Gossypium — Malvaceae

Around 15 spp. in the tropics and subtropics of both hemispheres.

2.2.1 Gossypium arboreum L., COTTON, race sudanense in NE and W. Africa, either introduced from India or autochtonous.

2.2.2 Gossypium herbaceum L., COTTON; populations of the annual African diploid cotton are found spontaneous in SW Africa; several cultivated races are known from Africa. In this continent, however, it has been replaced by the American tetraploids, G. barbadense, especially in Egypt, and G. hirsutum in tropical Africa.

2.3 Hibiscus — Malvaceae

A pantropical genus of around 160 spp.

2.3.1 Hibiscus cannabinus L., KENAF, diploid; wild and cultivated in east and southwest Africa, the most primitive cultivars in Angola. In Kenya and Tanzania, wild and feral populations (Wilson, 1979).

2.3.2 Hibiscus sabdariffa L., ROSELLA, tetroploid, central Africa, wild populations in northern Nigeria; a high diversity in Angola. var. altissima is planted for the stem fibers; var. sabdariffa for the succulent calyx, used to prepare a fresh drink.

2.4 *Honckenya* Tiliaceae

Wat Africa, 3 spp.

2.4.1 *Honckenya ficifolia* Willd., West Africa, wild and in cultivation trial.

2.5 *Raphia* Palmae

A pantropical genus with 8 spp.

2.5.1 *Raphia hookeri* Mann. & Wendl., West Africa rainforest, wild and cultivated for the fiber, a kind of piassava, and for the preparation of wine.

2.6 *Sansevieria* Agavaceae

Some 60 spp. in tropical Africa and Asia

2.6.1 *Sansevieria senegambica* Baker, Agavaceae, BOW STRING HEMP, West Africa, wild and cultivated, as other species of the genus, for the leaf fibers.

2.7 *Sida* Malvaceae

A pantropical genus with some 75 spp.

2.7.1 *Sida rhombifolia* L., West and Central Africa, often cultivated.

2.8 *Urena* Malvaceae

3 spp. in the tropics of America and Africa.

2.8.1 *Urena lobata* L., West-Central Africa, wild and cultivated.

2.9 Wissadula Malvaceae

Pantropic, 25 spp.

2.9.1 Wissadula amplissima R. E. Fries, East Africa, wild and cultivated.

3. FRUITS AND NUTS

Tropical Africa is rather poor in fruit species in comparison to SE Asia or tropical America. Only the tamarind and the akee have reached some importance outside Africa.

3.1 Adansonia Bombacaceae

10 spp. in the Old World tropics

3.1.1 Adansonia digitata L., BAOBAB, savannas and drier regions in the Sahel - Sudan; not in cultivation properly but widely utilized. The pulp of the fruit and the seeds are eaten in different ways, and the tree has many other different uses.

3.2 Annona Annonaceae

Some 900 spp., mostly American a few in West Africa.

3.2.1 Annona senegalensis Pers. W. Africa. Woody savannas, wild and cultivated.

3.3 Annonidium Annonaceae

3 spp. in West Africa

3.3.1 Annonidium mannii (Oliv.) Engl. & Dills. West Africa, rainforest.

3.4 Balanites Zygophyllaceae

2 spp. in the tropical Africa - Ethiopia

3.4.1 Balanites aegyptiaca (L.) Del., ; West-East Africa, in the Sahel. Used for the fresh fruits and the seeds, coooked to remove certain bitter substances, high in fat and protein.

3.5 Blighia Sapindaceae

3 spp. in West Africa

3.5.1 Blighia sapida Koenig, AKEE, West Africa, intermediate area between rain and deciduous forests; wild and cultivated. Introduced to tropical America and India; mature arils eaten raw or cooked, very poisonous when green.

3.6 Borassus Palmae

4 spp. from Africa to India.

3.6.1 Borassus aethiopium Mart., RONIER, West Africa; in wild populations (Chevalier, 1930), from the beaches to the rainforest, but mostly in open woods or savannas, or cultivated. Used for the unripe or ripe fruits, as a source of palm wine and for the edible shoots.

3.7 Boscia Capparidaceae

30 spp. from West to South Africa.

3.7 .1 Boscia senegalensis (Pers.) Lam., West Africa, wild, fruits eaten cooked.

3.8 Canarium Burseraceae

Around 100 spp. in the Old World tropics.

3.8.1 Canarium shweinfurthii Eng., West Africa in rainforest, used for the pulp and the seeds, cooked or roasted.

3.9 Carissa Apocynaceae

Some 20 spp. in the Old World tropics.

3.9.1 Carissa edulis (Forsk.) Vahl, KARANDA, West Africa to Egypt wild and cultivated. Introduced to other tropical areas.

3.9.2 Carissa macrocarpa (Eckl.) A. DC. (C. grandiflora) NATAL PLUM, East and South Africa, wild and cultivated; introduced to the American and Asiatic tropics.

3.10 Chrysophyllum Sapotaceae

Around 100 spp., mostly in tropical America.

3.10.1 Chrysophyllum albidum G. Don., WHITE STAR APPLE, West African rainforest, wild and cultivated.

3.10.2 Chrysophyllum delevoyi De Wild. (C. edule, C. africanum),AFRICAN STAR APPLE, West African rainforest, wild and cultivated.

3.10.3 Chrysophyllum perpulchrum Mildbr. and C. pruniforme Engl., wild in West Africa, utilized for the fruits.

3.11. Citropsis Rutaceae

An African genus with some 11 spp.. They are not fruit trees but may be important as breeding material or for grafting Citrus.

3.11.1 Citropsis spp., ,-West Africa, in the rainforests, may be important as rootstocks for Citrus.

3.12 Citrullus Cucurbitaceae

4 spp. in Africa and Asia.

3.12.1 Citrullus lanatus (Thumb.) Mansf., WATER MELON. East to South Africa in dry areas, wild populations, colocynthoides, in SW Africa, with white pulp, bitter or sweet. Many primitive cultivars in West and East Africa for fruit or fodder. Introduced since ancient times to Europe and Asia and the rest of the tropics and subtropics. Advanced cultivars, some triploid and seedless developed elswhere (USA, Indian, Europe)

3.13 Cordyla Papilionaceae

A monotypic genus, West Africa.

3.13.1 Cordyla pinnata (Lepr.) Milne-Rehd., WILD MANGO, West African, in woody savannas, fruits edible cooked or fresh, apparently variable in quality.

3.14 Cucumis Cucurbitaceae

Around 40 species in the tropics of the Old World.

3.14.1 Cucumis melo L., MELON. In West Africa, wild populations= agrestis, quite variable; many primitive cultivars in East and West Africa. Elsewhere, in USA and Europe.

3.15 Dacryodes Burseraceae

Some 50 spp. in the Old World tropics.

3.15.1 Dacryodes edule (G. Don.) H. H. Lam., BUSH BUTTER TREE. West Africa, in forests, often cultivated. Used for the pulp and seeds, cooked or roasted, but its main importance is as a source of oil.

3.16 Diospyrus Ebenaceae

Around 240 spp. in the tropics and subtropics of both hemispheres.

3.16.1 Diospyrus mespiliformis Hochst., MONKEY GUAVA, tropical Africa, from Senegal to East Africa, wild or tolerated; fruit eaten fresh.

3.17 Dovyalis Flacourtiaceae

25 spp. in Africa, Madagascar, India.

3.17.1 Dovyalis abyssinica (A. Rich.) Warb., East Africa, savannas and forests, wild and cultivated.

3.17.2 Dovyalis caffra (Hook. & Harv.) Warb.,, KEYAPPLE, East and South Africa, savannas, wild and cultivated.

3.18 Mammea Guttiferae

2 spp., one in tropical America, 1 in West Africa

3.18.1 Mammea africana Sabine, West Africa rainforest, fruits eaten fresh.

3.19 Nauclea Rubiaceae

Some 50 spp., from West Africa to Polynesia.

3.19.1 Nauclea latifolia Sm., AFRICAN PEACH, West Africa, savannas, wild, fruits gathered; cultivated in other regions of the tropics.

3.20 Parinari Chrysobalanaceae

Around 60 spp., in the tropics of South America and West Africa.

3.20.1 Parinari curatellifolia Planch., P. excelsa Sabine, West Africa, rainforest, wild and left when the forest is cut, for its fruits and seeds.

3.21 *Parkia* Mimosaceae

Some 20 spp., in the tropics of both worlds.

3.21.1 *Parkia biglobosa* (Jacq.) Benth., AFRICAN LOCUST. West Africa, in savannas, and forests, wild or in primitive cultivation, for the dry pulp and the seeds (used to prepare a kind of paste, rich in fat and protein).

3.22 *Phoenix* Palmae

Around 20 spp., tropics and subtropics of Asia and Africa.

3.22.1 *Phoenix reclinata* Jacq., West Africa, used for the fruits, fresh or in wine.

3.23 *Saba* Apocynaceae

3.23.1 *Saba senegalensis* (A.DC.) Pich. (*Landophia senegalensis*), West Africa, savannas, wild,fruits gathered and sold in markets.

3.24 *Tamarindus* Caesalpiniaceae

A monotypic genus, tropical Africa.

3.24.1 *Tamarindus indica* L. TAMARIND. Tropical Africa. *T. indica* is of very ancient cultivation, spread early to India, and after 1500, to the other parts of the tropics; seed propagated, some distinct types in Africa and America.

3.25 Telfairia Cucurbitaceae

An African genus with 2 spp.

3.25.1 Telfairia occidentalis Hook. f., FLUTED PUMPKIN, West Africa rainforest area, cultivated; used for the seeds cooked and eaten as nuts or vegetables. No information on its diversity (dioecious).

3.25.2 Telfairia pedata (Sm.) Hook. f., 'OYSTERNUT', West-East Africa, seeds roasted or cooked, also for oil extraction.

3.26 Treculia Moraceae

6 spp. in tropical Africa.

Treculia africana Dcne., AFRICAN BREAD FRUIT, West Africa rainforest, wild and cultivated, seeds eaten cooked or grounded.

3.27 Vangueria Rubiaceae

40 spp. in the tropics of Africa, Madagascar - India.

3.27.1 Vangueria madagascariensis J. F. Gmel. (V. edulis). East Africa, Madagascar, wild and cultivated.

3.28. Vitex Verbenaceae

Around 75 spp. in the tropics and subtropics of the Old and New World.

3.28.1 Vitex doniana Sweet, BLACK PLUM, West Africa, wild and cultivated.

3.29 Ziziphus Rhamnaceae

40 spp., mainly in SE Asia, some in Africa and South America, in dry areas.

3.29.1 Ziziphus mauritiana Lam., West Africa, Sahel to Arabia, Far East., two varieties are distinguished by Chevalier (1947): arthocantha and abyssinica; many cultivars.

3.29.2 Ziziphus spina-christi (L.) Desf. North, Central and West Africa, in dry areas, wild and cultivated.

4. GRAIN LEGUMES

4.1 Cajanus — Papilionaceae

A monotypic genus of the tropics of Asia and Africa, very close if not identical, to Atylosia.

4.1.1 Cajanus cajan (L.) Millsp. (Cajanus indicus Spreng.), PIGEON PEA. The common assumption that C. cajan is an African crop is based on the presence of a wild taxon, 'Kersting', formerly considered as a species, but probably only a population of C.cajan. The Indian origin of this crop seems well supported (vander Maesen, 1980). However, there are in Africa many land races. A basic collection of world wide materials, at IITA, Ibadan, Nigeria. Important collections in India at ICAR.

4.2 Cordeauxia — Papilionaceae

A monotipyc genus in East Africa.

4.2.1 Cordeauxia edulis Hemsl. YEHEB, mostly wild, in the arid zones of Somalia and S. Ethiopia, its seeds used as nuts (Miege & Miege, 1978).

4.3 Dolichos — Papilionaceae

Some 60 spp., African and Asian tropics.

4.3.1 Dolichos purpureus (L.) Sweet (D. lablab L., Lablab niger Medik.). As Africa is quite rich in species of Dolichos, D. purpureus is presumably of African origin; however, the largest number of cultivars, around 30, are found in India.

4.4 *Macrotyloma* Papilionaceae

An Old World genus, with 70 spp., mostly in Africa.

4.4.1 *Macrotyloma geocarpa* (Harms) Maréchal & Baudet (*Kerstingiella geocarpa* Harms), KERSTING GROUND NUT. West Africa, cultivated, wild in Cameroon= var. *tisseranti*. According to Hepper (1963), the cultivated types have 2n: 22, the wild, 2n: 20. The cultivation of this species and of *Voandzeia*, are decreasing due to the competition of peanuts (Amuti, 1980).

4.5 *Parkia* Mimosaceae

Pantropical, 20 spp., mostly in Africa.

4.5.1 *Parkia biglobosa* (Jacg) Benth. LOCUST BEAN, wild and tolerated in the savanna, seeds used in the preparation of a kind of porridge, highly nutritive.

4.6 *Pentaclethra* Mimosaceae

A tropical genus, America and Africa, with 3 spp.

4.6.1 *Pentaclethra macrophylla* Benth., OIL BEAN TREE, West Africa, wild, intensively gathered, seeds eaten cooked or roasted.

4.7 *Sphenostylis* Papilionaceae

5 spp. in Africa; very close to *Vigna*.

4.7.1 *Sphenostylis stenocarpa* (Hochst.) Harms, YAM BEAN, seeds used, but more important as a tuber crop (seed ROOT and TUBERS).

4.8 Tylosema Papilionaceae

A South African genus with 2 spp.

4.8.1 Tylosema esculentum (Burchell) A. Schreiber, MARAMA BEAN, wild and gathered in Bostwama and Namibia, for the seeds, eaten cooked (National Academic of Sciences of USA, 1979).

4.9 Vigna Papilionaceae

Between 100-150 spp., in Africa and Asia.

4.9.1 Vigna unguiculata (L.) Walp. COWPEA, wild, weedy and primitive cultivars in West Africa, the later spp. unguiculata, domesticated from the wild subspecies dekindtiana and mensensis. V. unguiculata and other related species such as V. campestris (Mart.) Wilczek, grow in the savanna - open wood areas, where they show a wide polymorphism. Collections of primitive and advanced cultivars at IITA (Porter et al. 1974).

4.10 Voandzeia Papilionaceae

A monotypic genus, West Africa.

4.10.1 Voandzeia subterranea (L.) Thouars, BAMBARRA NUT, widely cultivated in the open forest savanna region across the continent and extending to South Africa, and west to Angola and southern Zaire; wild populations in Nigeria - Cameroon; numerous cultivars in Nigeria, Zimbabwe, Ghana, etc. planted in gardens and being actively replaced by peanuts (Dokw & Karikari, 1971) (Johnson, 1968; Hepper, 1963).

5.5.1 Elaeis guineensis Jacq., AFRICAN OIL PALM, West Africa rainforest. Wild and semicultivated populations; also advanced cultivars. Incipient domestication in West Africa (Zeven, 1972), but at present mostly of the advanced cultivars, especially hybrids with E. oleifera, have been developed in Malaysia, or in European plantations in Nigeria, Ivory Coast, etc. The improvment at the beginning had a very narrow genetic base, especially in Indonesia and was established on the Dura genotype. In Zaire, a number of local populations were collected and tested, especially the 'Tenera' types and more recently the work in Est Africa breeding stations and in Malaysia include a wide diversity of West African genotypes, and so the breeding materials are of very different geographic origin.

A large number of incipient selections, highly polymorphic, are kept by the natives in home groves.

5.6 Guizotia — Compositae

An African genus with 8 spp.

5.6.1 Guizotia abyssinica (L.f.) Cass., NIGER SEED, East Africa, wild and cultivated; introduced to India, U.S.A., etc.

5.7 Hyptis — Lamiaçeae

A pantropical genus, with some 300 spp.

5.7.1 Hyptis spicigera Lam., [illegible], West to East Africa, wild and cultivated, often mixed with rice; seeds used as sesamum.

5.8 Irvingia — Simarubaceae

8 spp. in the tropics of Africa - Asia.

5.8.1 Irvingia gabonensis (Audbry-Lecomte) Baill., DIKA NUT, West Africa, rainforests; seeds used in the preparation of a paste that is mixed with foods and spices, and a fat, used as an adulterant of cacao butter.

5.9 Lophira — Simarubaceae

8 spp. in the tropics of Africa - Asia.

5.9.1 Lophira alata Banks, KAKU OIL TREE, West Africa, savannas and dry forests, nuts edible, oil used for cooking purposes. Very close is L. lanceolata Van Thieghm.

5.10 Pentadesma — Guttiferae

A West Africa genus with 4 spp.

5.10.1 Pentadesma butyracea Sab. LAMI, West Africa; seeds used to extract an edible oil.

5.11 Ricinodendron — Euphorbiaceae

3 spp. in tropical Africa.

5.11.1 Ricinodendron hendelotti (Baill.) Pierre, EZEZAN, West Africa, wild and tolerated, used locally for cooking or soap.

5.12 Ricinus — Euphorbiaceae

A monotypic genus, central and east Africa.

5.12.1 Ricinus communis L., CASTOR BEAN, Spontaneous populations all over tropical Africa, recognized as botanical varieties and forms on morphological characters and geographic distribution. A large number of landraces, feral and weedy populations. The advanced cultivars, for instance of low habit, have been bred in USA, USSR., etc.

5.13 Sesamum Pedaliaceae

A round 35 spp., in Africa, Asia and Australia.

5.13.1 Sesamum indicum L., SESAME. Tropical Africa, where the most primitive cultivars are still found. However, the largest diversity in outside Africa, especially in India and China. In West Africa, S. indicum is planted together with S. radiatum, but these two species to not hybridize, and with Cerotheca sesamioides. The closest species, S. capense and S. schencki, grow in East - South Africa, the last is considered by some specialists as the possible ancestor of S. indicum. In Africa sesame is known only in cultivation; in India there is a spontaneous race, malabaricum, which may be a weedy or an escape, and produces fertile hybrids with S. indicum. The improved cultivars have been developed outside Africa= India, U.S.A., U.S.S.R., Venezuela.

5.13.2 Sesamum radiatum Schum., West Africa in the savanna areas, wild and cultivated. S. alatum Thonn. is cultivated most as a vegetable in E. African

5.14 Telfairia Cucurbitaceae

2 species from West Africa to the Mascarenes islands. Although both

are used as vegetables for the tips of the vines and the cooked seeds, their main use is for the oil in the seeds.

5.14.1 Telfairia occidentalis Hook. f., FLUTED PUMKIN, West Africa rainforests, cultivated, seeds cooked.

5.14.2 Telfairia pedata (Sm.) Hook. f., OYSTER NUT, West-East Africa, cultivated, seeds eaten or for oil.

5.15 Treculia Moraceae

6 spp in West Africa

5.15.1 Treculia africana Dcne., AFRICAN BREAD FRUIT, West Africa, rainforest, seeds eaten cooked or ground, wild and cultivated.

5.16 Voandzeia (seed under Grain legumes).

6. PASTURES

A. Grasses (Jacques - Félix, 1962; León & Sgaravatti; Bogdan, 1977).

The African grasses are, perhaps, the most valuable of the genetic resources in tropical Africa. They include a large number of genera and species, which by the selection pressure of intensive grazing by wild and domestic herbivores, drought and fire, have reached a competition capacity which is not found in grasses of other regions. Up to now, only a very small fraction of their variability has been exploited. Their wide ecotypical diversity offers, in the same species, materials of wide adaptability, often happens that a forest ecotype results more promising than others growing in the savannas. Many of the cultivars obtained in local programs, are simply ecotypical selections, and the poliploidy and apomixis so frequent in many species, offer unique opportunities for future breeding.

Up to now there is no serious threat of genetic erosion in the African grasses. The lack of a modern cattle industry, with the consequent establihment of uniform pastures, is a most decisive factor in its conservation. But it is necessary to establish large living collections, where the ecotypes could be studies and evaluated in their resistance to drought, in yield, seed production and other factors, and to make them available to other tropical regions.

There are several species in which selected cultivars have been described, and on which commercial seed is available.

In pasture legume, on the contrary, Africa is rather poor in comparison to tropical America.

6.1 Acroceras — Paniceae

Some 15 spp. in Africa mainly, Madagascar to SE Asia.

6.1.1. Acroceras macrum Stapf, NILE GRASS, East to South and West Africa.

6.2 Andropogon — Andropogoneae

110 spp. in the tropics of the New and the Old World.

6.2.1 Andropogon gayanus Kunth. GAMBA, diploid and tetroploid populations tropical areas, wet or dry, three varieties, one of wide distributions, two in West Africa.

6.3 Beckeriopsis — Paniceae

5 spp. in Africa, especially in the east and South.

6.3.1 Beckeriopsis uniseta (Ness.) Robyns, NATAL GRASS, tropical and southern areas, wild and cultivated.

6.4 Brachiaria — Paniceae

An important genus of cultivated grasses, with some 50 spp., mostly in Africa.

6.4.1 Brachiaria brizantha (Hoscht.) Stapf SIGNAL, tetra and hexaploid populations, apomictic; central and eastern regions.

6.4.2 Brachiaria decumbens Stapf., East Africa, over 800 m., introduced to tropical regions; commercial cultivars selected in Australia.

6.4.3 Brachiaria humidicola (Rendle) Schweickt. CORONIVIA, East Africa, hexaploid, introduced to other tropical regions.

6.4.4 Brachiaria mutica (Forsk.) Stapf, PARA, West Africa, formerly adscribed to tropical America, widely distributed, one of the most important grasses in the tropics.

6.4.5 Brachiaria plantaginea (Link.) Hitch., West Africa, wet areas; introduced to tropical America.

6.4.6 Brachiaria radicans Napper, TANNER, West To East Africa in wet places.

6.4.7 Brachiaria ruzizensis Germ. & Evrard, CONGO, Central-Eastern Africa, cultivars selected in Australia.

6.5 Cenchrus Paniceae

Around 25 spp., in tropical and temperate areas of both worlds.

6.5.1 Cenchrus ciliaris L., BUFFEL, Central Africa to India; in dry areas a very polymorphic species many cultivars selected in Africa, USA, Austrlia, divided in two groups: tall and stoloniferous and low, non stoloniferous.

6.5.2 Cenchrus setigerus Vahl, ANJAN, East Africa to India, rather uniform, tetraploid and hexaploid types.

6.6 Chloris Chlorideae

40 spp., in tropical America and Africa to India.

6.6.1 Chloris gayana Kunth, RHODES, tropical and subtropical areas, many cultivars, diploid and tetroploid, cross pollinated.

6.7 Cynodon Chlorideae

7 spp., mostly in Africa.

6.7.1 Cynodon dactylon L., BERMUDA, in native conditions mainly in subtropical areas, many cultivars. In West Africa, var. aridus diploid, vigorous and variable.

6.7.2 Cynodon nlemfuensis Vanderyst, STAR, central and eastern regions, several cultivars, widely cultivated in the American tropics.

6.7.3 Cynodon aethiopicus Clayton & Harlan, East Africa, several cultivars, commonly planted in tropical America.

6.7.4 Cynodon plectostachyus (Schum.) Pilger, GIANT STAR, Eastern region, mainly cultivated. Information on this species in field trials outside Africa actually refers to C. aethiopicum.

6.8 Dichanthium — Andropogonae

8 spp. in tropical and temperate areas of the Old World.

6.8.1 Dichanthium annulatum (Forsk.) Stapf, MARVEL, Central Africa to India, where some selections have been made.

6.9 Digitaria — Paniceae

Around 380 spp., 50 in Africa, also in the American and Asiatic tropics.

6.9.1 Digitaria decumbens Stent., PANGOLA, East-South regions, a close ally of D. pentzi.

6.9.2 Digitaria eriantha Stent., WOLLY FINGER, South, East Africa to India.

6.9.3 Digitaria milanjiana (Rendle) Stapf, East Africa, very variable, close to D. pentzi.

6.9.4 Digitaria pentzii Stent. East South Africa, a highly variable complex, with diploid to hexaploid populations.

6.9.5 Digitaria swazilandensis Stent., SWAZI, eastern - southern regions.

6.9.6 Digitaria valida Stent., GIANT PANGOLA, South - Eastern regions, probably a variaty of D. pentzi.

6.10 Echinochloa Paniceae

25 spp. in the tropics of both worlds.

6.10.1 Echinochloa pyramidalis (Lam.) Hitchc. & Chase, ANTELOPE, Eastern - Southern regions, many varieties, di and triploids, mostly tetraploid.

6.11 Entolasia Paniceae

2 spp. in NE Africa.

6.11.1 Entolasia imbricata Stapf, BUMGOMA, Eastern region. A little known grass, of high protein content.

6.12 Hemarthria Andropogonae

8 spp. in the Old World tropics.

6.12.1 Hemarthria altissima (Poir.) Stapf & Hubb., LIMPO, Western to Eastern Africa, early introduced to South America, very variable, diploid and tetraploid populations.

6.13 Heteropogon Andropogoneae

A large genus, 90 spp., mainly in Africa, some in Asia and Australia; a source of potential pastures.

6.13.1 Heteropogon contortus (L.) Beauv. SPEAR, tropical Africa to Australia, a polymorphic species.

6.14 <u>Hyparrhenia</u> Andropogoneae

A large genus, 90 spp., mainly in Africa, some in Asia and Australia; a source of potential pastures.

6.14.1 <u>Hyparrhenia rufa</u> (Ness) Stapf, JARAGUA, tropical Africa; other Hyparrhenia spp. are promising as grasses for open pastures. <u>H. rufa</u> is a very important pasture in tropical America, where some new variants are known.

6.15 <u>Melinis</u> Paniceae

Close to 17 spp., all in Africa.

6.15.1 <u>Melinis minutiflora</u> Beauv., MOLASSES, West Africa to Madagascar, several cultivars and many different wild populations.

6.16 <u>Panicum</u> Paniceae

A large and complex genus, 500 spp. in the tropics and temperate areas of both worlds. In Africa, around 50 spp., several important pastures.

6.16.1 <u>Panicum coloratum</u> L. MAKARIKARI, East Africa, several cultivars, a quite polymorphic species.

6.16.2 <u>Panicum maximum</u> Jacq., GUINEA, tropical Africa, many natural populations and cultivars. An extremely variable grass, selection based on size of plants, clonally propagated; apomictic.

6.16.3 <u>Panicum trichocladum</u> K. Schum., IKOKA, East Africa, wild and cultivated in Kenya.

6.17 Pennisetum Paniceae

130 spp., 100 in Africa, several important as pastures.

6.17.1 Pennisetum americanum (L.) K. Schum., (P. typhoideum, P. glaucum), PEARL MILLET, West - Central regions, as a grass planted in other areas of the world, many cultivars.

6.17.2 Pennisetum clandestinum Hochst., KIKUYU, highlands of East Africa, several cultivars selected in Australia.

6.17.3 Pennisetum purpureum Schumach. ELEPHANT, tropical Africa, many cultivars and wild populations. Among the fist, 'Merkei' and 'Napici' are the most common in all tropical areas; several hybrids with P. americanum.

6.18 Rhychelytrum Paniceae

35 spp. from Africa, mostly in the east.

6.18.1 Rhychelytrum repens (Willd.) C.E. Hubb. (Tricholaena repens, T. rosea), NATAL, West to South Africa - Madagascar, widely cultivated in tropical America.

6.19 Setaria Paniceae

Around 100 spp., in the tropical and temperate areas of both worlds.

6.19.1 Setaria anceps Stapf, (S. sphaecelata), SETARIA, East and Southern regions, several cultivars, diploid and tetraploid.

6.20 Sorghum Andropogoneae

Some 60 spp. in the tropics and temperate regions of the Old World.

6.20.1 Sorghum sudanense (Piper) Stapf, SUDAN, hybrid populations (virgatum x bicolor), several cultivars, diploid and tetraploid.

6.21 *Themeda* Andropogoneae

15 spp., mostly in SE Asia.

6.21.1 *Themeda triandra* Forsk., ROOIGRASS, tropical and South Africa, apomictic, 2n, 4n, 6n and 8n populations.

6.22 *Urochloa* Paniceae

20 spp. in the tropics of the Old World, around 12 in tropical Africa.

6.22.1 *Urochloa mosambicensis* (Hack.) Dandy, tropical and South Africa, apomictic, tetraploid and hexaploid populations.

B. LEGUMES

6.23 Clitoria — Papilionaceae

40 spp. in the tropics and subtropics.

6.23.1 Clitoria ternatea L., CORDOFAN PEA, tropical Africa and Madagascar; several known cultivars.

6.24 Glycine — Papilionaceae

10 spp. in tropical Africa and Asia.

6.24.1 Glycine wightii (R. Grah.) Verdc. (G. javanica) GLYCINE, Eastern region to India; several subspecies natural populations and cultivars, diploid and tetraploid. Widely cultivated= Australia, tropical America.

6.25 Indigofera — Papilionaceae

A pantropical genus, with some 700 spp.

6.25.1 Indigofera spicata Forsk. (I. endecaphylla), TRAILING INDIGO, tropical Africa to Australia, diploid and tetraploid types, clonally propagated.

6.26 Lablab — Papilionaceae

A monotypic genus; the African populations are the source of several forage cultivars.

6.26.1 Lablab purpureus (L.) Sweet, HYACINTH BEAN, East Africa, several cultivars selected in Australia. ssp. uncinatus from E. Africa is widely used as a forage.

6.27 *Lototonis* Papilionaceae

A genus with some 100 spp. from South Africa to West Asia.

6.27.1 *Lototonis bainesi* Baker, South Africa, very narrow variability, introduced to Australia and tropical America.

6.28 *Macrotyloma* Papilionaceae

An Old World genus, with several species formerly in *Dolichos*, etc.

6.28.1 *Macrotyloma allixare* (Wight. & Arn.) Verdc. (*Dolichos axillaris*), tropical Africa and Madagascar, several cultivars selected in Australia.

6.29 *Trifolium* Papilionaceae

Some 300 spp., mostly in temperate areas of the northern hemisphere. In Africa the most interesting germplasm sources are in the highlands of Kenya and Tanzania.

6.29.1 *Trifolium semipilosum* Fresen, KENYA WHITE CLOVER, Eastern Africa highlands, several cultivars.

6.30 *Vigna* Papilionaceae

Around 50 spp., in the Old World tropics.

6.30.1 *Vigna luteola* (Jacq.) Benth. (*V. repens*), tropical Africa to SE Asia; cultivars selected in Australia.

7. ROOTS AND TUBERS

7.1 Dioscorea — Dioscoreaceae

A pantropical genus, with a few species in temperate areas. In Africa other species, not cultivated are gathered for their tubers.

7.1.1 Dioscorea abyssinica Hochst. Wild in E. Africa and cultivated, especially in Uganda.

7.1.2 Dioscorea bemandry Jum. & Perr. BEMANDRY, Madagascar, widely cultivated, similar to D. soso.

7.1.3 Dioscorea bulbifera L. West Africa, wild and cultivated, also in SE Asia, of independent domestication. The African types, of inferior quality to the Asiatic, were introduced after 1500 to tropical America; many clones in W. Africa.

7.1.4 Dioscorea cayenensis Lam. YELLOW YAM. Wild and widely cultivated in W. Africa, in the tropical rainforest region; quite close to D. rotundata but hardier, higher yielding and could be harvested in a longer period of the year (Coursey, 1967).

7.1.5 Dioscorea colocasiifolia Pax, West Africa, wild, and in cultivation restricted to Ghana.

7.1.6 Dioscorea dumentorum (Kunth) Pax, BITTER YAM, wild (poisonous) and cultivated types practically free of alkaloids; several clones known.

7.1.7 Dioscorea ovinala Baker, Madagascar, a species of relict cultivation, the tubers of good quality.

7.1.8 Dioscorea quartiniana A. Rich., West Africa in the Savanna region, many varieties.

7.1.9 Dioscorea praehensilis Benth., WHITE YAM, wild and cultivated, considered by some specialists as the ancestor to D. rotundata.

7.1.10 Dioscorea rotundata Poir., WHITE YAM, is the most important species in West Africa, known only in cultivation in the rainforest and the savanna regions, many clones. Quite close to D. cayenensis, but could be differentiated on anatomical characters (Coursey, 1976). Introduced to tropical America.

7.1.11 Dioscorea sansibarensis Pax, Central and East Africa; non-toxic forms widely cultivated.

7.1.12 Dioscorea soso Jum. & Perr., Madagascar, formerly widely cultivated, now displaced by other root crops.

Several other species are gathered or cultivated in small scale in Africa and Madagascar (Chevalier, 1936; Coursey, 1967, 1976).

7.2 Ensete Musaceae

An African - tropical Asia genus with some 7 spp.

7.2.1 Ensete ventricosum (Welw.) E.E. Cheesman, ENSETE, Ethiopia, widely cultivated for the corms.

7.3 Plecthranthus Lamiaceae

110 spp. in the tropics of Africa and Asia.

7.3.1 Plecthranthus esculentus N.E. Brown, (P. floribundus, Coleus dazo, C. esculentus, C. floribundus), KAFFIR POTATOE, West Africa in the forest region; several varieties described as species. Its cultivation is decreasing and may even dissapear due to the amount of labor it requires (Busson, 1965).

7.4 Psophocarpus Papilionaceae

An African - Asian genus, with 5 spp.; used also as a vegetable.

7.4.1 Psophocarpus scandens (Endl.) Verd. West and East Africa, Madagascar, wild and cultivated. Formerly reported as P. palustris.

7.4.2 Psophocarpus tetragonolobus (L.) DC. WINGED BEAN. It is included here as its closest allies are African: P. scandens, P. palustris, P. grandiflorus. (Verdcourt & Halliday, 1978), because it is not known in wild stage. In cultivation it is more common in SE Asia, and its highest variability is found in New Guinea, but this does not necessarily means that it is of Asian origin.

7.5 Solenostemon Lamiaceae

8 spp. in West Africa, formerly included in Plecthranthus.

7.5.1 Solenostemon rotundifolius (Poir.) J.K. Morton (Coleus dysintericus, Plectranthus tuberosus). SUDAN POTATOE. West Africa, in the savanna region where its cultivation has decreased in spite of high yield, taste and nutritive value, due to the expansion of introduced crops. (Busson, 1965).

7.6 Sphenostylis Papilionaceae

5 spp., in Africa.

7.6.1 Sphenostylis stenocarpa (Hochst.) Harms, YAMBEAN, West Africa, in the savanna region, widely cultivated for the roots and pods; extremely variable (Wilezek, 1954). Close is S. briarti De Wild., also used in Zaire for its tubers and seeds; some narrow-leaf variants in Eastern Africa (Okigbo, 1973).

7.7 Tacca Taccaceae

Africa to SE Asia, 15 spp.

7.7.1 Tacca leontopetaloides (L.) O. Ktze., BOLBOGO, West and Central Africa, in rainforests, wild populations.

8. RUBBER

Africa is quite rich in rubber-yielding plants, although no African species has reached world wide importance. In fact, Hevea is the main source of rubber for tropical Africa. The rubber yielding species of African origin are mostly Apocynaceae, trees or vines which latex have different characteristics than Hevea or Ficus, and are still locally used. Among the most important species, all of West Africa, are:

8.1.1 Funtumia elastica Stapf, Apocynaceae, a tree which yields a good quality rubber, of high elasticity. Its cultivation was attempted early this century, but was replaced by Para rubber.

8.2.1 Landolphia awariensis Beauv., Apocynaceae, produces a low quality rubber.

9. SPICES AND CONDIMENTS

9.1 Aeolanthus — Lamiaceae

25 spp. in Africa.

9.1.1 *Aeolanthus heliotropioides* Oliv., West Africa, wild and cultivated, young leaves used as condiment.

9.2 Aframomum — Zingiberaceae

50 spp. in tropical Africa.

9.2.1 *Aframomum angustifolium* (Sonn.) K. Schum., GREAT CARDAMOM, Madagascar, cultivated also in East Africa.

9.2.2 *Aframomum korarima* K. Schum., KORARIMA, cultivated in Ethiopia.

9.2.3 *Aframomum letestuanum* Gagnep., Cameroon, wild and cultivated (Westphal et al., 1980).

9.2.4 *Aframomum melegueta* (Rosc.) K. Schum., GRAINS OF PARADISE, MELEGUETA PEPPER. The origin of this spice is now agreed to be this West African species, cultivated from Sierre Leone to Nigeria (Hepper, 1967).

9.3 Afrostyrax — Huaceae

An African genus with 3 spp.

9.3.1 *Afrostyrax lepidophyllus* Mildbr., West Africa, wild and sold in markets.

9.4 Beilschmedia — Lauraceae

A pantropical genus with some 40 spp.

9.4.1 Beilschmiedia manni (Meiss.) Robyns & Wilczek, SPICI CEDAR, West Africa rainforest, ground seeds and flowers added to foods.

9.5 Fagara Rutaceae

140 spp. in the tropics of both worlds.

9.5.1 Fagara tessmannii Engler, West Africa, wild and cultivated, fruits used as spice.

9.6 Monodora Annonaceae

10 spp. in Africa and Madagascar.

9.6.1 Monodora myristica (Gaertn.) Dunal, CALABASH NUTMEG, West Africa, wet forests; seed used as a condiment.

9.7 Piper Piperaceae

A pantropical genus with around 700 spp., several spices in SE Asia.

9.7.1 Piper guineense Schum. & Thomm, ASHANTI PEPPER, West Africa, in rainforests, wild and cultivated, dry berries used to flavor food.

9.8 Plectranthus Lamiaceae

110 spp. in the tropics of Africa and Asia.

9.8.1 Plectranthus glandulosus Hook. f., West Africa, wild and cultivated leaves used as condiment.

9.9 Pycnanthus Myristicaceae

5 spp. in tropical Africa.

9.9.1 Pycnanthus angolensis Warb., FALSE NUTMEG, West Africa rainforest, used as a spice secondarily to their use as an oil source.

9.10 Rhamnus Rhamnaceae

Some 100 spp., mostly in the northern hemisphere.

9.10.1 Rhamnus pauciflorus Hochst. , Ethiopia, in the highlands used to give a bitter taste to foods and beer (Simmons, 1960).

9.11 Xylopia Annonaceae

60 spp. in the tropics of America and Africa.

9.11.1 Xylopia aethiopica (Dunal) A. Rich., AFRICAN PEPPER, West Africa, wild and cultivated, fruits used as condiment, formerly exported to Europe (Westphal, Mbouemboue and Boyomo, 1980).

10. STIMULANTS

10.1 *Catha* Celastraceae

A monotypic genus, East Africa - Arabia.

10.1.1 *Catha edulis* Forsk., KHAT, East Africa, from Ethiopia to Transvaal; early introduced to Arabia (Greenway, 1947); several market kinds known in Ethiopia (Getahun & Krikorian, 1973).

10.2 *Coffea* Rubiaceae

Around 55 spp. in Africa, Madagascar - India.

10.2.1 *Coffea arabica* L. ARABICA COFFEE, tetraploid, highly self fertile, native to the mountains of SW Ethiopia and adjacent areas of Sudan; many spontaneous populations (Meyer, 1968). The origin of *C. arabica* is still unexplained, but very likely it is an allotetraploid. If so, one of the possible parents may be *C. eugenioides*, diploid, also occurring in the highlands of Eastern Africa, where *C. arabica* originated. Many "wild" populations in the mountains of Ethiopia and Sudan, showing wide polymorphism, some of them valuable for resistance to diseases and pests. Collections mostly outside the region= CATIE, Turrialba, Costa Rica; Instituto Agronómico Campinas, Sao Paulo, Brasil. Breeding work in Colombia, Brasil.

10.2.2 *Coffea canephora* Froehn. ROBUSTA COFFEE, West Africa, from the coast to the mountains of Uganda; a diploid, open pollinated, highly polymorphic species. Different populations have been introduced to SE Asia - Indonesia, as "species": *C. robusta*, *C. laurenti*, *C. kouiloiensis* and other. C. arabica and C. canephora were in cultivation before the arrival of the Europeans, the first in Ethiopia from which it spread to Yemen, the second in the region of the great lakes. No other Coffea spp. were known in cultivation. C. congensis is quite similar in some traits to C. canephora; C. eugenioides to C. arabica. Breeding work in Robust in West Africa is aimed now to produce hybrids with C. arabica, using canephora lines with duplicate genomes. There are no important collections of C. canephora and is difficult to mantain the genetic identity of the entries, due to self-incompatibility.

10.2.3 Coffea liberica Hiern. LIBERICA COFFEE, West Africa, wild and cultivated. A series of inbreeding populations, diploid, which in some areas of the Congo basin show characteristic differences, such as the 'Indonesiés', or the 'Excelsa', more adapted to dry conditions. The cultivation of C. liberica is practically disappearing in Africa.

10.3 Cola Sterculiaceae

Some 50 spp. in West Africa.

10.3.1 Cola acuminata (Beauv.) Schott & Endl., KOLA, West African rainforest, from Nigeria to Gabon, wild and cultivated, has been supplanted by C. nitida, but still is produced and marketed in small quantities.

10.3.1 Cola nitida (Vent.) Schot. & Endl., KOLA. West Africa. Its probable area of origin is Ghan-Ivory Coast. Widely cultivated in West Africa from Sierra Leona to Nigeria and introduced to tropical America. Propagation clonal or by seed (van Einajten, 1969); apparently only a few cultivars have been established.

11. SWEETENERS

11.1. *Dioscoreophyllum* Menispermaceae

5 spp. in tropical Africa.

11.1.1 *Dioscoreophyllum cummiasii* Diels., SERENDIPIDITY BERRY, West Africa rainforest; the pulp of the fruits is intensely sweet (Adansi, 1970).

11.2 *Synsepalum* Annonaceae

4 spp. in West Africa

11.2.1 *Synsepalum dulcificum* (Schum. & Thonn.) Daniell, MIRACLE FRUIT, West Africa, wild and cultivated for the pulp of the fruit, which has the property of affecting the taste for a certain period, during which everything tastes sweet. Also *S. glycyodorum* Wernh., *S. stipulatum* (Radlk.) Engl., *S. subcordatum* De Willd., seem to have the same property.

11.3 *Thaumatoccocus* Marantaceae

A monotypic genus in West Africa.

11.3.1 *Thaumatoccocus danielli* Benth., West Africa, Rainforest clearings, sweetenign principle in the aril of the seeds (Adansi, 1970).

12. VEGETABLES

12.1 Abelmoschus — Malvaceae

50 spp. in the tropics from West Africa to Australia

12.1.1 Abelmoschus esculentus (L.) Moench., OKRA. Although in several recent papers (Borssum - Walkers, 1966; Bates, 1968) the original area of A. esculentus is adscribed to India, in other (Harlan et al., 1978) it is considered as African. Chevalier (1940) believes it derives from A. ficulneus, which is found wild and cultivated in East Africa, Madagascar, India, and describes several varieties in Central Africa.

12.2 Amaranthus — Amaranthaceae

A pantropical genus with around 60 spp.

12.2.1 Amaranthus cruentus L. Although this species originates in Central America, it shows in Africa, as a vegetable, several centers of diversifications: Nigeria, Angola, Mozambique, etc. (IBPGR, 1981).

12.3 Asparagus — Liliaceae

Around 300 spp., in the temperate and tropical areas of the Old World.

12.3.1 Asparagus abyssinicus Hochst. Ethiopia, wild, cultivated.

12.3.2 Asparagus racemosus Willd., Sudan wild, gathered for the shoots.

12.4 Celosia — Amaranthaceae

35 spp. in temperate and tropical regions.

12.4.1 Celosia argentea L., a pantropic species, with centers of diversity as a leaf vegetable in Africa, where several cultivars have been selected (Epenjuijsen, 1978). C. trigyna L. is also used as vegetable.

12.5 Ceratotheca Pedaliaceae

5 spp., from West to South Africa.

12.5.1 Ceratotheca sesamoides Endl., W.E. Africa, savanna region, wild and cultivated.

12.6 Corchorus Tiliaceae

A pantropical genus with around 40 spp.

12.6.1 Corchorus olitorius L. W.E. Africa, Madagascar, widely cultivated for the leaves, or gathered. C. aestuans L., C. tridens L., C. trilocularis L. also gathered.

12.7 Crassocephalum Compositae

30 spp. in Africa and Asia

12.7.1 Crassocephalum biafrae (Oliv. & Hiern)S. Moore, West Africa, wild and cultivated fo the young leaves.

12.7.2 Crassocephalum crepidioides (Benth.) S. Moore, West Indias, wild and cultivated.

12.8 Cucumis Cucurbitaceae

40 spp. in the tropics and subtropics of the Old World.

12.8.1 Cucumis anguria L., GHERKIN, West - East Africa, in the savanna region, wild (C. longipes) and cultivated, introduced to the West Indies and Brasil by the slaves (fresh fruit).

Several other Cucumis are gathered or are in incipient cultivation: C. dipsaceus Ehrenb., East Africa, C. ficifolius A. Rich., East Africa; C. hirsutus Sond., East Africa; C. metuliferous E. Mey., S.E.W. Africa; C. sacleuxi Paill. & Bois, E. Africa.

12.9 Gynandropsis — Cleomaceae

Pantropical, 15 spp.

12.9.1 Gynandropsis gynandra (L.) Briq. East Afric, cultivated (leaves, shoots).

12.10 Hibiscus — Malvaceae

160 spp., pantropical

12.10.1 Hibiscus acetosella Welw., West Africa,cultivated and wild (leaves).

12.10.2 Hibiscus mechowi Garcke, West Africa, cultivated and wild (leaves).

12.10.3 Hibiscus surattensis L., W. E. Africa, wild and cultivated (leaves).

12.11 Justicia — Acanthaceae

A pantropical genus with 300 spp.

12.11.1 Justicia insularis T. Anders., West Africa, cultivated (leaves).

12.12 Lagenaria — Cucurbitaceae

2 - 3 spp., native to Africa.

12.12.1 Lagenaria siceraria (Molina) Stand. GOURD. All over Africa, which is probably its area of origin; extremely polymorphic, wild and cultivated, used for the leaves and fruits. The African populations are considered as a subspecies, different than the Asiatic (Heiser, 1973). L. sphaerica (E. Mey.) Naud., spontaneous.

12.13 Launaea Compositae

30 spp., pantropical

12.13.1 Launaea taraxifolia (Willd.) Amin, WILD LETTUCE, West Africa (leaves), wild and cultivated.

12.14 Psophocarpus Leguminosae

Some 8 species in the Old World tropics.

12.14.1 Psophocarpus scandens (Endl.) Verdc. (S. palustris Desv.), West - East Africa, Madagascar (young pods and leaves).

12.14.2 Psophocarpus tetragonolobus (L.) DC. The area of origin is not yet known. Burkill (1906) assumed was East Africa. The widest diversity is found at present in Papua - New Guinea. Little in known about its African germplasm.

12.15 Rumex Polygenaceae

Around 100 spp., mostly in the northern hemisphere.

12.15.1 Rumex abyssinicus Jacq., East Africa (leaves), cultivated.

12.16 Sesamum Pedaliaceae

Some 15 spp., in the tropics of the Old World.

12.16.1 Sesamum alatum Thon.., GOGORO, West Africa (leaves), wild and cultivated.

12.16.2 Sesamum indicum L., SESAME, West-East Africa, used as a vegetable for the young leaves.

12.6.3 Sesamum radiatum K. Schum. & Thonn., West Africa (leaves), often cultivated.

12.17 Solanum Solanaceae

Around 1200 spp., all over the tropics and subtropics.

12.17.1 Solanum aethiopicum L., West - East Africa, OSUN, (leaves), wild and cultivated.

12.17.2 Solanum gilo Raddi, West Africa (young shoots), the cultivated population seems to belong to var. pierreanum.

12.7.3 Solanum incanum L., West Africa (young fruits) populations with bitter or non-bitter fruits.

12.17.4 Solanum macrocarpon L., West - East Africa, Madagascar (fruits, young leaves), wild and cultivated.

12.17.5 Solanum nigrum L. West - East Africa, Madagascar. A complex of populations, assigned in Africa to several varieties: guineense, nodiflorum, oleraceum; in Nigeria, two main groups: 'odu' and 'ogunmo' (Epenhuijsen, 1974) (leaves and young shoots).

12.18 Solenostemon Lamiaceae

8 spp. in West Africa.

12.18.1 Solenostemon monostachyus (P. Beauv.) Briq. (S. ocymoides), West Africa (leaves), wild and cultivated.

12.19 Sphenostylis Papilionaceae

5 spp., mainly in West Africa.

12.19.1 Sphenostylis stenocarpa (Hoscht.) Harms, West Africa, used as a vegetable for the leaves, wild and cultivated.

12.20 Struchium Compositae

12.20.1 Struchium sparganophora (L.) O. Ktze., BITTER LEAF, West Africa, cultivated and gathered for the leaves, eaten cooked.

12.21 Talinum Portulacaceae

15 spp., in Africa - India

12.21.1 Talinum arnotti Hook. f. and other Talinum, including the common T. triangulare (which is assumed to be of American origin), are cultivated or gathered for their leaves.

12.22 Telfairia Cucurbitaceae

2 spp. in West Africa

12.22.1 Telfairia occidentalis Hook. f. West Africa (young shoots and leaves).

12.22.2 Telfairia pedata (Sm.) Hook., East Africa - Madagascar (young shoots and leaves).

12.23 Trichosanthes Cucurbitaceae

Around 40 spp., mainly in SE Asia.

12.23.1 Trichosantes cucumerina L. (T. anguina), PATOLA, West Africa - Madagascar (fruits, leaves, shoots).

12.24 Vernonia Compositae

650 spp., in the tropics of the New and the Old Worlds.

12.24.1 Vernonia amygdalina Del. West Africa (leaves) cultivated and wild; other Vernonia, such as V. cinerea (L.) Less. and V. colorata (Willd.) Drake (V. senegalensis Less.) are gathered for their leaves.

12.25 Vigna Papilionaceae

Around 50 spp., Africa - Australia.

12.25.1 Vigna triloba Walp. West Africa, wild and cultivated (leaves).

12.25.2 Vigna unguiculata (L.) Walp., COWPEA, NIEBBE, all tropical Africa (young pods and leaves). Many land races, still quite poorly known (Chevalier, 1944; Westphal, 1974).

12.26 Voandzeia Papilionaceae

A monotypic genus, West Africa.

12.26.1 Voandzeia subterranea Thouars. BAMBARRA NUT, West Africa, many varieties (green pods and seeds).

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TROPICAL AMERICA

1. AMAZON

TROPICAL AMERICA

In the New World the geographic distribution of crop genetic resources is concentrated in three regions: 1) the Amazon - Orinoco basins and adjacent lowlands of South America; 2) the high Andes; 3) Mesoamerica, Harlan (1971) includes Mesoamerica and the Andes among his centers of crop diversity, the South American lowlands among the non-centers. Brücher (1968) does not recognize any center of concentration in South America, while for Zeven & Zhukovsky (1975) there is only one center covering all South America, other in Mesoamerica and one in North America.

A high degree of crop mobility may explain in part the lack of well defined limits in the centers of crop diversity in South America. It is well known that some crops introduced by the Europeans in South America immediately after the Conquest, spread so rapidly that they were years ahead of the advance of the Conquerors. Humboldt thought that the bananas, for example, found by many travelers cultivated by Indian tribes unknown to the Europeans, were native to South America. The spread of crops in pre-Columbian times may have followed a similar pattern, and before the Conquest some South American cultigens, like cassava, pineaple and peanuts, may have moved not only all over tropical South America but northwards all the way to Mexico. Because of ethnic affinities, crops moved also from the coastal regions of NE South America into the Antilles. The historical presence of crop species and their spread in Northern South America, has been thoroughly documented by Patiño (1963-1969).

1. <u>The South American Lowlands</u>

<u>Delimitation</u>: The South American lowlands extend in both sides of the Andes, from sea level to an upper limit which varies from 500-800 m, according to the criteria of ecologists or plant geographers. Within this vast area, five main subdivisions may be recognized from the point of view of crop germplasm distribution:

1.1. The Amazon - Orinoco basin, with all their tributaries, from the Eastern slope of the Andes to the Atlantic, usually called Amazon;

1.2 A narrow belt West of the Andes, from the Atrato strait, which separates Central from South America in NW Colombia, to the Peruvian desert;

1.3 The Caribbean belt, from Colombia to Trinidad, of very minor importance in comparison with the other two subdivisions. To this region may be added the Lesser and the Greater Antilles.

1.4 The dry region of NE Brasil, the "catinga"

1.5 The areas South of the Amazon rainforests= "campos" o "cerrado" extending to the subtropics.

These five divisions are based on environmental factors wich had determined crop origin and distribution. However, there are not clear cut bordelines among them, and quite often a crop,like <u>Capsicum</u> spp., may grow in several of them, distributed by man. The spread of crop results in complex patterns of distribution for the most important species, but many are still restricted to areas of original adaptation.

1.1. THE AMAZON

Natural vegetation. As in other parts of the world, in the Amazon crops germplasm diversity is determined by the interaction of two main factors: the native vegetation, as a basic source of materials utilized or domesticated, and the cultural development through human occupancy.

The Amazon is occupied in most of its extension by a rainforest, with one of the richest vegetation in the world. There is no idea of how many species of flowering plants are found within the region, but estimates run from 60,000 to 100,000 species (Schultes, 1980). As pointed by Hueck (1978) in this plant concentration "there is something for every need". The importance of the Amazon region is mainly its immediate potential as supplier of new plant materials. But also as shown by the studies of Gottlieb and others (1967) it may contribute to the clarification of basic problems, such as the chemical composition of the useful parts of the plants, which may lead to new uses of plant materials in the future. The limits of the Amazonian rainforest are represented in maps, more or less along the same boundaries, by Soares (1953), Smith (1962), Toledo Rizzini (1963), Meggers (1973) and other.

The Amazon rainforest apperars superficially as an uniform formation. But since the studies of Huber (1909), Ducke & Black (1953), and more recently of Murça Pires (1973), Prance (1977) and others, it has been shown to be extremely complex on its floristic composition, vegetational history and its relations to soil and climate. It was agreed until recently, that the environmental conditions in the Amazon had no important changes since the Tertiary, with an uniform climate through the Pleistocene. Now this concept changed, and although the information form pollen profiles is scarce, it is assumed that important climate changes occurred during the Quaternary, which were reflected in the spatial distribution of plant species, caused mainly by the fragmentation and reexpansion of the rainforest (Vuilleumier, 1971). It is accepted now, that between 18-13,000 years ago and even as recently as 4-2,000 years (Nat. Geogr. Mag. 1982), a much drier climate prevailed in the Amazon, with the consequent breakdown of the rainforest. If this happened, it was also a favorable factor for human dispersion.

The breakdown of the Amazonian forests led to the separation of plant populations and the formation of refuges, for animal and plant life. Prance (1973, 1977) has proponed such areas based on the present distribution of several tree species. If the hypothesis fits with the facts, such areas should receive special attention in their collection, study and preservation.

The floristic composition is far from being established in a satisfactory way. Some families: Leguminosae, Palmae, Moraceae, Euphorbiaceae, show here the highest development, in terms of total number and endemism. There is, of course, more floristic affinities with the African rainforest (Meggers et al. 1973) than with the SE Asia formations. The rate of endemic species is very high in all families, and the different plant types: trees, shrubs, epiphytes, etc., all are very well represented. The contribution of northern elements is rather poor since the Panama isthmus was not connected until the upper Miocene. On the contrary, the Amazon vegetation expanded later into Central America, which in its southern section shows elements of clear Amazonian origin (Allen, 1956). The North American elements: oaks, walnuts, alders, came late and are important only in the Andean formations (Flenley, 1979).

The richness and diversity of the Amazon vegetation is due to optimal conditions, especially temperature and moisture. Rainfall, above 2000 mm, has an almost continuos distribution throughout the region, with only a discontinuity, the "Obidos gap", in Central Amazon, where the rainfall decreases to around 1500 mm. This discontinuity separates Eastern from Western Amazon, an important division on floristic grounds and also on the distribution of useful species. Temperature, by latitude and altitude (most of the Amazon basin is belwo 100 m elev.), is optimum the yeararound. Soil, under optimal climatic conditions, acquires a very relevant influence; the Amazon soils, in all their complexity, follow a general pattern derived from their geological origin, which determine a correlation with the diversity of animal and plant life. a) the largest area, corresponding to the Guiana - Brasil shields, partly covered by old and recent alluvia, are "moderately" rich in plant and animal species; b) the Andean piedmont and the alluvia along the main rivers, "varzea", have the highest diversity; c) Central Amazon, the area along the medium and low course of the river and the lower course of its main tributaries, derived mostly from Tertiary sediments, have rather poor soils, and is of relatively low degree of biological diversity; d) narrow strips, south and north of Central Amazon, in the contact areas of a) and b), of Carboniferous origin and derived from calcareous rocks, are quite rich in species, although their areas are reduced in comparison to the other divisions (Fittkau, 1969).

Cultural aspects. The prehistory of the Amazon - Orinoco basin is based on very scant information, mainly from pottery styles and a few Carbon -14 dates; the oldest of these, 3000 years BP, comes from Marajó, in the Amazon delta. The earliest archeological information on crop plants is based only in artifacts which is assumed were used in food preparation. Like in the Near East, they may have been used to process wild products also. The conditions for the preservation of seeds,stems and other useful parts of crop plants are extremely adverse in the Amazon, because of soil acidity, temperature and moisture. There is also a paucity of historical information on crop plants in contrast to the richness of data for the West Indies, Peru or Mexico. Only a few prehistorical agricultural developments are known from the region, one of the most interesting are the ridged fields, which, were undoubtedly done by prehistoric man to grow food crops in flooded areas (Denevan, 1966). The extinction, migration and acculturation of the Amazonian Indians since the Conquest, are negative factors in establishing a coherent picture of how the agricultural systems were developed and distributed in the Amazon before the Conquest. On the other hand, a few factors show that human occupation is probably quite old; for instance, the many languages and dialects present or extinct in the region, and some coherence in the early pottery styles, which had a wide geographical dispersal, from Central and Western Amazon to the Caribbean coast and possibly the Pacific slope from Colombia to Peru.

Several hypothesis to explain the low status of agricultural development in the Amazon have been proposed by anthropologists (Meggers, 1971); Carneiro, 1974; Lathrap, 1970), but as stated by Roosvelt (1980), no one is completely acceptable. For most of them, the low fertility of the Amazonian soils is the main factor in determining the sparse population and therefore the incipient state of technology. Lathrap (1970) proposes the development of an expansion of human occupation from the central Amazon to the borders of the big rivers in the Andean piedmont and then to the Caribbean lowlands and perhaps to the Pacific slope of Ecuador and Colombia. This pattern fits with the scarce information on the dispersal of some Amazonian crops.

The botanical evidence on plant domestication is rather scarce. Ducke (1946) has discussed the relationship between cultivated and wild populations of the same species in the Amazon. General information on plant utilization and germoplasm concentration is given by Lévi-Strauss (1950) for wild plants, by Sauer (1950) on cultivated plants, and Brücher (1968, 1969) for specific crops of the region. Kerr & Clement(1980) describe the agricultural practices among some Amazonian Indians in relation to crops adaptation. But, in general, the patterns of crop evolution and the subsequent diversification and concentration of germplasm are very poorly substantiated; as a resumé the opinion of Lévi-Strauss (1950) is that in tropical South America, the agricultural levels were determined more by historic factors than by local plant resources.

The status of crop germplasm utilization in the Amazon shows different stages.

a) a large number of wild species are utilized, often in different ways, and their products sometimes are sold in local markets.
b) the majority of crops are in an incipient stage of domestication: planted or tolerated, which in the agricultural systems prevalent in the region may permit the introgression with their wild relatives

(Seibert, 1947). Ducke (1946) comparing wild and cultivated populations of the same species, found that their useful parts, especially in fruits, is larger in the cultivated plants. This difference, found also in West Africa, may be due to selection, management or both.

c) A few crops; fruits tress, guarana, have not expanded outside the region.

d) Some Amazonian crops are more developed outside the region: Hevea in SE Asia, Bactris gasipaes in Central America, but the Amazon is still a basic source of germplasm in their breeding.

e) There are still many species, wild or in incipient domestication, of potential use, many in danger of extinction.

ADDENDUM

1. The future of the genetic resources of the Amazon is very uncertain. The continuos deforestation for timber exploitation, agriculture or the inundation of large areas in hydroelectric projects, is threating the destruction of natural vegetation all over the region, but is at present more acute in certain areas of medium soil fertility, like Rondonia. Large traits of land, of no use for crops or cattle, may remain, but will not be representative of the natural vegetation.

2. There is little chance of success in situ preservation. As in other tropical areas, the natural distribution of crop species or their allies, follows the pattern of a few individuals per hectarea. Besides, the scant information tends to support the idea that population within the same species have a wide difference in their useful characters. Schultes (1979) shows how different are the natural

populations of Hevea brasiliensis in latex production, and Mora-Urpí (1983) referes to the diversity in the population of Bactris gasipaes, as a result of isolation, due to their reproductive system and the wide rivers that separate them. In other words, to obtain a satisfactory level of genetic conservation, the Amazon would require a very large number of sites.

3. There is also the possibility of losing germplasm of potential crop species. In the genus Hevea the different species produce distinct kinds of latex. Eventually some may develop into crops. In other case, Elaeis oleifera and possibly E. odora, contribute to the genetic improvment of the African oil palm. The natural populations offer very little possibility of being developed as a crop, but their role in improving the African oil palm is decisive.

4. Several incipient crops, especially fruits and nuts, have a potential value difficult to estimate. Passiflora edulis is a case of an Amazonian fruit which is an important crop in Hawaii, Central America, Venezuela, etc.

5. The Amazon belong to six countries=. Bolivia, Brasil, Colombia, Ecuador, Peru and Venezuela. Only Brasil has a strong genetic resources center, CENARGEN, which is actively collecting cacao,oil palms, cassava and other crops in the Brazilian Amazon.

1. CEREALS

1. *Oryza*

A pantropical genus, with around 25 spp.

1.1.1 *Oryza glaberrima* Stedu. There are reports that the African rice was (or is) cultivated in French Guiana.

1.1.2 *Oryza sativa*, the common or Asiatic rice, is grown all over the region, and the new cultivars have replaced the early introductions.

1.2 *Zea*

A Mesoamerican genus with 6 spp.

1.2.1 *Zea mays* L. MAIZE. In the Amazon maize diversity is rather scanty, with only of races represented (Brieger *et al*., 1958); in the northern region os South America the racial composition is more complex, as it mixes with the Caribbean and Central American races (Roberts, L M. *et al*., 1957; Grant, U. J. *et al*., 1963).

5.21.1 *Lecythis amapaensis* Ledoux, SAPUCAIA DO AMAPA; Eastern Amazon, fruits gathered.

5.21.2 *Lecythis usitata* Miers (*L. paraensis* Huber), SAPUCAIA, wild and cultivated (in Pará).

5.21.3 *Lecythis zabucayo* Aubl., Northern South America; wild and cultivated.

5.22 *Macoubea* Apocynaceae

Northern South America, six species.

5.22.1 *Macoubea witotorum* R.E. Schultes; cultivated by the Indians in the Colombian Amazon.

5.23 *Manilkara* Sapotaceae

Some 70 species in the tropics of both worlds, used for the latex and the fruits.

5.23.1 *Manilkara huberi* (Ducke) Standl., wild, intensively gathered. The trees are exploited also for rubber.

5.24 *Mauritia* Palmae

6 spp. in northern South America.

5.24.1 *Mauritia flexuosa* L.f., (*M. vinifera* Mort.), BURUTI, MIRITI, AGUAJE, MORICHE, wild populations extending from central Brasil to Venezuela; in wet, often inundates fields; some variability in fruit shape= sphoerical to ellipsoidal and in the color ot the exocarp at maturity= green to yellow. Incipient cultivation in a few areas, but the wild stands supply enough material for home consumption, very important in

3. FORAGES

No important species are found in the Amazon of grass or legumes forages. However, several of the central Brazilian species of forage legumes, extend into the southern areas of the Amazon.

4. FIBERS

4.1 *Ananas* Bromeliaceae

A South American genus with five species.

4.1.1 *Ananas erectifolius* L. B. Smith, CURUA; Amazon, especially in the eastern part; only in cultivation.

4.2 *Neoglaziovia* Bromeliaceae

A Brazilian genus of two species.

4.2.1 *Neoglaziovia variegata* (Arruda) Mez., CARUA, NE Brasil, wild and cultivated (Xavier, 1942).

5. FRUITS AND NUTS

The Amazon basin is the area of origin and diversity of many fruit species (Romero Castañeda, 1961 - 1969, Fouque, 1972 - 1974; Cavalcanti, 1976 - 1979; Calzada Benza, 1980; Clement, Muller & Chavez, 1982) The majority of them occur in Western Amazon, and their state as crops varies widely: a few are unknown in wild state mostly are in incipient cultivation or tolerated around the dwellings, in some species the fruits are gathered from wild plants. Ducke (1946) and Kerr & Clement, (1980) have shown that there are phenotypic differences between the cultivated and wild populations.

The potential value, in terms of genetic resources, is higher in the fruit species than in any other group of crops in tropical South America. As the rainforest is continuously destroyed, the need to save and keep the germplasm of native fruit trees should receive first priority in South America.

5.1 Anacardium — Anacardiaceae

Fifteen species of tropical America, the majority in the Amazon basin.

5.1.1 Anacardium giganteum Hank., CAJUI; all over the Amazon, wild or rarely cultivated.

5.1.2 Anacardium microcarpum Ducke, CAJUI; wild, gathered in E. Amazon.

5.1.3 Anacardium negrense Pires & Froes, CAJUTIM; Western Amazon, used only for the nuts.

5.1.4 Anacardium occidentale L., CASHEW, CAJU, MARAÑON, MEREY; the probable area of origin extends from Eastern Amazon to the coastal region; many primitive cultivars and spontaneous populations, in urgent need to be assembled and evaluated for yield, disease resistance and nut characteristics. Highly polymorphic; Lima et al. (1952), for instance, have described 44 different types based on fruit characters, only for Pernambuco.

5.2 Ananas Bromeliaceae

A South American genus with 5 species.

5.2.1 Ananas comosus (L.) Merrill, PINEAPPLE, PIÑA, ABACAXI; wild (or spontaneous) populations reported from Paraguay, Brasil and Venezuela. These areas should be collected again, since there is no comprehensive assemblage of primitive cultivars. In the same genus, but not closely related to A. comosus, are:

5.2.2 Ananas bracteatus (Lindl.) Schult., formerly cultivated by the Amazonian indians for its fruits.

A collection of the wild relatives of A. comosus is mantained at the CNPM EMBRAPA station at Cruz das Almas, Bahia (Clement, Muller & Chavez, 1980).

5.3 Annona Annonaceae

Of the 120 species a large number are found wild in the Amazon. However, it is very likely that all cultivated species in the region are introduce

5.3.1 Annona muricata L., SOURSOP, GUANABANA; found only in cultivation, may have originated in Northern South America.

5.4 Bactris Palmaceae

An American genus with some 240 spp., 14 of them have been included in the genus Guilielma, but most specialists agree that there are no valid distinctions between the two genera.

5.4.1 Bactris gasipaes H. B. K. , PUPUNHA, CHONTADURO, PEJIBAYE. Cultivated and apparently wild in several areas of the Amazon. A very polymorphic species, open pollinated and of long selection by man. The cultivated taxa is divided by Mora-Urpí (1983) in two complexes or races= "Amazon" and "Western", corresponding the first to the populations extending east of the Andes from Bolivia to Honduras. The western race extends from northern Ecuador to Nicaragua. There are morphollogical and physiological differences between the two groups, which in turn contain each one many subraces or interbreeding populations. A wide variability is found outside South America, especially in Costa Rica, a basic collection at CATIE, Turrialba, Costa Rica and INPA, Manaus.

The validity of several taxa, B. mattogrosensis B. microcarpa, etc as species, is still in discussion.

5.5 Bagassa Moraceae

Only two species, in N. Brasil - Guianas

5.5.1 Bagassa guianensis Aubl., gathered for its fruits, wild populations in Amazon and Guiana.

5.6 Bertholletia Lecythidaceae

Two species only, from the Amazon to the Antilles.

5.6.1 Bertholletia excelsa H.B.K., BRASIL NUT; native populations in the rainforest of the Amazon (from Acre to Pará), Colombia, Venezuela, Guiana; not much known about its diversity, but the large area occupied suggest the possibility of many distinct populations.

5.7 Bonafousia — Apocynaceae

Around 15 species in tropical America, formerly included in Tabernomontana.

5.7.1 Bonafousia longituba Markgr., PAIETY; fruits are gathered from wild populations in Brasil - Surinam.

5.8 Bunchosia — Malpighiaceae

Some 50 species in tropical America, with a concentration in Northern South America.

5.8.1 Bunchosia armeniaca (Cav.) Rich., CIRUELA DE FRAILE; possibly from Western Amazon, no information on its genetic diversity.

5.9 Caryocar — Caryocaraceae

Some 20 species, from Costa Rica to Brasil, mostly in the Amazon - Orinoco basin.

5.9.1 Caryocar villosum (Aubl.) Pers., PIQUIA; Amazon to Northern South America.

5.10 Cassia — Leguminoseae

A large genus, more than 500 species, in tropical and temperate regions.

5.10.1 Cassia leiandra Benth., MARIMARI, wild and cultivated in central and Western Amazon.

5.11 Chrysophyllum Sapotaceae

Some 120 species, chiefly in Tropical America.

5.11.1 Chrysophyllum excelsum Huber., UAJARA; wild and cultivated in the Amazon.

5.12 Couepia Chrysobalanaceae

Around 60 species in the American tropics, mainly in South America.

5.12.1 Couepia bracteata Benth., PAJORA; cultivated and wild in the Amazon.

5.12.2 Couepia longipendula Pilger, CASTANHA DE GALLINA; central Amazon, cultivated but mainly gathered from wild tress (Rodrigues, 1976).

5.12.3 Couepia subcordata Benth.; cultivated and wild in central Amazon.

5.13 Couma Apocynaceae

A genus of some 15 species in the Amazon and Northern South America; used for the fruits and latex.

5.13.1 Couma guianensis Aubl., SORVA; wild in the Amazonia - Guiana rainforest, fruits gathered; important as a source fo rubber.

5.13.2 Couma macrocarpa Barb. Rodr., SORVA GRANDE, Eastern Amazon, wild, fruits gathered.

5.13.3 Couma utilis (mart.) Muell-Arg., SORVA; cultivated and wild in central and Eastern Amazon. Also a source of rubber.

5.14 Duckesia Humiriaceae

An endemic Amazonian genus, with only one species, formerly in Saccoglotis.

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5.14.1 Duckesia verrucosa (Cucke) Cuatrec. (Saccoglotis verrucosa). UCCI-COROA; wild and gathered.

5.15 Endopleura Humiriaceae

Endemic to the Amazon, one species.

5.15.1 Endopleura uchi (Huber) Cuatrec., UCCI; Amazon, especially in Pará, cultivated and wild.

5.16 Erisma Vochysiaceae

Twenty species in the Amazon & Guiana.

5.16.1 Erisma japura Spruce, YAPURA; Western Amazon, seeds gathered from wild trees.

5.17 Eugenia Myrtaceae

Around 1,000 species in the tropics and subtropics, better represented in Southern Brasil than in the Amazon.

5.17.1 Eugenia stipitata McVaugh, ARAZA-BOI; Western Amazon, a very valuable fruit of recent domestication (Pinedo, Ramírez & Blasco, 1981).

5.18 Genipa Rubiaceae

Six species, most of them in the Antilles and Northern South America.

5.18.1 Genipa americana L., GENIPAPO; through Amazon and Northern South America, cultivated and wild.

5.19 Grias Lecythidaceae

A South American genus of 15 species, utilized for its fruits.

5.19.1 Grias neuberthi Macbr., SACCHA MANGO; wild and cultivated in the Amazonian area of Peru.

5.20 Inga Leguminosae

A complex genus of the American tropics with some 200 species, from Mexico to Uruguay; used for shade of coffee and cacao; the edible part are the fleshy, sweet arils.

5.20.1 Inga alba (SW.) Willd., INGA CHICHICA; Amazon, wild and cultivated.

5.20.2 Inga cinnamomea Benth., INGA-ASSU; Amazon, wild and cultivated (in Belem and Manaus).

5.20.3 Inga edulis Mart., INGACIPO; Amazon - Northern South America, wild and cultivated, very polymorphic.

5.20.4 Inga fagifolia (L.) Willd., INGA CHICHI; wild and cultivated, the last group is called var. belemensis.

5.20.5 Inga macrophylla H.B.K. Amazon, wild and cultivated.

5.20.6 Inga ruiziana G. Don, Amazon - Central America; cultivated in the Amazon.

5.20.7 Inga setifera D.C. INGA-DOS INDIOS; Amazon, wild and cultivated.

5.21 Lecythis Lecythidaceae

Fifty species in tropical America, mainly in the Guiana - Amazon region, used for the nuts.

5.21.1 *Lecythis amapaensis* Ledoux, SAPUCAIA DO AMAPA; Eastern Amazon, fruits gathered.

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5.23 *Manilkara* Sapotaceae

Some 70 species in the tropics of both worlds, used for the latex and the fruits.

5.23.1 *Manilkara huberi* (Ducke) Standl., wild, intensively gathered. The trees are exploited also for rubber.

5.24 *Mauritia* Palmae

6 spp. in northern South America.

5.24.1 *Mauritia flexuosa* L.f., (*M. vinifera* Mort.), BURUTI, MIRITI, AGUAJE, MORICHE, wild populations extending from central Brasil to Venezuela; in wet, often inundates fields; some variability in fruit shape= sphoerical to ellipsoidal and in the color ot the exocarp at maturity= green to yellow. Incipient cultivation in a few areas, but the wild stands supply enough material for home consumption, very important in the region, and industrial uses (ice cream, juices)

5.25 Myrciaria Myrtaceae

Some 65 species in the tropics and subtropics of South America.

5.25.1 Myrciaria dubia (H.B.K.) McVaugh (M. paraensis), CAMU-CAMU; western Amazon, wild and cultivated (highest content of vitamin C among fruits).

5.26 Oenocarpus Palmae

A palm genus of about 15 species in tropical South America; pulp used for beverages, seeds for oil.

5.26.1 Oenocarpus distichus Mart., BACABA, also O. bacaba Mart. and O. multicaulis Spruce, Amazon; wild, the pulp of the fruit is used for refreshments.

5.27 Parahancornia Apocynaceae

Eight species in the Amazon, good timber, edible fruits.

5.27.1 Parahancornia amapa (Huber) Ducke, AMAPA; eastern Amazon, wild and gathered.

5.27.2 Parahancornia peruviana Monachino, Western Amazon; fruit large, gathered,worth of cultivation.

5.28 Parinari Chrysobalanaceae

Some 60 species in the American tropics; fruits and seeds are eaten.

5.28.1 Parinari montana Aubl., PAJURA; eastern Amazon to Guiana, wild, excellent fruit.

5.29 Passiflora Passifloraceae

A genus of 500 species in tropical America, Asia and Australia; many are ornamental, fruits are edible in many species.

5.29.1 Passiflora edulis Sims., MARACUYA; the variety "flavicarpa" is widely cultivated in Brasil, the typical variety also cultivated.

5.29.2 Passiflora nitida H.B.K. Brasil; wild, gathered and sold in the markets.

5.29.3 Passiflora quadrangularis L., (P. macrocarpa, P. tetragona), MARACUYA-ASSU, BADEA; northern South America, several varieties known.

5.30 Physalis Solanaceae

Tropics and subtropics of both worlds, 100 species, mostly in South América; fruits edible; ornamental.

5.30.1 Physalis peruviana L., UCHUVA; western Amazon, widely cultivated.

5.31 Platonia Guttiferae

A Brazilian monotypic genus.

5.31.1 Platonia insignis Mart., BACURI; western Brasil - Paraguay, but little known outside the region recently reported some superior types in the Marajo islands (Clement et al, 1982).

5.32. Poraqueiba Icacinaceae

Three species in Northern South America.

5.32.1 Poraqueiba paraensis Ducke, UMARI; eastern Amazon, cultivated and wild.

5.32.2 Poraqueiba sericea Tul, UMARI; middle and western Amazon, gathered from wild trees.

5.33 Poupartia Anacardiaceae

A genus of 12 species, found in Madagascar and Brasil.

5.33.1 Poupartia amazonica Ducke, FRUTA DE CEDRO; middle and eastern Amazon, wild, gathered.

5.34 Pourouma Moraceae

An American genus of around 50 species, from Mexico to Bolivia.

5.34.1 Pourouma cecropiaefolia Mart., MAPATI, UVILLA; western Amazon, wild and cultivated; a related species, P. sapida, with fruits of inferior quality, is considered as its ancestor (Schultes, 1979).

5.35 Pouteria Sapotaceae

From Mexico to Brasil, some 50 species; fruits trees, latex, timber.

5.35.1 Pouteria caimito (R. & P.) Radlk., ABIU, CAIMO; western Amazon to Colombia, cultivated and wild.

5.35.2 Pouteria macrocarpa (Huber) Baehni, CUTITI GRANDE; Amazon, known only in cultivation (Ducke, 1946).

5.35.3 Pouteria macrophylla (Lam.) Eyma, (Lucuma rivicoa), CUTITIRIBA; middle and eastern Amazon, wild and cultivated.

5.35.4 Pouteria pairiry (Ducke) Baehni, PARIRI; wild and cultivated, especially in eastern Amazon.

5.35.5 Pouteria speciosa (Ducke) Baehni, PAJURA DE OBIDOS; middle Amazon, wild and cultivated.

5.35.6 Pouteria ucuqui Pires & Schultes, UCUQUI; middle and western Amazon, wild but intensively gathered.

5.36 Psidium Myrtaceae

Tropical America, some 140 species, many fruit trees.

5.36.1 Psidium acutangulum D.C. (Britoa acida), , ARAZA-PERA; Amazon-northern South America, wild and cultivated.

5.36.2 Psidium guajava L., GUAVA, GUAYABA; all over tropical America, many wild or spontaneous populations and a few selected strains.

5.36.3 Psidium guineensis Sw. (P. araca), same distribution as P. guajava; natural hybrids between the last two species have been recognized.

5.37 Quararibea Bombacaceae

Tropical America, Mexico to Brasil, 50 species, fruits, spices.

5.37.1 Quararibea cordata (H.B.K.) Vischer, (Matisia cordata), SAPOTE, western Amazon to Colombia, widely cultivated and also wild; quite variable. A small collection at INPA, Manaus, Brasil (Clement, Müller & Chavez, 1982).

5.38 Rheedia Guttiferae

Some 45 species from Mexico to Bolivia and in Madagascar, edible fruits in several wild species.

5.38.1 Rheedia macrophylla (Mart.) Planch. & Triana; Amazon, wild and cultivated.

5.39 Rollinia Annonaceae

Around 65 species, from Central America to Argentina.

5.39.1 Rollinia pulchrinervis A. DC. (R. deliciosa), BIRIBA; an important fruit in the Amazon, probably introduced.

5.40 Solanum Solanaceae

A pantropical genus; in the region only a few species of incipient cultivation. Several wild species also supply fruits.

5.40.1 Solanum platyphyllum H. & B., Amazon and northern South America; cultivated and wild.

5.40.2 Solanum sessiliflorum Dunal, CUBIU; western and cenral Amazon, wild and cultivated.

5.40.3 Solanum topiro H.B.K. (S. hyporhodium), TOPIRO, COCONA; western Amazon, widely cultivated, primitive types: georgicum and alibile, in the Amazon region of Colombia (Schultes & Romero-Castañeda, 1962; Heiser, 1972).

5.41 Spondias Anacardiaceae

A pantropical genus (not in Africa) of 12 species, several fruit trees.

5.41.1 Spondias mombin L., (S. lutea), TAPEREBA; wild and cultivated all over the Amazon, extending to Central America.

5.42 Sterculia Sterculiaceae

Tropics of both worlds, some 300 species, seeds of several Sterculia are used as nuts.

5.42.1 Sterculia apetala (Jacq.) Karst., Mexico - Venezuela, wild; seeds gathered and eaten as nuts.

5.43 Talisia Sapindaceae

50 species, from Mexico to Northern South America and the Antilles.

5.43.1 Talisia cupularis Radlk., central Amazon, wild, gathered.

5.44 Theobroma Sterculiaceae

A tropical American genus of 22 species, the useful part are the arils which are eaten fresh or prepared in refreshments and ice creams.

5.44.1 Theobroma bicolor H.B.K., Sterculiaceae, CACAU-RANA; extending from Brasil to Mexico; in the Amazon according to Ducke (1946), only in cultivation; used for the pulp surrounding the seeds.

5.44.2 Theobroma grandiflorum (Sprang,) Schum., CUPUASU; Amazon, especially in the eastern part, wild and widely cultivated; fruit used for refreshments and ice creams.

5.44.3 Theobroma speciosum Willd., Amazon, wild, gathered for the arils of the seeds.

5.44.4 Theobroma subincanum Mart., Amazon-northern South America, gathered from wild plants.

5.45 Thielodoxa Rubiaceae

Some five species in Northern South America.

5.45.1 Thieldoxa sorbilis Huber, PURUI GRANDE; central and lower Amazon, wild and cultivated.

5.45.2 Thielodoxa stipularis Ducke; western Amazon, wild and cultivated.

5.45.3 Thielodoxa verticillata Ducke; central Amazon, cultivated and wild.

6. GRAIN LEGUMES

6.1 Phaseolus. In P. vulgaris and P. lunatus there are many primitive cultivars, most of them in the drier areas. The second species shows a remarkable diversity in NE Brasil. No comprehensive surveys have been done on the autochtonous populations of cultivated beans, and the many species of wild Phaseolus in the region have not received a modern taxonomic treatment. A large number of introduced varieties are under cultivation, especially in Central and Southern Brasil.

6.2 Vigna unguiculata is sparsely cultivated, especially in the Amazon headwaters, in place of the common bean.

7. INSECTICIDES

7.1 Clibadium — Compositae

15 spp. in tropical America.

7.1.1 Clibadium surinamense L., used as a fish poison, known only in cultivation.

7.2 Lonchocarpus — Papilionaceae

A tropical genus with around 150 spp. in America, Africa and Australia.

7.2.1 Lonchocarpus nicou (Aubl.) DC., TIMBO, western Amazon, used for the roots as a source of rotenone and for fish poison; several varieties have been described (Hermann, 1947); clonally propagated.

7.2.2 Lonchocarpus urucu Killip & Smith, URUCU, west Amazon, cultivated as a fish poison.

8. OIL PLANTS

a) Palms

One of the main plant potential of the Amazon and neighbouring areas are the palms, for the oil contained in the pericarp and the kernels (Burret, 1938; Hodge, 1975; Balik, 1979).

More important sources:

8.1 Acrocomia

26 spp., from Mexico to Argentina.

8.1.1 Acrocomia sclerocarpa Mart., MAÇAUBA, Amazon - Southeast Brasil; oil similar to African oil palm

8.2 Astrocaryum

Around 40 species, from Guatemala to Brasil.

8.2.1 Astrocaryum murumuru Mart., MURUMURO Venezuela - Guiana - Amazon; kernel oil an important commercial production

8.2.2 Astrocaryum tucuma Mart., Amazon - Venezuela, several varieties; used especially for the kernels.

8.2.3 Astrocaryum vulgare Mart., AWARRA, TUCUMA Amazon - Central Brasil, important quantities of kernels

8.3 Attalea

A South American genus with 34 spp.

8.3.1 Attalea monosperma Barb. Rodr., CURUATINGA, Guianas - Amazon, used for the kernel oil.

8.4 Butia

A small genus, allied to Cocus

8.4.1 Butia capitata (Mart.) Becc., same distribution and uses; several varieties have been described.

8.5 Elaeis

3 spp., 2 in America, 1 in Africa

8.5.1 Elaeis guineensis Jacq., AFRICAN OIL PALM, DENDEZEIRO; populations of early introductions in the Bahia area, not well known and evaluated.

8.5.2 Elaeis odora Trail (Barcella odora), PIASSAVA-BRAVA; Amazon, a poorly known relative of the African oil palm, found only in few places in the Amazon; especially in the upper Rio Negro used for the pericarp oil.

8.5.3 Elaeis oleifera (H.B.K.) Cortes, Amazon-Honduras; many wild populations, the ones around Tefe, in central Amazon, of high yield in pericarp and kernel oil. Most of the new cultivars of African oil palm are hybrids between E. oleifera and E. guineensis. Colections at United Fruit C° station at Coto, Costa Rica; CENARGEN, Manaus, Brasil; MARDI, Malaysia.

8.6 Jessenia

A complex genus with 1-2 spp. in northern Amazon.

8.6.1 Jessenia bataua (Mart.) Burret, PATAUA, SEJE; Venezuela - Guiana - Amazon, wild and cultivated utilized for the pericarp oil, quite similar to olive oil in composition and properties (Balick & Gershoff, 1981).

8.6.2 Jessenia polycarpa Karst., SEJE, a source of superior oil for cooking, soap, medicine, from wild plants which are destroyed to collect the fruits.

8.7 Mauritia

Some 20 spp., from Colombia to Brasil.

8.7.1 Mauritia flexuosa L., MIRITI, BURITI, MORICHE, Peru - Guianas - Brasil, wild in swampy areas and cultivated; mesocarp oil of excellent quality.

8.7.2 Mauritia vinifera Mart., MURITI, BORITI, central and western Amazon; used especially in Peru.

8.8 Oenocarpus

8 spp., mostly Amazonian.

8.8.1 Oenocarpus bacaba Mart., BACABA, Peru - Guianas; gathered from wild stands for the pericarp oil.

8.8.2 Oenocarpus distichus Mart., BACABA, Eastern Amazon, gathered for the pericarp used to extract a fine oil or to prepare a refreshment, "vinho de bacaba".

8.9 Orbignya

Some 17 spp., from Mexico to Brasil, most in the Amazon.

8.9.1 Orbignya martiana Barb. Rodr., BABASSU, Amazon basin to SE Brasil. Under this name are included now (Lleras, Giacometti & Coradin, 1983) several "species"= Oleifera, speciosa, etc. The babasu populations cover a vast area, from the rainforest to the dry zones in NE Brasil, and the wild stands are one of the primary source of vegetal oil in the world. There is a wide diversity and collections are assambled by CENARGEN at San Luiz, Maranhao, Brasil.

8.10 Scheelea

A complex genus, of around 40 spp, from Mexico to Argentina, several locally utilized for the kernel oil.

8.10.1 Scheelea excelsa Karst., COROZO, wild exploited for the kernel oil.

8.11 Syagrus

Some 50 spp., including hybrids, in South America and one species in West Indies.

8.11.1 Syagrus coronata (Mart.) Becc., LICURI, ARICURI, central - eastern Brasil, gathered for the kernel oil.

b) Other oil crops.

8.12 Caryocar

Some 20 spp., from Costa Rica to Brasil, mostly in the Amazon - Orinoco basin.

8.12.1 Caryocar amygdaliferum Matis, ALMENDRON, Amazonian Colombia, seeds a source of fat used in the preparation of food.

8.12.2 Caryocar nuciferum L., SUARI, wild and cultivated in Brasil and Guianas, for the oil contained in the nuts.

8.12.3 Caryocar villosum (Aubl.) Pers., PIQUIA, has been considered as a potential oil source and introduced to Malaysia.

8.13 Caryodendron — Euphorbiaceae

2 spp. in northern South America.

8.13.1 Caryodendron orinocense Karst., TACAY, INCHI; wild and in incipient cultivation in western Amazon; a potential oil crop.

c) Other oil sources.

8.14 Aniba — Lauraceae

55 spp. in the Amazon.

8.14.1 Aniba duckei Kosterm., ROSEWOOD, western Amazon, source of rosewood oil, obtained from natural stands, now practically depleted. It is difficult to propagate and slow growing.

8.15 Conabea — Scrophulariaceae

7 spp. from the Amazon to West Indies.

8.15.1 Conobea scoparioides Benth., central Amazon, a source of thymol.

8.16 Croton — Euphorbiaceae

A pantropical genus with 600 spp., many containing oil in the seeds.

8.16.1 Croton cajucara Benth., a potential source of linalol, easy to propagate; central Amazon.

8.17 Dicypellium Lauraceae

A monotypic species, Amazon.

8.17.1 Dicypellium cariphyllatum Nees, the bark contains eugenol.

8.18 Lippia Verbenaceae

Around 120 spp. in tropical America.

8.18.1 Lippia origanoides H.B.K., central Amazon, a source of thymol.

19. ROOTS AND TUBERS

The Amazon area and the northern part of South America are quite rich in primitive cultivars, and allied species of important and secondary root crops.

9.1 *Calathea* Marantaceae

An American genus with 130 species.

9.1.1 *Calathea allouia* Lam., LLEREN, LAIREN, Eastern Peru to Dominican Republic; a relict crop, (Chevallier, 1936; Martin & Cabanillas, 1976); 2 or 3 clones in Amazonia.

9.2 *Canna* Cannaceae

Some 55 species, several ornamental, of the American tropics.

9.2.1 *Canna edulis* Ker., ACHIRA, QUEENSLAND ARROWROOT, its possible origin in the Eastern Andes, but it is not known in wild state; no information on its genetic diversity; used also as forage (Chaparro & Cortés, 1978).

9.3 *Dioscorea* Dioscoreaceae

A large genus, 600 species, mostly in the tropics of the New and Old World, and extending to temperate regions (Europe & Japan).

9.3.1 *Dioscorea adenocarpa* Mart., Amazon - Central Brasil, gathered from wild plants.

9.3.2 *Dioscorea dodecaneura* Vell., Amazon, wild, tubers gathered, two varieties have been described.

9.3.3 Dioscorea hastata Vell. (D. hassleriana); Amazon, reported as cultivated by the Indians. These three species are probably not in cultivation any more.

9.3.4 Dioscorea trifida L., KUSH-KUSH, MAPUEY, Northern South America to Guatemala; quite variable especially in the size and color of the tubers; some eight cultivars known in Amazonia (Kerr & Clement, 1980).

9.4 Ipomoea Convolvulaceae

Some 500 species, in the tropics of both worlds.

9.4.1 Ipomoea batatas L., SWEET POTATO, many primitive cultivars all over South America, of special interst are the clones of the Atlantic coast of Colombia and the coastal areas of Ecuador and Peru. Some of the native cultivars in central Brasil are now being evaluated and selected.

9.5 Manihot Euphorbiaceae

An America genus, with around 100 species, concentrated in two discontinuous areas: NE Brasil and Western Mexico (Rogers & Appan, 1973). M. esculenta, the only species cultivated as a food crop does not seem to have close relatives, although artifical hybrids have been obtained with other species, of Manihot.

9.5.1 Manihot esculenta Crantz, CASSAVA, YUCA, MANDIOCA. A very polymorphic species, known only in cultivation, formed by 80 - 100 clones. These are well recognized by local people in their phenotypic characters, and by the bitternes of their roots. However, due to their spread by man, it is not possible to locate their original sources. A classification by "groups" has been proposed by Rogers & Fleming (1973), based on morphological characters. There are some areas in the Amazon which have not been properly explored and the spread of new cultivars is endangering the survival.

There is no comprehensive survey of the cassava diversity in the Amazon, and there are reports that interesting cultivars kept by the Indians have not been collected. Collections are kept at CIAT, Cali, Colombia; in Brasil at the Universidade Federal de Bahia, EMBRAPA-IPEAL, etc. (Nestel & McIntyre, 1975).

For other spp. of Manihot, see under Central - Southern Brasil.

9.6 Maranta — Marantaceae

Around 20 species, all from the American tropics. many ornamentals.

9.6.1 Maranta arundinacea L., ARROWROOT, ARARUTA; Amazon to the Antilles, two or three clones known.

9.6.2 Maranta ruiziana Loern., Amazon: Peru to Colombia, reported as cultivat by the Indians.

9.7 Oxalis — Oxalidaceae

800 species, tropics and temperate regions.

9.7.1 Oxalis spp. According to Tamayo (1963), a species which he assigns to O. latifolia H.B.K., is utilized in the lowlands of Venezuela for its edible roots or tubers. A similar plant is reported by Lathrap (1977) from Eastern Peru.

9.8 Pachyrhizus Leguminosae

6 species, all from the American tropics.

9.8.1 Pachyrhizus tuberosus (Lam.) Spreng., JICAMA; cultivated at a wide altitudinal range, 500 - 2500 m; several varieties. It is likely that P. ahipa, of the Andes of Bolivia, is only a population of P. tuberosus.

9.9 Xanthosoma Araceae

An American genus of around 40 species.

9.9.1 Xanthosoma sagittifolium (L.) Schott., a large assamblage of clonal cultivars, to which may correspond populations named X. caracu, X. jacquini, X. mafafa, X. violaceum. The area of original dispersion could be the Amazon, and from there it spread to the Caribbean and Mexico.

10. RUBBER

10.1 *Hevea* — Euphorbiaceae

10 spp. in the Amazon.

10.1.1 *Hevea benthamiana* Muell.-Arg., northwestern Amazon to the Orinoco, wild populations showing rather limited variability (Schultes, 1956); Ducke (1939) has described 5 varieties. The latex is of good quality, and wild trees are sometimes tapped; the resistance of the foliage of *H. benthamiana* to the South American leaf blight is being utilized now, grafting a crown of *H. benthamiana* on high yielding trunks of *H. brasiliensis*.

10.1.2 *Hevea brasiliensis* (Willd.) Muell.-Arg., RUBBER, SERINGUEIRA, south of the Amazon river to Matto Grosso and Parana - Bolivia, and from the Ucayali to Amapa. It probably shows less phenotypical variability than the other species of the genus. However, latex yield and quality differ widely among populations, and also disease resistance. It is very urgent to collect and assemble it in living collections, with representative samples of the populations. The natural area of *H. brasiliensis* is reduced continaully due to agricultural expansion, hydroelectric projects, etc.

10.1.3 *Hevea guianensis* Aubl., SERINGUEIRA AMARELLA, eastern Amazon - Maranhao - Surinam - Madeira - Rio Negro. The most variable of the species of *Hevea*; the yellow latex producer a rubber of inferior quality.

Other 4 species of *Hevea*: *H. nitida* Mart., *H. pauciflora* (Spruce) Muell.-Arg. *H. rigidifolia* (Spruce) Muell.-Arg., and *H. spruceana* (Benth.) Muell.-Arg., yield inferior latex for the present standards. But they may be of potential utilization if a thinner latex is required for industrial uses (Shultes, 1979), or for disease resistance (Imle, 1978).

NON ELASTIC RUBBER

10.1.4 *Couma macrocarpa* Barb. Rdor., Apocynaceae, SORVA, CASPI, western Amazon, exploited from wild stands.

RESINS

10.1.5 *Hymenaea courbaril* L., Leguminosae, JUTAI, Tropical America, Mexico to Brasil. Wild and cultivated, used for the fruits which contain very scarce pulp but highly nutritive, and for the resin, the "South American copal".

11. SPICES AND CONDIMENTS

11.1 Capsicum — Solanaceae

A tropical American genus of around 50 species, mostly in South America (Hunziker, 1956; Pickersgill, 1971; Esbaugh, 1977; Pickersgill, Heiser & McNeill, 1979).

11.1.1 Capsicum baccatum L., CHILE-PEPPER; wild in Southern Brasil. Includes a cultivated taxon, with many land races = pendulum, and two wild taxa; praetermissum and tomentosum.

11.1.2 Capsicum chinense Jacq., cultivated, wild populations in the Amazon and NW South America.

11.1.3 Capsicum frutescens L., wild populations in Brasil - NW South America to Mexico; many primitive cultivars.

11.2 Cyperus — Cyperaceae

11.2.1 Cyperus sp., PIPRIOCA, Amazon, wild and cultivated; the underground stems reported to be used as condiment, also used in medicine.

11.3 Eryngium — Umbelliferae

Some 230 species in the subtropics and tropics of Eurasia and America.

11.3.1 Eryngium foetidum L.; tropical America, wild and cultivated.

11.4 Eupatorium — Compositae

A large genus, 1200 spceis, in the New and Old World.

11.4.1 Eupatorium ayapana Venten., YAPANA; Amazon, cultivated.

11.5 Piper Piperaceae

Around 2000 species in the tropics.

11.5.1 Piper suffitor Trealese, JACAMI; Amazon to Para; it is probable that this is Piper guineense Schumach., introduced from Africa.

11.6 Spilanthes Compositae

A genus of 60 species distributed in tropical America, SE Asia, and NE Australia.

11.6.1 Spilanthes oleracea Jacq., (S. acmella var. oleracea); PARA CRESS, YAMBU; Amazon, wild and cultivated.

12. STIMULANTS

12.1 Erytroxylum — Erythroxylaceae

200 spp., mostly in tropical America.

12.1.1 Erythroxylum coca L., COCA, eastern slopes of the Andes to the Amazon, a cultivated variety, 'Ipadu', often clonally propagated (Plowman, 1979).

12.2 Paullinia — Sapindaceae

A pantropical genus of 120 spp., many in tropical America.

12.2.1 Paullinia cupana H.B.K., GUARANA, CUPANA, western Amazon to the Orinoco basin, apparently only in cultivation; two groups of populations are distinguished; the cupana in the Orinoco, and the sorbilis in western and central Amazon (Ducke, 1937).

12.2.2 Paullinia yoco R.E. Schultes & Killip, YOCO, SE Colombia and Ecuador, wild and cultivated by the Indians, who recognized several varieties; stems are used in the preparation of a beverage with cafein contents (Schultes, 1951).

12.3 Theobroma — Sterculiaceae

A tropical American genus with 22 spp.

12.3.1 Theobroma cacaô L., CACAO, native populations all over the Amazon - Orinoco basin, with a higher diversity in western Amazon, which is also a source of resistance to the witches broom disease. T. cacao is very polymorphic; in South America its diversity comes from the hybridization of populations introduced to Venezuela from Central America, of the

Criollo types, with the native populations. This led to the so called "Trinitarian complex', widely cultivated in NE South America. Regional populations, due probably to the introduction of a few individuals, isolation and natural selection, has resulted in races or varieties of distinct characteristics= 'Nacional' in Ecuador; 'Porcelana' in SW Venezuela, and others. Soria (1966) has described the most important of these populations.

The destruction of the rain forests is threatening the dissapearance of valuable cacao populations. Also, the introduction of selected cultivars= clones or hybrids, is displacing the primitive varieties all over the Amazon.

13. VEGETABLES

The Amazon - Orinoco basin in spite of the richness of plant species, is very poor in native vegetables. This is contrary to the case of similar areas in SE Asia and West Africa, in which a large number of species are utilized as vegetables, both cultivated or wild.

13.1 Carica — Caricaceae

Some spp., in tropical America.

13.1.1 Carica monoica Desf., COL DE MONTAÑA, eastern Andes (Peru), cooked leaves.

13.2 Cissus

Around 325 spp., in temperate and tropical areas.

13.2.1 Cissus gongyloides Burch., CUPA, Amazon, cultivated (Kerr, Possey & Wolter, 1978).

13.3 Cucurbita — Cucurbitaceae

An American genus with around 25 spp.

13.3.1 Cucurbita maxima Duch., a large number of primitive varieties all over South America, with some special types in Brasil and Peru.

13.3.2 Cucurbita moschata Duch., probably introduced early from Mesoamerica; some interesting types in Bolivia, the "jokos" (Cárdenas, 1969).

13.4 Euterpe — Palmae

Around 9 spp., in tropical America.

started in West Africa. Other species reported for South America are T. arnotti Hook. f., T. patens Willd., T. portulacifolium Asck. & Scheweinf. (Martin & Ruberté, 1975).

13.8 Xanthosoma Araceae

An American genus with around 40 spp.

13.8.1 Xanthosoma brasiliensis (Desf.) Engler, BELEMBE, Amazon, cultivated. This species is planted for its leaves, as the corns are small and rather insipid. The tender leaves of X. sagittifolium are sometimes used as a vegetable.

14. WAX

14.1 Calathea Marantaceae

Some 130 spp., from Mexico to Brasil

14.1.1 Calathea lutea (Audbl.) Schultes, CAVASSU; Central to South America, especially in the Amazon, wild; was collected for the leaves; a potential crop.

4.1. A. NE BRASIL

The dry area in NE Brasil has a few native crops.

1. FIBERS

1.1 *Attalea* Palmae

An American - African genus of some 50 species; some used for the oil contained in fruits and seeds.

1.1.1 *Attalea funifera* Mart., PIASSAVA; NE Brasil, wild and cultivated for the leaf fibers.

1.2 *Gossypium* Malvaceae

The genus *Gossypium* is represented in the region by a cultivated species and a wild taxon.

1.2.1 *Gossypium barbadense* L., COTTON, numerous land races forming the variety *brasiliensis*, extending to central and NE Brasil (Neves *et al*., 1968).

1.2.2 *Gossypium mustelinum* Watt, (*G. caicoense*): NE Brasil, a wild tetraploid, apparently not utilized and in way of extinction,; it is an interesting taxon for its possible relation to the other cultivated tetroploid species, *G. barbadense* and *G. hirsutum*. (Pickersgill & Barrett, 1975).

1.3 *Neoglaziovia* Bromeliaceae

A Brazilian genus of two species.

1.3.1 *Neoglaziovia variegata* (Arruda) Mez., CARUA, NE Brasil, wild and cultivated (Xavier, 1942).

2. FRUITS

2.1 Spondias — Anacardiaceae

A pantropical genus (not in Africa) of 12 species, several fruit trees.

2.1.1 Spondias tuberosa Arruda Cam., IMBU; wild and cultivated in NE Brasil, tupical of dry areas, one of the best fruits in the genus.

2.2 Ziziphus — Rhamnaceae

Tropics and subtropics of both worlds, in dry areas, 100 species.

2.2.1 Ziziphus joazeiro Mart., dry areas in NE Brasil, wild and cultivated.

3. OIL CROPS

3.1 Licania Chrysobalanaceae

Distributed from Florida to Brasil, 130 species; one described from Malaysia. Used for the oily seeds or the pulp of the fruit.

3.1.1 Licania rigida Benth. OITICICA, NE Brasil, wild and cultivated.

3.2 Orbignya Palmae

The babasu populations in NE Brasil contain millons of plants, and the kernel oil is one of the most important products. All comes from wild stands, as the only cultivation is done up to now, in experimental plots. The center of the babasu industry and the place where a permanent collection is being established by CENARGEN, is at San Louiz, Maranhao.

4. WAX

4.1 Copernicia Palmae

Some 27 spp., the majority in Cuba, 3 in South America.

4.1.1 Copernicia prunifera (Miller) H. Moore, CARNAUBA, NE Brasil, cultivated and gathered for the leaf wax.

4.1. B. CENTRAL BRASIL

The region south of the Amazon has a number of local crops, some of which are of world wide importance. Other are still restricted to the region, and some wild materials offer possibilites for domestication or for breeding. Several of them may grow in subtropical areas.

1. OIL CROPS

1.1 Arachis — Papilionaceae

22 spp., from the Amazon to Argentina.

1.1.1 Arachis hypogaea L., PEANUT; an allotetraploid originated probably in the lowlands of Bolivia, resulting of the cross of two diploids. At present, the candidates for its parentage are A. batizocoi and A. cardenasi. The infraspecific diversity in A. hypogaea has been established by Krapovickas (1968) as related to geographic distribution, in a primary center: Eastern Bolivia, and four secondary centers: i. Guarani (South Brasil - Argentina); ii. Goias - Minas Gerais Brasil), iii Rondonia - Northwest Brasil, and iv. Peru. Northeast Brasil, as a tertiary center, has been added by Gregory & Gregory (1976); details on genetic resources are given by Gregory et al.(1973).

1.2 Acrocomia — Palmae

Around 30 spp., from Mexico to Argentina.

1.2.1 Acrocomia totai Mart., MBOCAYA, Brasil - Paraguay, an important local source of kernel

1.3 Caryocar Caryocaraceae

A neotropical genus, with around 15 spp.

1.3.1 Caryocar brasiliensis Camb., PIQUIA, central Brasil, especially in the cerrado, a local source of fat.

3. FORAGE LEGUMES

An important contribution in genetic resources are the South American species of forage legumes, still practically unexploited. The few surveys done on small areas, show a wide infraspecific diversity (Souza Costa & Brando Ferreira, 1977). The "domestication" process of the South American forage legumes is carried on in Australia, where commercial cultivars of several species have been releases (León & Sgaravatti, 1971; Skerman, 1977).

3.1 Aeschynomene Papilionaceae

A pantropical genus, with around 90 spp. An important center of diversity is in Central - south Brasil - Paraguay - Bolivia.

3.1.1 Aeschynomene americana L., tropical America.

3.1.2 Aeschynomene falcata (Poir) D.C.; Venezuela - Paraguay.

3.2 Arachis Papilionaceae

Some 15 spp., from southern Brasil to Argentina.

3.2.1 Arachis glabrata Benth., Brasil - Argentina.

3.2.2 Arachis monticola Krapov. & Riggioni; Brasil - Argentina.

3.3 Calopogonium Papilionaceae

5 spp., in Central and South America.

3.3.1 Calopogonium mucunoides Desv., Mexico - Argentina.

3.4 Centrosema Papilionaceae

Around 30 spp in tropical America.

3.4.1 *Centrosema pubescens* Benth., tropical America. Commercial cultivars developed in Australia.

3.5 *Desmodium* Papilionaceae

A pantropical genus of around 170 spp., some extending to the subtropics.

3.5.1 *Desmodium barbatum* (L.) Benth & Oerst., USA - Argentina.

3.5.2 *Desmodium canum* (Gmel.) Schinz & Thell.; tropical America.

3.5.3 *Desmodium discolor* Vogel; tropical America.

3.5.4 *Desmodium uncinatum* (Jacq.) D.C.; South America. Commercial cultivars developed in Australia.

3.6 *Macroptilium* Papilionaceae

Some 5 spp., segragated from *Phaseolus*, from Mexico to Argentina.

3.6.1 *Macroptilium lathyroides* (L.) Urb.; tropical America. Commercial cultivars developed in Australia.

3.7 *Stylosanthes* Papilionaceae

25 spp., pantropical.

3.7.1 *Stylosanthes guianensis* (Aubl.) Sw. (*S. gracilis*), STYLO; South America. Commercial cultivars developed in Australia.

3.7.2 *Stylosanthes hamata* (L.) Taub.; northern South America. Commercial cultivars developed in Australia.

3.7.3 *Stylosanthes humilis* H.B.K.; central South America. Commercial cultivars developed in Australia.

4. FRUITS

A number of Myrtaceous fruits, some of them well known outside South America, are natives to the central and subtopical areas of Brasil. Some are grown in other parts of the tropics and in subtropical regions, such as Florida and California.

4.1 Campomanesia — Myrtaceae

80 spp. in South America, commonly called GUABIROBA.

4.1.1 Campomanesia aurea Berg., central - south Brasil

4.1.2 Campomanesia guazumifolia Camb. (Britoa sellowiana Berg), is the most commom and has been cultivated in other regions.

4.2 Eugenia — Myrtaceae

An American genus, especially in South America.

4.2.1 Eugenia brasiliensis Mart., GRUMIXANA, Amazon - central Brasil, several varieties in cultivation.

4.2.2 Eugenia klotzschiana Berg, PERA DO CAMPO, central Brasil.

4.2.3 Eugenia lutschnathiana Berg, PITOMBA central Brasil.

4.2.4 Eugenia pyriformis Camb., UVALHA, cental - southern Brasil.

4.2.5 Eugenia cabelluda Camb., CABELUDA, central Brasil.

4.2.6 Eugenia uniflora L., PITANGA, cultivated in many areas outside South America.

4.3 Feijoa — Myrtaceae

A monotypic genus, southern Brasil.

4.3.1 Feijoa sellowiana Berg., FEIJOA, wild and cultivated for the edible petals and fruits; introduced to Central and North America. Several varieties.

4.4 Myrciaria — Myrtaceae

Some 60 spp. in South America. The species differentiation is not clear. Each of the three cultivated species, originating in central Brasil, have many varieties.

4.4.1 Myrciaria cauliflora Berg, JABOTICABA - SABARA.

4.4.2 Myrciaria jaboticaba Berg, JABOTICABA

4.4.3 Myrciaria trunciflora Berg, JABOTICABA DE CABINHO.

4.5 Paiaeva — Myrtaceae

A monotypic genus, cental Brasil.

4.5.1 Paiaeva langsdorfi Berg, CAMBUCI, wild and cultivated, especially in Sao Paulo.

4.6 Psidium — Myrtaceae

110 spp. in the American tropics.

4.6.1 Psidium cattleianum Sabine, STRAWBERRY GUAVA, central - souther Brasil, widely cultivated; introduced to other tropical areas.

1.2. THE PACIFIC LOWLANDS OF NW SOUTH AMERICA

The lowlands of the northwestern corner of South America comprise a narrow coastal area between the Pacific and the Andes, from the isthmus of Panama to northern Ecuador, and some of the intermountain valleys between the Andean cordilleras. It contains one of the richest vegetations of the World: Ecuador may have the greatest number of flowering plants per space unit in South America (Gentry, 1977). In spite of this richness, only a few species have been domesticated in the region.

It is quite possible that Indians moved some crops or superior cultivars from the upper Amazon to the coastal regions of the Pacific. Pound (1938) suggest such kind of dispersal for superior varieties of cacao, and according to Lathrap (1970), the favorable conditions for agriculture of the Guayas valley may have attracted the Indians from the upper Amazon to establish settlements in the coast of Ecuador.

1. BAMBOO

2.1 Bambusa — Gramineae

A genus of SE Asia, with only one species of outside that region.

2.1.1 Bambusa angustifolia (McClure) H.B.K. (Guadua angustifolia), GUADUA; the only true bamboo in the American tropics, cultivated and spontaneous in Colombia.

2. CEREALS

2.1 *Zea* Gramineae

An American genus with 6 spp.

2.1.1 *Zea mays* L. MAIZE, an interesting race, 'Chocosito' is found in the Chocó, Colombia, adapted to conditions of extreme humidity (Patiño, 1956).

3. FIBERS

3.1 *Aechmea* Bromeliaceae

Around 90 spp. in the American tropics.

3.1.1 *Aechmea magdalenea* André, PITA FLOJA, Mexico to Northern South America, in Colombia has been intensively used, obtained from natural stands or from incipient cultivation.

4. FORAGES

4.1 *Axonopus* Gramineae

An American genus with 12 spp.

4.1.1 *Axonopus scoparius* (Fluegge) Hitch., IMPERIAL; clones of this species originating in S. Colombia, are widely cultivated in tropical America, from 500-1000 m. Its relation to a close taxon, *A. micay*, is still not clear.

3. FRUITS

3.1 Borojoa — Rubiaceae

An endemic genus with one species.

3.1.1 Borojoa patinoi Cuatr.; Western Colombia, wild and cultivated (Cuatrecasas, 1948, 1953).

3.2 Bactris — Palmae

Around 21 spp., from Mexico to Brasil.

3.2.1 Bactris gasipaes H.B.K. CHONTADURO; cultivated and spontaneous populations, well differentiated in Northern Ecuador and in the Chocó region in Colombia.

3.3 Carica — Caricaceae

21 spp. in tropical America.

3.3.1 Carica papaya L. According to Badillo (1971), Northwestern South America is most probably the area of origin of the papaya. The varietal diversity in this area is not especially striking.

3.4 Gustavia — Lecythidaceae

Around 20 spp., from Costa Rica to Brasil

3.4.1 Gustavia superba (H.B.K.) Berg, PACO; Western Colombia to Panamá, cultivated and wild.

3.5 Patinoa Bombacaceae

An endemic genus, with one species.

3.5.1 Patinoa almirajo Cuatr., ALMIRAJO; Western Colombia, wild and cultivated (Cuatrecasas, 1953a).

3.6 Phytelephas Palmae

4 spp. in South America.

3.6.1 Phytelephas macrocarpa R. & R., IVORY PALM, TAGUA; Ecuador, the young fruits are eaten fresh and the mature kernels used as vegetable ivory.

3.7 Rheedia Clusiaceae

Around 17 spp. in Central and South America.

3.7.1 Rheedia madruno (H.B.K.) Planch. & Triana, MADROÑO; Ecuador - Colombia on the Pacific slope, cultivated and wild, quite variable.

1.3. THE CARIBBEAN WATERSHED - ANTILLES

A large part of Northern South America is occupied by deciduos forests and savannas ("llanos"), especially in the Orinoco basin, but also in isolated pockets in NE Brasil. Along the Caribbean coast extends a narrow belt of xerophytic vegetation. The area is therefore poor in number of species in relation to the other regions of South America.

The Antilles may be considered as part of this region, mainly for its cultural connections, as migration into the Lesser Antilles and later on to the Greater Antilles, started from the Coastal areas of Venezuela (Rouse, 1964). Through this connection, several Amazonian crops spread up to Cuba.

A few species, mainly fruit trees, were probably domesticated in the Antilles and the Caribbean coast of South America. It is also an interesting area for cotton, in which some races evolved in the Lesser Antilles due to isolation. The savannas are also rich in Leguminosae, of potential use as forage crops.

1. CEREALS

1.1 *Zea* Gramineae

An American genus with 4 spp.

1.1.1 *Zea mays* L., MAIZE; Cuba is an important source of yellow dents, some used in breeding in other parts of the world (Hatheway, 1957).

2. FIBERS

2.1 Gossypium — Malvaceae

A pantropical genus, in all continents, around 20 spp.

2.1.1 Gossypium hirsutum L., COTTON; has several isolated strains in the Antilles. Some of them, like Marie Galante, had a special role in cotton breeding. The populations are quite reduced in number and are dissapearing fast, but have been well collected.

3. FRUITS

3.1 Byrsonima — Malpighiaceae

Around 120 species, mostly in dry areas of Northern South America.

3.1.1 Byrsonima crassifolia (L.) Kunth, MURUCI, PERALEJO, MANTECO; tropical America from Mexico to Brasil, wild in savannas and dry places, the highest diversity occurs in Guatemala; many botanical varieties have been recognized among the wild populations of South America.

3.2 Chrysobalanus — Chrysobalanaceae

4 spp., in tropical America, one extending to Africa.

3.2.1 Chrysobalanus icaco L., wider diversity in the Caribbean, but no cultivars have been selected.

3.3 Chrysophyllum — Sapotaceae

Around 100 spp. in tropical America and Western Africa.

3.3.1 Chrysophyllum cainito L., STAR APPLE; probably domesticated in the Antilles, the best varieties are found in Cuba and Hispaniola. Other species gathered in the Greater Antilles are C. bicolor Poir., C. oliviforme L., and C. argenteum Jacq.

3.4 Eugenia Myrtaceae

Around 200 spp. in tropical America.

3.4.1 Eugenia floribunda West., GUAVA BERRY, Puerto Rico - Lesser Antilles; three varieties in the Virgin Islands.

3.5 Inga Mimosaceae

Around 200 spp., from Mexico to Uruguay.

3.5.1 Inga fagifolia (L.) Willd., GUAMO; Antilles - Northern South America, superior cultivars in Puerto Rico.

3.6 Genipa Rubiaceae

A tropical American genus, with 6 spp.

3.6.1 Genipa americana L., GENIP; Antilles - Brasil; superior varieties in Dominican Republic.

3.7 Grias Lecythidaceae

45 spp., in South America - Antilles.

3.7.1 Grias cauliflora L., ANCHOVY PEAR; Antilles, cultivated.

3.8 Malpighia Malpighiaceae

Some 20 spp. in South America and Antilles.

3.8.1 Malpighia glabra L., BARBADOS CHERRY, ACEROLA; clonal cultivars originated from Antillean plants are widely planted elsewhere.

3.9 Mammea Clusiaceae

2 spp., one in tropical America, the other in West Africa.

3.9.1 Mammea americana L., MAMEY; this species was very likely domesticated in the Greater Antilles, and its spread to the rest of tropical America ocurred in historical times. As it descends probably from one tree, its diversity is extremely restricted.

3.10 Passiflora Passifloraceae

400 spp., mostly in tropical America, a few in Asia and Australia.

3.10.1 Passiflora maliformis L., wild and cultivated in the Antilles.

3.11 Pereskia Cactaceae

18 spp. in Central - South America - Antilles.

3.11.1 Pereskia aculeata Mill., BARBADOS GOOSE BERRY; wild and cultivated in the drier areas of Venezuela and the Antilles.

3.12 Rollinia Annonaceae

20 spp. in Central - South America.

3.12.1 Rollinia mucosa Jacq., Guiana - Antilles, wild and cultivated.

4. OIL (essential)

4.1 Dipteryx — Papilionaceae

10 spp. in Northern South America.

4.1.1 Dipteryx odorata (Aubl.) Willd. TONKA; wild and cultivated in Venezuela, Antilles and Northern Brasil.

4.2 Pimenta — Myrtaceae

5 spp. in Central America to Antilles.

4.2.1 Pimenta racemosa (MIll.) J. W. Moore (P. acris), BAYRUM, wild and cultivated in Puerto Rico.

5. ROOTS AND TUBERS

5.1 Calathea — Marantaceae

120 spp. in tropical America.

5.1.1 Calathea allouia (Aubl.) Lindl., LAIREN; widely cultivated in the Antilles; no information is available on its diversity (Chevalier, 1936; Martin & Cabanillas, 1976).

5.2 Dioscorea — Dioscoreaceae

A pantropical genus 600 spp., some in temperate areas.

5.2.1 Dioscorea trifida L., MAPUEY. Although this crop may have originated in the Amazon, many cultivars are known in the Caribbean. In spite of its good quality, it is being replaced by the African Dioscorea.

5.3 Ipomoea Convolvulaceae

Around 400 spp., in tropical and temperate areas.

5.3.1 Ipomoea batatas L., SWEET POTATO; a high diversity in Cuba and other Great Antilles, especially of primitive cultivars (white flesh).

5.4 Maranta Marantaceae

30 spp. in tropical America.

5.4.1 Maranta arundinacea L., ST. VINCENT ARROW ROOT; this cultigen may have moved from the Amazon, instead of being domesticated in the Lesser Antilles as assumed by Stutervant (1969). It is more intensively cultivated in the Lesser Antilles than elsewhere, but only two clones are known.

5.5 Xanthosoma Araceae

40 spp. in tropical America.

5.5.1 Xanthosoma sagittifolium (L.) Schott. In the Antilles is the highest concentration of cultivars, the result of introduction rather than local evolution; several clones are in the process of dissapearing, due to the competition of superior cultivars of X. sagittifolium or the introduced Colocasia esculenta.

6. SPICES

6.1 Pimenta — Myrtaceae

5 spp. in Central - South America - Antilles.

6.1.1 *Pimenta dioica* (L.) Merr., ALLSPICE; wild and cultivated in Jamaica and Puerto Rico, extremely variable.

7. STIMULANTS

7.1. Agave — Agavaceae

Around 250 spp., North America to northern South America.

7.1.1 *Agave cocuy* Trel., COCUY, Venezuela, source of an alcoholic drink, prepared as the Mexican tequila (Tamayo, 1963).

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THE ANDES

Delimitation

The Andean area as a center of crop genetic resources, extends from the Sierra de Merida in Venezuela to the Calchaquies valleys in NW Argentina. Two altitudinal belts may be recognized in germplasm concentration: a) the high Andes, with a lower limit between 1800 to 2000 m, and the higher between 3500 and 4000 m, which is the main source of local domestications, and b) the low Andes, from sea level to 1800 - 2000, in which introduced crops are predominant.

Relief and climate

The Andes is a series of highly folded mountains, with their main axis running north - south along the Pacific coast of South America. In relation to its length, from 10°N to 40°S, it is a very narrow body of mountains. At its widest span, the central Andes in southern Peru and Bolivia, the mountain chains to the East and West, encircle a high plateau or Altiplano formed by intermountain valleys, lakes and large salt pans. North of the Altiplano, the Peruvian Andes are cut longitudinally into three mountain chains, by rivers running towards the North and then turning to the east; they are the head waters of the Amazones. In Ecuador, especially in the South, the chains mix into a complex relief, and in Southern Colombia two rivers cut longitudinal valleys forming again three cordilleras. The Andes continue in the northern end towards the east as the Sierra Andes to the Northern end, the Eastern section of the cordillera is transversally cut by many rivers which join to form the Amazonas.

The climate conditions are quite different in the two sides of the Andes. In the Western slope, from the Strait of Atrato to Southern Ecuador, prevail wet conditions which affect not only the Pacific lowlands but also the high mountains. From Southern Ecuador to Northern Chile, the desert covers the coastal areas and extends towards the western slopes of the cordilleras. In the Eastern slope, the humidity of the Amazon lowlands determines areas of high rainfall in the lower mountains, but the cordilleras block the expansion of wet areas towards the west.

Natural vegetation

The altitude and climatic conditions in the Andes determine a series of altitudinal belts of different types of vegetation.

In the western slope, from southern Ecuador to northern Chile, the desert extends from sea level up to some 1800 - 2000 m. with xerophytic formations or a special kind of vegetation, "lomas". From 2000 to 4000, is the sierra bush or scrub forest, which corresponds to the main Andean agricultural region. Above 4000 is the puna, a dry or wet grassland formation up to the snow line, at around 5000 m. On the Eastern side, the forest covers the slopes and a belt called "ceja de montaña", 2000 to 3500 m, corresponds to the agricultural area.

In the Andes north of Ecuador, the highest limit for the agricultural belt is at 3500 m., lower than in the central Andes; above is the paramo, with the snow line at 4600 -4700 m, also lower than in Bolivia or Peru.

The floristic elements are mainly of southern origin or endemic, but some northern genera, like <u>Juglans</u>, have extended up to Bolivia. The plants at the higher altitudes do not offer many materials to be domesticated. But many of them develop underground organs: fleshy roots or tubers, to ensure their survival during the winter. Some of the roots and tubers are very attractive for their shape and color, and provide, after cooking or roasting, an abundant food. Also plants like the chenopods, that grow up to the puna level, may supply very nutritious grains, of high protein content. In both cases, it took a lot of ingenuity to develop methods to dry the tubers in a product, "chuño", that may be stored and used when there are not fresh tubers, and in the case of the chenopods, to remove the saponins of the seed to make them palatable. The high Andes agriculture was bases on these tubers, roots and grains; the prehistoric introduction of maize and the post european of barley and wheat, added new materials to the diet.

The lower Andean agriculture is an array of crops of different origin, mostly introduced from the eastern lowlands; there is now doubt that as maize arrived from Mesoamerica, other crops like cucurbitas and beans may have come the same way, as their presence in the high Andes seems to be very old.. Very few species, of which cotton is an example, are of local domestication. All together, the Andean region offers a remarkable concentration of crop germplasm (Cook ., 1925).

Cultural aspects

Primitive man was in the Andes some 10.000 years ago, in small and transhumant groups, depending on hunting for food and clothing (Lynch, 1971; Jensen & Kautz, 1974). Very likely due to the scarcity of game and the increase in population, plant domestication was started in different parts of the region. The archeological proofs to locate the areas of primitive domestication are very scarce. Only in Central Peru (McNeish, 1971) there are indications, as early as 6.000 BC, of the beginning of agriculture. For the coast of Peru, however, Engel (1970) and Patterson (1971) have established chronological patterns for the development of agriculture. According to Engel (1970) there was a period of incipient agriculture between 4.000 - 2000 BC, and of archaic agriculture from 400 to 1.000 AD. The richness of plant materials and their status of preservation, makes quite easy to establish the agricultural sequences and the kinds of crops that were grown in coastal Peru (Yacovleff & Herrera, 1934-5; Towle, 1961). For the Andes properly, the information is restricted to central Peru, where the dates for beans are around 6.000 BC (Kaplan, Lynch & Smith, 1973), amaranths, squash, chilies, around 6500 BC (McNeish, Nelken, Terner & Cook, 1970).

At the arrival of the Europeans the Andean agriculture was more advanced than any in Europe. One fo the rules of the Inca domination,which extended from northern Ecuador to central Chile, has a special significance in crop diversity. It was the practice of moving whole communities -including their special crops and domestic animals- to new areas in the empire. The result, as has been shown for the Huanuco valley by Bird (1966), is that even now ethnic groups of different origin living closeby still plant different varieties.

<u>The present situation</u>

A large number of the Andean crops have adaptability limitations. They were domesticated at high altitudes and primitive man developed complicated systems of processing, which are unknown elsewhere. With the exception of potatoes, the other had a restricted spread outside the Andes. Oxalis tuberosa grows in Mexico; Arracacia xanthorhyza in Central America, East Africa and especially in southern Brasil.

The impact of introduced crops in the Andean crops placed them in a critical level, and their importance was decreasing fast (Gade, 1969). However, in recent years the situation has changed. The work of national scientists, supported by research in developed countries showing the high nutritive value of some of them, plus the help rendered by GTZ, IBPGR and other agencies, has changed the situation. Expeditions in several countries, storage facilities and some technological advances and breeding results are now placing the Andean crops on a satisfactory stage of conservation and improving their use as foods and industrial crops.

1. CEREALS

1.1 Zea — Gramineae

An American genus with 6 spp.

1.1.1 Zea mays L., MAIZE. The Andean region, especially the highlands of Peru is a very important center of racial diversity. Maize is a very old introduction from Mesoamerica, but shows several independent lines of evolution in the Andes (Brown & Goodman, 1977). The races of Andean maize are quite well collected and analyzed, both in general terms (Mangelsdorf, 1974; Brown & Goodman, 1977) and by countries: Bolivia (Ramírez et al, 1960; Rodríguez et al, 1968); Colombia (Roberts et al, 1957); Ecuador (Timothy et al., 1963); Peru (Grobman, Salhuana & Sevilla, 1961); Venezuela (Grant et al.,1963). Collections at Universidad Agraria, La Molina, Peru, 5200; Colombia, IICA, 4000 entries.

2. FIBERS

2.1 Furcraea — Agavaceae

An American genus of some 20 species, in the highlands from Central America to Bolivia.

2.1.1 *Furcraea andina* Trel., CABUYA; Ecuador - Bolivia, wild and cultivated.

2.1.2 *Furcraea foetida* (L.) Haw. (*F. gigantea*); Colombia - Venezuela.

2.1.3 *Furcraea humboldtiana* Trel.; Colombia and Venezuela.

2.1.4 *Furcraea macrophylla* (Hook) Baker; Colombia.

2.2 Gossypium — Malvaceae

2.2.1 *Gossypium barbadense* L., COTTON; wild in Ecuador, Peru and Galapagos (var. *darwini*); cultivated and feral populations in northern South America (var. *brasiliense*) and in the west side of the Andes (Ecuadorean group) (Stephens, 1973). In spite of the intensive cultivation in the region there are still many primitive cultivars. Two diploid taxa: *G. raimondi* Ulbr., coastal Peru, almost extinct; *G. klotzchianum* Anderss., from Galapagos; the former has been considered a variety of the second. Collection of local cultivars: La Molina, Lima, Peru, 400 accessions.

3. FRUITS

3.1 Annona — Annonaceae

Some 120 species, mostly in the lowland tropics. The following is the only species found in the Andes, and could be introduced from Mesoamerica.

3.1.1 Annona cherimolia L., CHIRIMOYA; a large number of forms in the interandean valleys at 1.000 - 2.000 m. from Colombia to Chile. Popenoe (1921), based on the abundance of "wild" populations assumed that A. cherimolia is native of the Eastern slopes of the Ecuadorian Andes.

3.2 Crataegus — Rosaceae

A North American genus of some 200 species.

3.2.1 Crataegus pubescens (H.B.K.) Steud., (C. stipulosa) reported by Popenoe (1924) as wild in Sourhern Ecuador; a Mexican species that has adapted so well to the Andes that spontaneous and cultivated populations seem to grow better than in its native home; a similar case occurs with Prunus serotina and maybe with Annona cherimolia.

3.3 Carica — Caricaceae

A group of species and hybrids adapted to the highland conditions of the Andes.

3.3.1 Carica candicans Gray, MITO; Central Peru, wild and gathered.

3.3.2 Carica x heilborni Badillo (C. pentagona, C. chrysopetala). BABACO, HIGACHO, two clones of hybrid origin according to Badillo (1971) originated in Ecuador and introduced in Colombia (C. fructifragans),New Zealand, etc.

3.3.3 Carica pubescens Lenné & Koch (C. candamarcensis), PAPAYUELA, Venezuela - Bolivia, cultivated; according to Popenoe (1924) wild in Southern Ecuador.

3.4 Cyphomandra Solanaceae

Thirty species in Central and Sourh America, especially in the highlands.

3.4.1 Cyphomandra crassifolia (Ort.) Mcbr. (C. betacea), TREE TOMATO; known only in cultivation, Colombia - Bolivia, at 1.000 - 2.000 m; some variants are characterized by different color of the fruits. In Ecuador there are other species of Cyphomandra with edible fruits in incipient domestication.

3.5 Inga Leguminosae

An American genus of around 200 species, mainly in Brasil.

3.5.1 Inga densiflora Benth., GUAMO; the most common species of Inga utilized for its fruits in the highlands of Colombia.

3.5.2 Inga feuillei D. C., PACAE; known only in cultivation in the coastal area of Peru, up to 1.500 m; probably an early introduction from the Eastern Andes.

3.6 Juglans Juglandaceae

Around 15 species, Eurasia, North America, Andes. The Andean species are not clearly differentiated.

3.6.1 Juglans boliviana Dode, NOGAL; wild and cultivated in Bolivia and Peru.

3.6.2 Juglans honorei Dode, NOGAL; Ecuador, wild and cultivated.

3.7 Macleania Ericaceae

Forty-five species in Central and South America, at high altitude (2.200 - 3.800 m).

3.7.1 Macleania ecuadorensis Harold, M. laurina Blake, M. popenoi Blake; Colombia - Ecuador, wild and gathered. These fruit plants are worth of domestication and improvement.

3.8 Passiflora Passifloraceae

Around 500 species, mostly American; in the Andes the subgenus Tacsonia includes some native fruits and ornamentals.

3.8.1 Passiflora mollissima (H.B.K) Bailey, TACSO, CURUBA; Colombia - Peru, known only in cultivation.

3.8.2 Passiflora pinnatistipula Cav., TACSO; Ecuador.

3.8.3 Passiflora popenoi Killip. GRANADILLA DE QUIJOS; wild and cultivated in Ecuador.

3.8.4 Passiflora tripartita (Juss.) Poir., TACSO; wild and cultivated in Ecuador.

3.9 Persea Lauraceae

Around 150 species in the tropics, a few in the Andes.

3.9.1 Persea americana Mill., AVOCADO, PALTA, in the highlands of Colombia and Ecuador there are some native populations, still not well known. Avocado cultivation is old in Central Peru, but the native races have been replaced by imported cultivars.

3.10 Physalis Solanaceae

Around 100 species of worldwide distribution mainly in North America.

3.10.1 Physalis peruviana L., UCHUBA, Colombia - Bolivia, cultivated and spontaneous.

3.11 Pouteria Sapotaceae

Around 50 species in the American tropics- several with edible fruits in Mesoamerica and the Amazon.

3.11.1 Pouteria arguacoensium (Karst.) Baehni, MANZANO; wild and cultivated in the Sierra Nevada of Colombia.

3.11.2 Pouteria lucuma (R. & P.) Ktze., LUCUMO; Chile to Southern Ecuador, only in cultivation; in Peru several varieties of clonal propagation (Calzada Benza et al., 1972). Collection, Universidad Agraria La Molina, 36 entries.

3.12 Prunus Rosaceae

A genus of Eurasia and North America, with 35 species.

3.12.1 Prunus serotina Ehrh., CAPULIN; introduced from Mexico, some of the best types are found in Ecuador, (Popenoe & Pachano, 1922).

3.13 Rubus Rosaceae

A large genus, 250 species mainly in the Northern hemisphere; in the tropics found at high altitude.

3.13.1 Rubus adenotrichus Schlecht., MORA; Mexico - Peru, wild but intensively gathered in the Andes (2.000 - 3.800 m).

3.13.2 Rubus floribundus H.B.K., MORA, Mexico to Bolivia; gathered for its fruits.

3.13.3 Rubus glaucus Benth., MORA DE CASTILLA; Mexico - Ecuador; cultivated and wild, quite variable, some strains in Ecuador (Popenoe, 1921a).

3.13.4 Rubus urticaefolius Poir., MORA; Venezuela - Peru, wild and gathered as the other Rubus, it is extremely variable.

3.14 Solanum Solanaceae

Around 1700 species, all over the world. The Andes is an important center of concentration of species.

3.14.1 Solanum muricatum Ait., PEPINO, Colombia - Bolivia; very polimorphic Bitter (1913) described five varieties: papallosistylum, protogenum, popayanum, praecadens and teleutogenum, a classification that Cárdenas (1950) considers artificial. Correll (1962) recognized only two varieties: glaberrimum, cultivated, from Central Peru, and protogenum which includes the rest. In Peru all the cultivars are seedless and the plants are propagated by cuttings. In Colombia there are primitive types, some with many fertile seeds. Ecuador seems to have the highest diversity. Heiser (1964) is inclined to derive S. muricatum from S. caripense, a view which is not supported by Brucher (1966).

3.14.2 Solanum quitoense Lam., NARANJILLA, LULO, Colombia - Peru, 1500 -2600 m; known only in cultivation and there is no closely related Solanum in the area (Heiser, 1972). Schultes & Cuatrecasas (1953) recognize two varieties: typica, spineless, from Ecuador to Southern Colombia, and septentrionalis, with spines in the leaves and branches, from Central and Northern Colombia.

3.15 Vaccinum Ericaceae

Some 300 - 400 species of world wide distribution. In tropical America at high altitudes in Mexico - Peru.

3.15.1 Vaccinum floribundum H.B.K. MORTIÑO; Colombia - Ecuador; wild but intensively gathered like some other Ericaceae of the Andes, and sold in the markets. V. floribundum should be selected and cultivated.

4. GRAIN LEGUMES

4.1 Canavalia — Leguminosae

Some 50 species, in the tropics of the New and the Old World, three of them under cultivation.

4.1.1 Canavalia ensiformis (L.) D.C. During the Inca period was intensively cultivated, now is a relict crop in Central Peru (Sauer & Kaplan, 1969)

4.2 Erythrina — Leguminosae

Some 100 species in the tropics and subtropics; ornamental, forages, shade trees.

4.2.1 Erythrina edulis Triana, BAJU; Colombia - Peru; at 1.500 - 2.000 m, only in cultivation (seeds eaten cooked).

4.3 Lupinus — Leguminosae

Around 200 spp. in the New World, Europe, Africa, several in cultivation: grain, forage, ornamental.

4.3.1 Lupinus mutabilis Sweet, TARWI, Colombia to Bolivia, a very polymorphic species, cultivated at 2.000 - 3.500 m; many wild relatives in the puna, some advanced cultivars (Gade, 1969; Baer & Gross, 1977). Collections: Peru: La Molina, 300; Huancayo Exp. Sta. 1800 entries; Cuzco, University, 1200 entries.

4.4 Phaseolus Leguminosae

Some 200 American spp., four of them cultivated for their grains.

4.4.1 Phaseolus coccineous L. This Mesoamerican species is sporadically cultivated in the Andes; a group of populations called Murutungo are planted by Indians in NE Venezuela (Berglund-Brücher & Brücher, 1974).

4.4.2 Phaseolus lunatus L., LIMA BEAN. The group of cultivars called Lima, characterized by large, flat, white seeds with a low content of HCN, are supposed to have their center of origin in the coastal area of Peru (Mackie, 1943). By historical records it is known that a similar kind was found in the coast of Brasil at the time of the discovery. In fact, Lima beans show at present more diversity in Eastern Brasil than in Peru. In the last country archeological rests show they where utilized since around 2.000 BC.

4.4.3 Phaseolus vulgaris L., COMMON BEAN; there is not a survey of the varieties in the Andean region, although this may be one of the areas where the common bean was domesticated (Kaplan, 1981) and is of anciente cultivation (Kaplan, Lynch & Smith, 1973). The dominant cultivars at high elevations (above 2.000 m), are characterized by spherical seeds of dark uniform color or spotted often with contrasting tones. A group of them, the "nuñas:, from Ecuador to Bolivia, are eaten roasted like peanuts. In the Andean lowlands the diversity is narrower and many foreign cultivars have been introduced. Large collection at CIAT, Cali, Colombia, around 30.000 accessions.

5. PSEUDOCEREALS

5.1 Amaranthus — Amaranthaceae

A pantropical genus of 60 species; three of them are used for their seeds.

5.1.1 *Amaranthus caudatus* L. (*A. edulis*); Ecuador to Argentina, only in cultivation, several grain races in the Andes (Hunziker, 1952; León, 1964). Collection at Cuzco, University, 80 accessions.

5.2 Chenopodium — Chenopodiaceae

Most of 150 species grow in temperate regions; two are cultivated for the seeds (Hunziker, 1952; León, 1964; Tapia *et al*., 1979).

5.2.1 *Chenopodium pallidicaule* Allen, CAÑIGUA: Peru - Bolivia, at 3.500 - 4.000 m; several land races, no wild populations, often spontaneous. Collections at Puno, University, 420 accessions; Patacanaya, Bolivia, 400.

5.2.2 *Chenopodium quinoa* Willd., QUINOA; Colombia - Argentina - Chile, above 3.000 m. A good number of primitive varieties are recongnized, some selection has also been done recently (Tapia *et al*., 1979). Collections at the National University, Bogotá, Colombia, 1500 accessions; Puno, University, 2200 accessions; Puno, University, 1300; Patacanaya, Bolivia, 1400.

6. ROOTS AND TUBERS

6.1 Arracacia — Umbelliferae

An American genus, from Mexico to Bolivia, with some 55 species.

6.1.1 *Arracacia xanthorhiza* Bancroft (*A. esculenta*), ARRACACHA, Colombia - Bolivia, known only in cultivation; numerous clones are known (Briceño, 1975), especially in Peru and Central Colombia. Small collections at ICA, Colombia, 12 entries; Cajamarca University, Peru, 30.

6.2 Canna — Cannaceae

Some 55 species in the American tropics and subtropics.

6.2.1 *Canna edulis* Ker., ACHIRA; this cultigen originated probably in the tropical foothills of the Eastern Andes, but is cultivated up to 2.500 m; only tow cultivars are known in the Andes (Gade, 1966; Chaparro & Cortês, 1978).

6.3 Ipomoea — Convolvulaceae

A pantropic genus with 500 species, a few cultivated: vegetable, root crops, ornamentals.

6.3.1 *Ipomoea batatás* L., SWEET POTATO, the clonal diversity in the Andean region is high, especially in the coastal area, where it is used for food and forage and has been in cultivation for 10.000 years. According to Martin, Jones & Rubertê (1974) some primitive cultivars are found in Eastern Colombia and Ecuador.

6.4 Lepidium Cruciferae

A genus of 150 species distributed in temperate regions and tropical mountains.

6.4.1 Lepidium meyeni Walp., MACA, high Andes of Peru, above 3.500 m, cultivated and wild, some four cultivars (León, 1964).

6.5 Lophophytum Balanophoraceae

A South American genus with four species.

6.5.1 Lophophytum meyeni A. Gray (L. quadrangulare), Peru - Bolivia, a parasite on the root of totora (Scirpus spp.) the fleshy stem is eaten fresh.

6.6 Mirabilis Nyctaginaceae

An American genus with 60 species; ornamentals.

6.6.1 Mirabilis expansa R. & P., MAUKA; a relict crop in the high Andes of Bolivia and Ecuador; diversity unknown (Rea & León, 1965).

6.7 Neowerdemannia Cactaceae

6.7.1 Neowerdemannia vorwercki Fries, ACHACANA, Bolivia; the fleshy roots are collected from wild plants and sold in the markets (Cárdenas, 1969).

6.8 Nothoscordum Alliaceae

Around 35 species, in the New World, mainly at high elevations.

6.8.1 Nothoscordum andicola Kunth, CHULLCUS; Peru, wild, bulbs collected and eatern (Herrera, 1943).

6.9 Oxalis Oxalidaceae

A large genus, 800 species chiefly in tropical America and South Africa.

6.9.1 Oxalis tuberosa Molina, OCA; Colombia - Chile, known only in cultivation; many clones, showing some geographic concentration (León, 1964; Cárdenas, 1969). Collections at University of Puno, Peru, 650 entries; Bolivia, IBTA, Belen, 425 entries.

6.10 Pachyrrhizus Leguminosae

A tropical American genus of some six species.

6.10.1 Pachyrrhizus tuberosus (Lam.) Spreng. JICAMA. A cultigen in the Andes has been described as a different species, P. ahipa (Wedd.) Parodi, but it does not seem to differ from the lowland populations of P. tuberosus.

6.11 Polymnia Compositae

Twenty species in tropical America.

6.11.1 Polymnia sonchifolia Poepp. & Endl., YACON; Venezuela - Argentina, at middle elevations, 1.500 - 2.500 m, no information on varietal diversity. Used also as forage (León, 1964).

6.12 Solanum Solanaceae

In the large genus Solanum the tuberous species are placed in the subsection Hyperbasthrum. which includes cultivated and wild species.

a) Cultivated species (Hawkes, 1963).

6.12.1 Solanum ajanhuiri Juz. & Buk., 2x; Northern Bolivia.

6.12.2 Solanum curtilobum Juz. & Buk., 5x; Central Peru - Southern Bolivia.

6.12.3 Solanum x chaucha Juz. & Buk., 3x; Central Peru to Bolivia.

6.12.4 Solanum goniocalyx (Juz. & Buk.) Hawkes, 2x; Central Peru.

6.12.5 Solanum juzepczuki Buk., 3x; Central Peru - Southern Bolivia.

6.12.6 Solanum phureja Juz. & Buk., 2x; Venezuela - Northern Bolivia.

6.12.7 Solanum stenotomum Juz. & Buk., 2x; Peru.

6.12.8 Solanum tuberosum L. spp. andigena (Juz. & Buk.) Hawkes, 4x; Venezuela - Northwestern Argentina.

The taxonomic status of the cultivated potatoes given above, may change with new research.

The cultivated species in the Andes include many primitive cultivars, still not systematically studied. Partial descriptions for Bolivia, are giben by Hawkes (1944), Cárdenas (1948-1963) and for Peru by Ochoa (1964, 1965, 1975), and advanced cultivars, released by breeding programs, especially by the CIP, Lima, Peru, 7500 entries.

b) Allied wild species, mainly in the Serie Tuberosa, which includes some 60 species, distributed from Venezuela to Chile - Argentina, with the highest concentration in Peru - Bolivia - Northwestern Argentina. Some may be of hybrid origin; most are triploid, but there are tetraploid and pentaploid species (Vargas, 1943; Hawkes, 1963; Ochoa, 1962).

6.13 Tropaeolum — Tropaeolaceae

Some 90 species, from Mexico to Argentina; several ornamental.

6.13.1 Tropaeolum tuberosum R. & P., MASHUA, Colombia - Bolivia, at high elevations; known only in cultivation, some 50 clones are known, with two centers, one in Colombia, the other in Southern Peru - Bolivia (León, 1964). Collections: Bolivia, IBTA, Belen, 130 entries; Peru, University of Huananga, 350 entries.

6.14 Ullucus Basellaceae

A South American genus with one species.

6.14.1 Ullucus tuberosus Lozano, ULLUCO, MELLOCO, Venezuela - Northern Argentina; wild (Herrera, 1941) and cultivated; many clones, with no clear geographic concentration. Brücher (1967) considers the wild populations as a different species, U. aborigeneus Brücher. Collections: Bolivia, IBTA, Belen, 400 entries.

7. SPICES, CONDIMENTS & FOOD DYES

7.1 Capsicum Solanaceae

There are 30 species in tropical America. Of the five cultivated species, one is found in the Andes, where two wild species are also found.

7.1.1 Capsicum cardenasi Heiser & Smith, ULUPICA; Bolivia, fruits collected from wild plants and sold in the markets.

7.1.2 Capsicum pubescens R. & P. ROCOTO; Ecuador - Bolivia, only in cultivatio quite variable (Esbaugh, 1979). Belongs to the group of the Capsicum with purple flowers of Southern Peru and Bolivia, such as C. cardenasi and C. eximium, from which C. pubescens may derive.

7.2 Chenopodium Chenopodiaceae

Some 150 species, mainly in the temperate regions.

7.2.1 Chenopodium ambrosioides L., PAICO; used in the Andes as a condiment; for this purpose several strains have been selected.

7.3 Escobedia Scrophulariaceae

Fourteen species in tropical America; in Mexico and the Andes the roots are used to color foods.

7.3.1 Escobedia scrabifolia R. & P. PALILLO; Colombia - Peru, wild but as it is intensively used its cultivation has been attempted in Peru, without success (Herrera, 1943).

7.4 Opuntia Cactaceae

Around 250 spp. concentrated in the highlands of Mexico and Peru - Bolivia.

7.4.1 Opúntia soehrensi Britton & Rose, AYRAMPU; Southern Peru - Bolivia, wild seeds gathered to color foods and beverages.

7.5 Porophyllum Compositae

Around 50 species in the American tropics.

7.5.1 Porophyllum ruderale Cass., QUILLQUIÑA, Bolivia, wild and cultivated, leaves used as condiment.

7.6 Tagetes Compositae

Some 50 species in tropical America.

7.6.1 Tagetes graveolens L'Herit., and T. mandoni Sch. Bish., HUACATAY; Southern Peru - Bolivia, wild and cultivated, leaves used as condiment.

8. STIMULANTS

8.1 <u>Erythroxylum</u> Erythroxylaceae

A large genus of around 250 species, mostly in tropical America. Two species cultivated, <u>E. coca</u> and <u>E. novo-granatense</u>.

8.1.1 <u>Erythroxylum novo-granatense</u> (Morris) Hiern., TRUXILLO COCA; Peru, wild and cultivated in the Northern coastal area and Western foothills of the Andes (Plowman, 1979).

9. TOBACCO

9.1 <u>Nicotiana</u> Solanaceae

A genus of wide distribution: North and South America, Australia, Polynesia; several species utilized, only two in cultivation.

9.1.1 <u>Nicotiana</u> <u>rustica</u> L., AZTEC TOBACCO. An amphidiploid occurring wild, var. <u>pavoni</u>, in Peru. Its possible parents, <u>N.</u> <u>paniculata</u> and <u>N.</u> <u>undulata</u>, grow wild in Southern Andes.

9.1.2 <u>Nicotiana</u> <u>tabacum</u> L. TOBACCO, derived possibly from an ancestor of <u>N.</u> <u>sylvestris</u> and from <u>N.</u> <u>tomentosa</u> or <u>N.</u> <u>tomentosiformis</u>, both wild in the Southern Andes. Some wild species, American and Australian have been used in tobacco breeding to incorporate resistance to virus and fungal diseases.

10. VEGETABLES

10.1 Amaranthus — Amaranthaceae

A pantropical genus of around 60 species, used for the seeds and tender shoots.

10.1.1 Amaranthus spp.m YUYOS, collected from wild plants, in a selective form by Indian women: only certain species and tender shoots; quite often the only leaf vegetable consumed by the Andean indians.

10.2 Cucurbita — Cucurbitaceae

Some 16 species, mainly in North and Central America.

10.2.1 Cucurbita maxima Duch., ZAPALLU; in the Andes are grown several varieties of large fruits. The widest diversity is found in Argentina where a close species, C. andreana Naud., grows wild, and in Brasil C. maxima is the only Cucurbita of South American origin; C. ecuadorensis Cütler & Whitaker, is the only wild species so far reported for South America.

10.2.2 Cucurbita moschata Duch., this species was very likely introduced in the Andean region, although some prehistoric seeds have been assigned to it. The widest diversity is found in the interandean valleys in Bolivia (Cárdenas, 1950).

10.3 Cyclanthera — Cucurbitaceae

A tropical American genus with around 15 species.

10.3.1 Cyclanthera explodens Naud., Colombia - Northern Peru, cultivated and wild.

10.3.2 Cyclanthera pedata Schr., CAIHUA; Colombia - Argentina, known only in cultivation; closely related wild species are found in Peru and Bolivia.

10.4 Lobelia Campanulaceae

Some 200 species, mainly in the tropics, some ornamentals.

10.4.1 Lobelia nana H.B.K., PILLI, Peru - Bolivia, wild at high altitudes, 4.500 m; leaves gathered and cooked.

10.5 Lycopersicon Solanaceae

Some eight species in the Andean region (Rick, 1973, 1976; Holle, Rick & Hunt, 1978; Esquinas-Alcázar, 1981).

10.5.1 Lycopersicon esculentum Mill., TOMATO. Although the genus is native to the Andes, there is no proof that the tomato was cultivated there in pre Columbian times. The horticultural varieties were taken to Europe from Mexico, where it was a minor crop. The present diversity of the cultigen and of its spontaneous variety, cerasiforme, in the Andean region is within the rank common to other areas in tropical America.

The wild species are: L. cheesmani Riley (Galapagos); L. chmielewski (Peru); L. chîlense Dunel, L. hirsutum H.B.K.; L. parviflorum and a closelly allied Solanum, S. pennelli Correl, L. peruvianum (L.) Mill., L. pimpinellifolium (Juz.) Mill., (Ecuador - Peru).

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3. MESOAMERICA

MESOAMERICA

Introduction

Vavilov (1931) considered Mesoamerica as the most important center of crop diversity in the New World. As one of the world's hearths of agriculture, crop utilization in Mesoamerica is ancient and complex, and crop germplasm has been intensively exploited. However, two isolated facts show that there are still materials of potential utilization in Mesoamerica; one is the domestication of Dioscorea species as a source of cortisone, the other the recent discovery of a wild relative of maize.

Delimitation of the region

Mesoamerica is limited to the East by the Gulf of Mexico and the Caribbean, and to the West by the Pacific Ocean. As a cultural unit (Kirchoff, 1943) its northern limits are the valleys of the Panuco and Santiago rivers, which cut Central Mexico East-West, and it extends northwards along the Pacific coast to include Nayarit. To the South, the limit starts in NW Honduras and ends in NW Costa Rica. As a geographical unit (Maldonado - Kordell, 1964), the northern limit coincides more or less with the cultural boundary, but to the South it extends to the Atrato Strait, between Panama and Colombia.

The natural factors

1. Geographic configuration. The richness of crop genetic resources in Mesoamerica is in a large part determined by its complex relief. This has lead to crop isolation, and through natural selection, to the break of

cultivated species or cultivars into smaller units, thereby increasing their diversity. The main configurative features of Mesoamerica are as follows: a) The Mesa Central of Mexico, at the northern limit of Mesoamerica, is a roughly flat area at 2000 - 3000 m alt., bordered East and West by high cordilleras and to the South by the volcanic chain of Central Mexico. The Mesa Central has large flat areas, easy to cultivate, which were formed when shallow lakes dried up in recent times. The volcanic slopes are also very fertile, and the borders of permanent lakes are farmed using a special system, the chinampas (Coe, 1964); b) South of the Mesa Central, there is an area of complex relief, which ends to the South in the isthmus of Tehuantepec; c) the southern part of Mexico and Central America between the isthmus of Tehuantepec and Atrato, is formed by a series of mountain chains, in the northern part running East to West, in the southern section NW - SE. In both sides of the mountains there are alluvial plains - the Pacific and Caribbean lowlands.

2. Natural vegetation. Middle America is a bridge connecting North and South America, and through which the expansion of animal and plant life and the migration of man took place. If the bridge was interrupted, and there is enough geological evidence that it was several times, the flow of biota, in one or the other direction, was temporarily stopped. In the Mid-Tertiary, the Tehuantepec and the Atrato isthmus were under the sea, and it was not until the Pliocene that a permanent bridge was established (Whithmore & Stewart, 1965). In this way, two vegetations of very different origin and composition - the North and South American paleofloras - were

intruded in each other in their original areas and left a mixed flora in Mesoamerica. Some Northern elements, like *Quercus*, *Pinus*, *Juglans*, moved southward and expanded along the highlands during the Pleistocene (Graham, 1973); and also many species of Southern origin reached up to Mexico. The Mesoamerica flora, however, has a large endemic component (Burges, 1980). The diversity in species and habit types, provided an ample material for domestication.

There is no information on floristic statistics in Mesoamerica, but roughly it may be said that the species concentration per area unit increases from North to South, and from the high mountains to the lowland rainforests. As it occurs in the Amazon and SE Asia, the richness of the natural flora is not correlated with the number of cultigens domesticated in the area.

Man and crops

1. Peopling. As a passway in the southward emigration of early man in the New World, it could be expected that the earliest signs of human occupancy are in North America. However, they are in Peru, 22 000 BC (McNeish, 1976). In Mesoamerica, the oldest date is at Valsequillo, Puebla, Mexico, 21 800 BC (Irwin-Williams, 1978). A period of hunting and seed gathering preceded agriculture. Incipient cultivation started in Mesoamerica around 7000 BC (McNeish, 1971). The sequence of agricultural development for Tehuacan in Central Mexico, is among the most complete in the world. It shows a decrease in plant gathering as the main source of food, crop production, increased in importance (McNeish, 1971a).

2. Mesoamerica as one of the hearths of agriculture. The proofs for an independent development of agriculture in Mesoamerica come mainly from archeological findings: Tamaulipas in Eastern Mexico (McNeish, 1958); Central Mexico (Palerm, 1955; Mangelsdorf, McNeish & Willey, 1964; McNeish, 1967); Oaxaca, in SW Mexico (Flannery et al., 1967), and the Maya area (Turner, 1978). As in other hearths of agriculture, it included plant domestication, from the basic food crops to ornamentals (Vavilov, 1931; Dressler, 1953); crop management; drainage, irrigation, etc.; food preparation and preservation; animal domestication. Also, the development of ceramics, metalurgy and other techniques involved in crop production and utilization.

Plant domestication in Mesoamerica was a series of local developments; for instance, it is very likely that Cucurbita pepo was domesticated in the central part of Mexico, cacao in the Pacific lowlands of Guatemala, and so on. The autochtonous cultigens and others that were introduced, formed a crop array which under the Aztecs rule in the XVI century, was probably the richest and most varied in the world.

Status of crop germplasm in Mesoamerica

1. Conservation. The factors affecting germplasm conservation in Mesoamerica are similar to other areas of primitive agriculture. Among the factors that help to preserve crop diversity, are the practices of interplanting several crops or varieties in the same field; maintenance of special seed stocks; tolerance of useful plants around dwellings; preservation of certain trees when the forests are destroyed, and finally, and of foremost importance, are the techniques to prepare and utilize plant products.

Among the negative factors are: a) the destruction of the natural vegetation for agricultural and other uses. Besides the biological losses (Gomez-Pompa, Vázquez & Guevara, 1972), in the destruction of the rainforest the wild populations of a cultivated species are lost or decimated. As mentioned above, the practice among the Indians of leaving useful trees when they cut the forest, is not followed when forests are cut to establish large plantations; b) the changes in crops and cultivars imposed by cultural factors is threatening the native germplasm. As it may be seen in the following table, (A) the introduced cultivars do not improve the nutritional status neither are they easier to produce; c) the lack of technological development in crop production and utilization does not create the need to maintain, improve or **diversify** germplasm. In a few cases, like pejibaye (Bactris gasipaes), in which fruit and palm-cabbage production has developed into an important industry, the need to preserve and introduce germplasm, led to the establishment of the most complete collection of this species; d) the lack of interest in the native cultures on the part of the local scientists in the collection, not only of germplasm, but also of plant lore, which is part of the Indian culture. Only in Mexico, a few scientists have tried to collect and preserve the native plant lore (Hernández-X, 1970; Barrera, 1979).

2. Conservation measures. The approaches in genetic conservation include: a) seed storage, as a means of keeping viable seed for long periods. In Mesoamerica it could be applied to a rather reduced number of crop species, because the majority has short viability ("reluctant species");

TABLE A

NUTRITIVE VALUE OF LOCAL AND INTRODUCED VEGETABLES

IN EL SALVADOR

	Protein "g"	Vitamin A A. mg.	Phosphorus mg.	Calcium mg.
LOCAL				
Crotalaria	7.1	3.843	74	248
Solanum	5.1	1.883	74	226
Amarantus	4.5	2.740	78	280
Cucurbita	4.8	0.970	113	116
Yucca elephantipes	2.0	0.020	64	28
Erythrina (new leaves)	5.5	1.085	86	88
INTRODUCED				
Radishes	0.9	----	26	24
Beets (leaves)	2.5	----	30	81
Lettuce	1.4	0.175	37	23
Carrot	1.0	3.138	42	33
Cauliflower	3.1	0.010	55	30
Cabbage	1.7	0.008	29	48

Source: INCAP.

their reproductive system favors heterogeneity, or because they produce seeds in small quantity or very sporadically; b) in situ conservation, especially of species growing in forests, is extremely risky (as large areas are destroyed continuously or will require expensive supervision; c) tissue culture storage offers possibilities, once the laboratory techniques are developed into practical operations of maintenance and propagation; d) living collections, which although they present many problems in their establishment and management, are up to now the best solution. In Mesoamerica this means to establish field collections in the three major ecological conditions: i) highlands; ii) lowlands with permanent humidity; iii) lowlands with alternate seasons. Field collections will require among other facilities: a) seed storage; b) tissue culture, to maintain, distribute and clean propagation materials; c) quarantine facilities or connections; d) documentation systems, either manual or computer operated; e) facilities for exploration and introduction.

3. Technical network. The coordinated effort of the countries, and the technical and economic help from other governments or institutions, may allow the establishment of a net work of genetic collections as a base to distribute superior or new germplasm, or to use and preserve it for plant breeding. It would also promote the basic and applied studies of the crops of the region, and the possible domestication of new crops.

4. Exploration. Mesoamerica urgently requires the exploration of crop genetic resources, with two main purposes: a) to assemble germplasm for maintenance and utilization, in view of the threats of genetic erosion; b) to collect the information on native crops: diversity, management, utilization, etc., a knowledge that is now in the poorer classes, often in remote places. As there is a genetic erosion in the loss of germplasm, there is a cultural erosion when the knowledge on crops is lost forever. The lack of interest in this aspect on the part of local scientists has to be overcome through publications, meetings, courses, conferences, etc. A kind of revival is going on at present in the uses and folklore of the medicinal plants of Mesoamerica, and the same may occur with other groups of useful plants. Exploration is the only way to tap the knowledge on crop plants from people, to know their distribution and uses, to expand and to conserve their diversity in the collections.

1. CEREALS

1.1 Zea Gramineae

A Mesoamerican genus with 6 pp.

1.1.1 Zea mays L., MAIZE. The archeological evidence (Mangelsdorf, McNeish & Galinat, 1967) supports the Mesoamerican domestication of corn. Cytological information, based on frequency and type of chromosome knobs (McClintock, Kato Y Blumenschein, 1981) shows that in Mexico is represented the whole spectrum of variability of Z. mays. In Mexico and Central America this species is divided in "races". For Mexico, Wellhausen et al. (1952) recognise four ancient indigenous races; four races introduced to Mexico in prehistoric times; 13 prehistoric mestizo races; four modern incipient races, and seven other poorly defined. Hernández-X.& Alanis (1970) have added more recently other five.

For the rest of Mesoamerica, with the exception of Guatemala, the maize races have not been thoroughly defined. In Guatemala (Wellhausen et al., 1957) occur some of the same races than in Mexico, with two primitive (one common to Mexico) and 11 exotic and derived races. A center of maize diversity occurs in NW Guatemala, which Mangelsdorf & Cameron (1942) considered a secondary center of origin of maize (the other was in South America). Anderson (1947) suggested that it is a center of convergence rather than of origin.

For other countries of Central America (Wellhausen et al., 1957), the number of races recognized is less numerous than in Mexico or Guatemala.

Since the race survey was done, the varietal components of maize have changed, but no recent information is available on the present racial composition. It is very likely that some primitive varieties may have been reduced or disappeared, but it is certain that foreign germplasm has spread in many areas of Mesoamerica with the consequent introgression and enrichment of the local germplasm.

The wild relatives of cultivated maize are all of Mesoamerican origin, and to some have been assigned new taxonomic position (Iltis & Doebley, 1980).

1.1.2. *Zea mays* spp. *mexicana* (Schroeder) Iltis (*Euchlaena mexicana*) TEOCINTE of which three races were described by Wilkes (1967); Central Mexico.

1.1.3. *Zea mays* spp. *parviglumis*, from SW Mexico and NW Guatemala, includes two teocinte races of Wilkes (1967). Numerous hybrids are known between some populations of these wild taxa and cultivated maize.

1.1.4. *Zea luxurians* (Dur. & Aschers.) Bird, TEOCINTE; SE Guatemala, Honduras, El Salvador, perennial.

1.1.5. *Zea perennis* (Hitchc.) Reeves & Mangelsdorf, TEOCINTE, a tetraploid perennial, Central - NW Mexico.

1.1.6. *Zea diploperennis* Iltis, Doebley & Guzmán; diploid, perennial, from Jalisco, Mexico (Iltis *et al*., 1979).

The survival of the wild allies of maize, like teocinte, is threatened by different factors in Mesoamerica (Galinat, 1973); some seed collections are maintained for basic studies.

2. FIBERS

2.1 Agave — Agavaceae

An American genus of which around 300 species have been described; some ornamentals. As fiber plants three species are cultivated, but many others are occasionally used. Agave amaniensis Trelease & Nowell, was selected in Kenya from a Mexican introduction, and is replacing A. sisalana in commercial production. Other species producing fibers are A. cantala Roxb., and A. lechequilla Torrey, from Northern Mexico.

2.1.1. Agave fourcroydes Lem., HENEQUEN; Mexico, especially in Yucatan, wild (?) and cultivated, several varieties known differing in leaf shape, fiber production and quality.

2.1.2. Agave letonae F. W. Taylor, SALVADOR HENEQUEN; El Salvador, only in cultivation.

2.1.3. Agave sisalana Perrine, SISAL; Mexico (Yucatan) widely cultivated in tropical America (Brasil), East Africa, India; several clones known in the native area or selected in Brasil and East Africa.

2.2 Gossypium — Malvaceae

An important center of diploid species in Western Mexico, and of G. hirsutum, the most important of the cultivated cottons.

2.2.1. Gossypium barbadense L., occurs in Mesoamerica in Belice and the Atlantic coast of Guatemala and belong to the brasiliense race, possibly coming from the Antilles (Stephens ,1973).

2.2.2. Gossypium hirsutum L., COTTON; Mexico - Central America - Antilles.

A large number of populations, in different stages of domestication, classified by Stephens (1965) in i) wild; ii) semiferal; iii) commercial; iv) primitive cultigens; v) improved native types; vi) commercial introductions. Wild forms are found only in the coastal area of the Gulf of Mexico, and domestication may have been started in the Tehuantepec region (Stephens, 1973). Hutchinson (1947) recognized seven races: i) morilli, ii) richmondi, iii) palmeri, from Western Mexico, in reduced areas; iv) punctatum and v) latifolium, are spread all over Mexico - Guatemala; vi) yucatanense, in SE Mexico, wild; vii) mari-galante from El Salvador southwards.

2.2.3. Diploid species. Nine diploids, all in Mexico (Lemeshev, 1978; Fryxell, 1965).

1. Gossypium aridum (Rose & Stand.) Skov.
2. Gossypium armorianum Kearn.
3. Gossypium davidsoni Kell.
4. Gossypium gossypioides (Ulbr.) Standl.
5. Gossypium harknesi Brand.
6. Gossypium laxum Phill.
7. Gossypium lobatum Gentry.
8. Gossypium thurberi Tod.
9. Gossypium trilobum Moc. & Sessé.

3. FODDER CROPS

3.1. *Brosimum* Moraceae

Fifty species in tropical and Central and South America, some utilized for the latex.

3.1.1. *Brosimum alicastrum* Swartz, RAMON; Mexico - El Salvador - Antilles. Wild and cultivated. One of the main sources of fodder in SE Mexico (Pardo, Tejada & Sánchez, 1980). Also used for the seeds, is the so called Mayan bread fruit tree (Cook, 1935).

3.2 *Desmodium* Leguminosae

A large genus, more than 300 species, chiefly in tropical America and Asia. The wild populations in Mesoamerica of *Desmodium* and other Leguminosae of potential use as forage, have not been surveyed as well as their South American counterparts. The most promising are:

3.2.1. *Desmodium adscendens* (Sw.) D. C.

3.2.2. *Desmodium barbatum* (L.) Benth.

3.2.3. *Desmodium canum* (J.F. Gmel.) Schinz. & Thell.

3.2.4. *Desmodium intortum* (Mill.) Urb.

3.2.5. *Desmodium nicaraguense* Oerst.

3.3 *Leucaena* Leguminosae

Some 50 species described, mostly from North America.

3.3.1. *Leucaena leucocephala* (Lam.) De Wit (*L. glauca*). GUAJE; Florida-Mexico - South America. A highly polymorphic species, of which recently many populations have been selected for plant habit, mimosine content, ability to regenerate after cutting or browsing, etc.

Some of the most promising cultivars come from the coastal areas of El Salvador.

3.4 Macroptilium Leguminosae

A Mesoamerican genus with two species, formerly in Phaseolus.

3.4.1. Macroptilium atropurpureum (D.C.) Urb. (Phaseolus atropurpurens)

SIRATRO; Mexico - South America. Some Mexican introductions through hybridization and back crossing, yielded a superior forage, 'Siratro', in Australia.

3.5 Tripsacum Gramineae

Two clones from Mesoamerica of T. andersoni, are known as 'Prodigioso' and 'Guatemala', and are widely cultivated in the region and other tropical areas.

4. FRUITS

4.1 Annona Annonaceae

Some 120 species, moslty in Tropical America, a few in West Africa, some wild species like A. glabra L., and A. scleroderma are occasionnally utilized for their fruits. Although the most common of the cultivated species are widely distributed in Tropical America, they show several areas of higher variability.

4.1.1 Annona cherimolia L., CHERIMOLLA. Spontaneous and cultivated from Mexico to Costa Rica, generally above 1000 m alt, quite variable in fruit characters (see Andes).

4.1.2 Annona diversifolia Safford, ILAMA, PAPAUSA; western Mexico - El Salvador; offers a wide diversity, especially on fruit characters: color, size, color of the pulp. A species worth collecting and improving horticulturally, especially adapted to the lowland tropics. 'Imary' is a cultivar selected in El Salvador.

4.1.3 Annona muricata L., SOUR SOP, GUANABANA; its diversity is narrower than in South America. Only known in cultivation.

4.1.4 Annona purpurea Moc. & Sessé, SONCOYA; Mexico - Panama, wild and cultivated.

4.1.5 Annona reticulata L., (A. lutescens) CUSTARD APPLE, Mexico - South America, quite variable; the best types in N. Guatemala, with bright red fruits.

4.1.6 Annona squamosa L., SUGAR APPLE, SARAMUYO; Mexico - South America; quite variable in fruit shape, color and size, especially in Yucatán (Ponce, 1978). Artificial hybrids cherimolia x squamosa, called "Atemoyas" are more adapted to lowland conditions.

4.2 Bactris Palmae

A South American genus, of which one species is cultivated in Mesoamerica.

4.2.1 Bactris gasipaes H.B.K. (Guilielma gasipaes) PEJIBAYE; a cultigen, Honduras - Panamà (in Central America), represented by a high number of cultivars, some recently introduced to germplasm collections, intensively used as fruit and for the "cabbage palm".

4.3 Beilschmiedia Lauraceae

Some 120 species, in the tropics of the New World and SE Asia, Australia and New Zealand.

4.3.1 Beilschmiedia anay (Blake) Kosterm., ANAY, in Mexico and Guatemala; wild and cultivated; the avocado-like fruits are sold in country markets.

4.4 Bourreria Boraginaceae

Around 50 species in Mexico, Central America and the Antilles.

4.4.1 Bourreria pulchra Millp., KAKALTE; S. Mexico, said to be planted as shade in coffee fields; fruits gathered and sold in the country markets, seeds eaten roasted.

4.5 Byrsonima Malphigiaceae

Around 120 species, mostly in Northern South America.

4.5.1 Byrsonima crassifolia (L.) DC., NANCE, Mexico - Brasil; a highly polymorphic species; the best types are cultivated in the Pacific coast of Guatemala.

4.6 Calatola — Icacinaceae

A Mesoamerican genus of some three species.

4.6.1 Calatola mollis Standl. and C. costaricensis Standl., wild and tolerated in the highlands; seeds used as nuts.

4.7 Carica — Caricaceae

An American genus with some 25 species and several interspecific hybrids, the highest concentration in NW South America.

4.7.1 Carica papaya L., PAPAYA; Mexico - Antilles, primitive cultivars interbreeding populations and spontaneous or tolerated; some distinct variants, like peltata in Southern Central America.

4.8 Casimiroa — Rutaceae

A genus with some seven species (Martínez, 1957) from Mesoamerica.

4.8.1 Casimiroa edulis Llave et Lex., (C. tetrameria, C. sapota) ZAPOTE BLANCO; MATASANO Mexico, wild and cultivated, introduced to several regions: Argentina, Florida, Cuba, etc. very polymorphic, 20 varieties with 10 forms described by Martínez (1957).

4.9 Chrysobalanus — Chrysobalanaceae

Four species in the tropics of America and Africa.

4.9.1 Chrysobalanus icaco L., COCOPLUM; tropical America, wild and cultivated; in the Pacific coast of Guatemala there are some interesting varieties.

4.10 Chrysophyllum Sapotaceae

A tropical American genus of 150 species.

4.10.1. Chrysophyllum cainito L., STAR-APPLE; Antilles, known only in cultivation. In Mesoamerica probably introduced after the Conquest; several varieties differing in color and size of fruits.

4.11 Couepia Chrysobalanaceae

Some 60 species from Mexico to Brasil; in South America several species are cultivated as fruit trees.

4.11.1. Couepia polyandra (H.B.K.) Rose (C. floccosa), ZUNCILLO, OLOSAPO, Mexico - Costa Rica; a primitive fruit tree, seldom sold in markets, varieties different in fruit size.

4.12 Crataegus Rosaceae

A complex genus, with some 200 recognized species, in Northern temperate regions.

4.12.1 Crataegus pubescens (H.B.K.) Standl., TEJOCOTE, MANZANITA; Mexico, wild and cultivated; probably introduced to the highlands of Guatemala; no information on variability.

4.13 Crescentia Bignoniaceae

A tropical American genus with some five species.

4.13.1. Crescentia alata H.B.K., MORRO; Mexico - Costa Rica; wild and tolerated; seeds used to prepare beverages of high nutritive value.

4.14 <u>Diospyros</u> Ebenaceae

A genus of 500 species in the Old and New World, in temperate and tropical regions.

4.14.1 <u>Diospyros</u> <u>digyna</u> Jacq. (<u>D.</u> <u>ebenaster</u>), ZAPOTE NEGRO; Mexico - Costa Rica, wild and cultivated, many varieties, differing in shape and size of the fruits. <u>D.</u> <u>conzatti</u> Standl. is a Mexican taxon probably related to <u>D.</u> <u>digyna</u>, may be a wild population.

4.15 <u>Hylocereus</u> Cactaceae

Some 23 species from Mexico to Peru, introduced to other regions.

4.15.1 <u>Hylocereus</u> <u>undatus</u> (Haw.) Britton & Rose, PITHAYA; Mexico; wild and cultivated, introduced to many regions for its excellent fruit; outstanding variety in the Guatemala highlands.

4.16 Inga | Leguminosae

Some 200 species, used in Mesoamerica to shade coffee and cacao and for the fruit (edible aril); seeds sometimes eaten cooked.

4.16.1. *Inga densiflora* Benth., GUABO; Costa Rica - Colombia; wild and cultivated.

4.16.2. *Inga jinicuil* Schlecht., JINICUIL; MEXICO, wild and cultivated.

4.16.3. *Inga paterno* Harms, PATERNO; El Salvador, cultivated.

4.17 Leucaena | Leguminosae

Around 50 spp., mostly in North America.

4.17.1. *Leucaena leucocephala* (Lam.) De Wit (*L. glauca*). GUAJE. and probably other spp., are intensively used in SE Mexico for the seeds of the young pods, eaten fresh.

4.18 Licania | Chrysobalanaceae

A tropical American genus of 150 species, some utilized for the fruits in Central and South America.

4.18.1 *Licania platypus* (Hemsl.) Fritsch., ZUNZAPOTE; Mexico - Colombia, wild and cultivated.

4.19 Mammea | Clusiaceae

2 spp. one in tropical America, the other in West Africa,

4.19.1 *Mammea americana* L., from the Antilles, widely cultivated, does not show much variability.

4.20 Manilkara Sapotaceae

Some 70 species in tropical America and SE Asia.

4.20.1. Manilkara zapota (L.) van Royen (Achras zapota, Manilkara achras) CHICOZAPOTE; Mexico - Costa Rica, wild and cultivated; a very polymorphic species, varying considerably in habit, branching pattern, size and quality of the fruits; selected cultivars in Philippines, Florida, etc. Wild stands in Petén still tapped for chewing gum. A close taxon, M. chicle (Pittier) Gilly, grows wild from Mexico to El Salvador.

4.21 Melothria Cucurbitaceae

A tropical American genus of around 10 species.

4.21.1. Melothria dulcis Wunderlin, Costa Rica; to this species probably belongs a plant in incipient cultivation; the pulp of the fruit is prepared in refreshments and juices.

4.22 Monstera Araceae

Around 50 species from Mexico to the Antilles; mostly ornamental.

4.22.1. Monstera deliciosa Liebn., Mexico - Panama; wild and cultivated (as ornamental); fruits edible, sometimes sold in markets.

4.23 Opuntia Cactaceae

Some 250 species, with the highest concentration in Mexico, extending to Bolivia.

4.23.1. Opuntia ficus-indica Mill., TUNA MANSA; Mexico, widely cultivated.

4.23.2. Opuntia megacantha Salm-Dyck.; Mexico; widely cultivated, several varieties.

4.23.3. Opuntia streptocantha Lemaire; Mexico; wild and cultivated.

According to Diguet (1928) other Opuntia cultivated in Mexico are: O. cardona Weber, NOPAL CARDON; O. robusta Wendl., NOPAL CAMUESO; O. leucotricha DC., NOPAL DURAZNILLO.

4.24 Parmentiera Bignoniaceae

An American genus of eight species; one from Panama, P. cerifera, used for the fruits as forage.

4.24.1. Parmentiera aculeata (H.B.K.) L. Wms. (P. edulis); Mexico - Honduras, wild and cultivated.

4.25 Persea Lauraceae

A genus of 150 species, from Mexico to Colombia.

4.25.1. Persea americana Miller (P. gratissima), AVOCADO, Mexico - Northern South America. A very complex taxon, with wild and cultivated populations. The cultivated avocados have been traditionally divided in three races: i) Caribbean (an improper name since avocado was unknown in the Antilles); ii) Mexican; iii) Guatemalean (Popenoe, 1919). The wild populations have been named americana, drymifolia, (Mexico), and nubigena (Mexico - Costa Rica). There is no complete agreement on the relationship between the wild and cultivated avocados. Kopp (1966) and Williams (1977) agree that the Mexican race derives from drymifolia; Williams (1977) derives the Caribbean also from drymifolia, but it seems from the studies of García (1975, 1978) and García & Ichikawa (1978) that there is more similarity between the

Caribbean and Guatemalean than between the Caribbean and the Mexican. The closest species to P. americana are P. schiedeana Nees, P. floccosa Mez., P. steyermarki Allen, P. primatogena L. O. Wms. & Molina, and P. parviflora L. O. Wms. The problem of resistance to root Phytophtora has led to considerable surveys on the wild avocados and the other species of the genus (see Avocado Yearbooks, 1944 to 1974).

4.25.2. Persea schiedeana Nees, COYO, YAS; Mexico - Panama, wild and cultivated.

4.26 Pouteria — Sapotaceae

An American genus with some 50 species, several fruit trees also in South America.

4.26.1 Pouteria campechiana (H.B.K.) Baehni (Lucuma salicifolia), CANISTEL; Mexico - Panama, wild and cultivated. An extremely polymorphic species with a wide range of types, differing in plant habit, size and shape of fruit, etc.; some clones selected in Florida.

4.26.2. Pouteria hypoglauca (Standl.) Baehni; Mexico - El Salvador, wild and sporadically cultivated. Also quite polymorphic, in several areas a relict crop (Reko, 1948).

4.26.3. Pouteria sapota (Jal.) Moore & Stern, (Callocarpum mammosum), ZAPOTE; Mexico - Panama, wild and cultivated. A very polymorphic species, differing primarily in fruit shape and color. Some of the best types come from SW Nicaragua; other, borucana, from the boundary between Costa Rica and Panama.

4.26.4. *Pouteria viridis* (Pittier) Cronquist, Guatemala - Costa Rica; is probably a variety of *P. sapota*.

4.27 *Prunus* Rosaceae

A large genus of temperate North America and Eurasia.

4.27.1. *Prunus serotina* subsp. *capuli* (Cav.) McVaugh (*P. salicifolia*), CAPULIN; Mexico - Guatemala, wild and cultivated. Taken during the colonial times to Ecuador, it is here where the best types are grown.

4.28 *Psidium* Myrtaceae

An American genus of around 140 species, several used as fruits.

4.28.1. *Psidium friedrichstahlianum* (Berg.) Niedenzu; CAS; Mexico - Panama, several varieties.

4.28.2. *Psidium guajava* L., GUAVA; New World tropics, an extremely polymorphic species; natural hybrids with *P. guineense* are often found in Central America. Due to its abundance and diversity, no efforts have been made in Mesoamerica, like elsewhere (Florida, India) to select superior cultivars.

4.28.3. *Psidium sartorianum* (Berg) Niedenzu; ARRAYAN; Mexico - El Salvador, wild and cultivated.

4.29 Rollinia Annonaceae

An American genus with some 65 species, from Mexico to Argentina, in the Antilles and Brasil two species are important fruits.

4.29.1. Rollinia jimenezi Safford, ANONILLO; CostaRica - Mexico, wild and cultivated.

4.29.2. Rollinia rensoniana Standl., CHURUMUYO; El Salvador, wild and cultivated.

4.30 Rubus Rosaceae

A large genus, with around 250 species and many varieties, especially in the Northern hemisphere.

4.30.1. Rubus adenotrichus Schlecht., MORA; Mexico - Costa Rica, wild and tolerated, gathered and sold in markets.

4.30.2. Rubus glaucus Benth., MORA; Guatemala - Ecuador, often cultivated, the best of the tropical American species.

4.31 Sambucus Sambucaceae

A widely dispersed genus: North America to Australia, with some 40 species.

4.31.1. Sambucus mexicana Presl., SAUCO; Mexico - Guatemala, only in cultivation (as ornamental), fruits eaten.

4.32 Spondias Anacardiaceae

Ten-twelve species in tropical America, SE Asia and Polynesia.

4.32.1 Spondias mombin L., JOBO, HOGPLUM; tropical America; quite variable; in El Salvador there are some interesting cultivars.

4.32.2. Spondias purpurea L. (S. mombin); SPANISH PLUM, CIRUELO, JOCOTE; Mexico - Panama; known only in cultivation, introduced to other regions; clonally propagated only, numerous varieties growing from sea level to 2 000 m (Souza-Novelo, 1949; McBryde, 1945); intensive cultivation in Oaxaca, Mexico.

5. GRAIN LEGUMES

5.1 Phaseolus — Papilionaceae

A tropical American genus with many species in Mesoamerica; several of the species originally described as *Phaseolus* have been transferred to *Macroptilium* and other genera.

5.1.1. *Phaseolus acutifolius* Gray, TEPARI; USA to El Salvador. Two groups are established: i) the cultivated types, var. *latifolius*, sporadically planted from NW USA to Southern Mexico - Guatemala - El Salvador. ii) the wild populations, var. *acutifolius* and var. *tenuifolius*, are probably local types similar to variants occurring in other species of *Phaseolus* (narrow or broad leaf mutations). Tepari is becoming a relict crop in Mesoamerica (Bukasov, 1930; McBryde, 1945).

5.1.2. *Phaseolus coccineus* L., AYOCOTE; Mexico - Costa Rica, widely cultivated in USA, Europe, Africa. A very polymorphic species, in which three groups of taxa could be recognized: i) wild populations, especially in Central Mexico: *formosus*, *obvallatus* and *polyanthus*, to some of which Marechal *et al*. (1978) assigned a subspecific rank; ii) the cultivated *coccineus*, a group of high diversity; according to Ivanov (1929) its center or dispersion are the highlands of Chiapas - Guatemala; iii) *polyanthus*, a group of cultivars clearly distinct of the cultivated *coccineus*, and often planted together; it extends to the Antilles where it was first described as *dumosus*, and to Northern South America as *P. flavescens* (Berglund-Brücher & Brücher, 1974). In Mexico, it has been called P. coccineus spp. darwinianus (Hernández-X., Miranda Colin & Prywer, 1959) and its taxonomic status is still doubtful (Smartt, 1973).

5.1.3. Phaseolus lunatus L., LIMA BEAN, includes two groups: i) wild populations, called sylvester by Baudet (1977), in Mesoamerica from Mexico to Costa Rica; ii) the cultivated types, which are not common in Mesoamerica and are planted in the lowlands. Two populations are interesting: 'ibex', from Campeche-Yucatan, with red seeds, often bitter, and the types in Chiriquí, Panamá. Introduced cultivars are planted elsewhere.

5.1.4. Phaseolus vulgaris L., COMMON BEAN. Several groups are included: i) wild beans, first collected in Guatemala in 1931 and in 1943 (McBryde, 1945); later on in Mexico (Miranda Colin, 1967; Gentry, 1969), Honduras and other countries; some types may be introgressions with the cultivated beans. The wild beans have received specific or subspecific rank under the name aborigeneus. In spite of the many collections done in the region, there is not yet any work dealing with the phenotypic diversity of P. vulgaris in Mesoamerica. Bukasov (1981) characterized the beans of Mexico - Central America as follows: seeds small, elipsoidal - flat, chiefly of dark color (very few white); compact growth; planting materials mixed; late varieties more common; lack of advanced cultivars. The situation has not changed since Bukasov visited the area almost 60 years ago.

5.1.5. Wild species of *Phaseolus*. The concentration of wild species is centered in Mexico and there is no recent revision of the status of the genus that may permit to establish the number of species in *Phaseolus* in Mesoamerica. Many of the published names are synonyms or have been transferred to other genera. The list of around 70 species by Miranda (1966), give an idea of the diversity of *Phaseolus* in Mexico. South of Mexico the number of wild *Phaseolus sensu lato* decreases (not in the cultivated species: Guatemala, 27 (Standley & Steyermark, 1946; Costa Rica, 13 (Standley, 1937).

6. OIL PALMS

6.1. *Elaeis oleifera* (H.B.K.) Cortés; Honduras - Brasil; wild in Costa Rica and Panama on both coasts, quite variable; an important genetic source for the improvement of the African oil palm (*E. guineense* Jacq.)

6.2. *Orbygna* - *Scheelea* complex; several poorly known 'species' from NE Mexico to South America, wild but often gathered. The potential value as crops of these species depends on the expansion of the cultivation of *Elaeis*, and on the development of technology to extract the kernel oil.

7. PSEUDO CEREALS

7.1 Amaranthus — Amaranthaceae

Around 60 species in the tropics, used as vegetable or for their seeds. In Mesoamerica two grain crops, formerly important, now reduced to relict cultivation.

7.1.1. Amaranthus cruentus L., ALEGRIA; SW Mexico - Central Guatemala, a relict crop of discontinuous distribution (Sauer, 1950, 1967).

7.1.2. Amaranthus hypochondriacus L. (A. leucocarpus), HUAUHTLI, ALEGRIA; NW USA - Mexico - Guatemala, in cultivation only, a highly polymorphic species (Sauer 1950, 1967) recent collections in Mexico and Central America (Feine, 1980; Hauptli, Lutz & Jain, 1980) are part of a renewed interest in its cultivation due to its high food value. In Mexico several varieties are recognized by the color of the seed (Martínez, 1925, 1959).

8. ROOTS AND TUBERS

8.1 Arracacia — Umbelliferae

An American genus of around 50 species. A. xanthorriza, from the Andes, is cultivated for the tuberous roots.

8.1.1. Arracacia dugesi Coult. & Rose, ACOCOTE; a poorly known species (Bois, 1904).

8.2 Dalembertia — Euphorbiaceae

A mexican genus of four species.

8.2.1. Dalembertia populifolia Baill., JICAMA DE CERRO; SE de Mexico, wild, sometimes the roots are sold in the markets.

8.3 Ipomoea — Convolvulaceae

Several species of the region are interesting for their tuber forming habit.

8.3.1. Ipomoea batatas (L.) Lam., SWEET POTATO; most of the diversity in the region seems to be due to rather recent introductions. A wild Mexican, Ipomoea, hexaploid, I. trifida according to Nishiyama et al. (1961) is considered by Nishiyama (1971) as the ancestor of I. batatas, but by Jones (1967), Martin, Jones & Ruberté (1974), as a feral population of this species. To Nishiyama, Miyazaki & Sakamoto (1975) I. trifida is a primitive form of the sweet potato.

8.4 Manihot Euphorbiaceae

Some 90 species, with two areas of concentration, one in NE South America, the other in Western Mexico. The two sections of the genus Manihot existing in Mesoamerica, Parvibracteata and Foetida, contain a few species with tuberous roots; one of them, M. pringlei Watson, of NE Mexico, may be the source of some archeological material identified as M. esculenta. Often reported to have edible roots is M. aesculifolia (H.B.K.) Poh. (Rogers & Apan, 1973).

8.4.1. Manihot esculenta Crantz, CASSAVA, YUCA, GUACAMOTE; known only in cultivation. The varietal disversity is by far more reduced than in Northern South America. The primitive cultivars belong to the group of sweet manioc, and are replaced by introduced clones.

8.5 Pachyrhizus Leguminosae

An American genus with five species, one cultivated and two wild in the region.

8.5.1. Pachyrhizus erosus (L.) Urban, JICAMA, Mexico - El Salvador; very polymorphic, two botanical varieties recognized (Clausen, 1944), one with entire leaflets: typica, the other palmately - lobed: palmatilobus. The classification according to root types, common in the Mexican markets, is quite arbitrary (Schroeder, 1968).

8.6 Solanum Solanaceae

In Mesoamerica, potatoes are of rather recent introduction; wild allies important as a source of resistance to late blight.

8.6.1. Solanum tuberosum L., POTATO. Bukasov (1930) has described four variants of S. tuberosum for Mesoamerica: mexicanum, tolucanum, chalcoense and guatemalense, and Ugent (1968) the primitive cultivars.

Wild species. In Mexico - Central America there are several wild tuberiferous species, some of which produce edible tubers which are gathered by the Indians (Flores, 1969). Among them are S. agrimonifolium Rydb., S. bulbocastanum Dun., S. cardiophyllum Lindl., in which the subspecies ehrenbergi produces edible tubers; S. clarum Correll; S. demissum Lindl., a source of resistance to late blight; the hybrids S. xedinense, between S. tuberosum and S. demissum, spontaneous or artificially produced; some populations have edible tubers; S. güerreroense Correll; S. hougassi Correll; S. iopetalum (Bitt.) Hawkes; S. lesteri Hawkes; S. morelliforme Bitt. & Muench., S. polyadenium Greenm., S. stoloniferum Schlecht. & Bouché; S. verrucosum Schlecht.

9. SPICES & CONDIMENTS

9.1 Capsicum — Solanaceae

A genus with around 27 species, of which only five are found North of Panama, two wild and three in cultivation.

9.1.1. *Capsicum annuum* L. extends from Mexico to Northern South America.

i) The cultivated populations, or var. *annuum* have spread widely in the New and the Old World.

ii) The wild populations, var. *aviculare* has the same geographic range, but is more common in Mexico.

iii) The semidomesticated populations extend from Mexico to Honduras,

iv) Many cultivars in Mexico (Muñoz & Pinto, 1966), among them the most important in local consumption and export. The new selected cultivars are replacing the old varieties, but there are good collections in storage (Laborde & Pozo, 1982).

9.1.2. *Capsicum chinense* Jacq., is a rather recent introduction, becoming an important crop in Mexico (Habanero), Costa Rica and Panama.

9.1.3. *Capsicum frutescens* L., wild and cultivated in Mesoamerica: Guatemala - CostaRica, with many cultivars.

9.1.4. *Capsicum pubescens* R. & P. is cultivated in the highlands; an early introduction from South America, it was described as *C. guatemalense*.

9.1.5. Wild species

9.1.5.1. *Capsicum ciliatum* (H.B.K.) Ktze.; Mexico - Peru.

9.1.5.2. *Capsicum lanceolatum* (Greenman) Morton & Standl.; Mexico - Honduras.

9.6 Pimenta Myrtaceae

Around 18 species in tropical America.

9.6.1. Pimenta dioica (L.) Merr. (P. officinalis), ALLSPICE; Mexico - Costa Rica - Antilles, wild and cultivated; a very polymorphic species, some selections in Jamaica.

9.7 Quararibea Bombacaceae

Some 50 species in tropical America.

9.7.1. Quararibea funebris (La Llave & Lex.) Stand., CACAOXOCHITL; Mexico, wild and cultivated, the flowers used to flavor chocolate.

9.8 Vanilla Orchidaceae

Around 90 species, chiefly in tropical America.

9.8.1. Vanilla planifolia Andrews, VANILLA; Mexico - Panama, wild and cultivated. In Eastern Mexico (Veracruz - Yucatan) several clones are planted; vanilla culture is decreasing in Mexico and wild plants are threatened by the destruction of the forests.

9.8.2. Vanilla pompona Schiede, Mexico - Bolivia - Antilles, wild and cultivated.

10. STIMULANTS

10.1 Theobroma Sterculiaceae

Of the 22 species a few are found in Mesoamerica, three of them are cultivated.

10.1.1. Theobroma angustifolium Moç. & Sessé; Mexico - Costa Rica, wild and cultivated; the seeds are used to prepare a kind of chocolate or to mix with cacao seeds.

10.1.2. Theobroma bicolor H. & B., PATASTE; Mexico - Brasil, wild, cultivated in Mexico - Guatemala to prepare a pastry or candy, and a chocolate of inferior quality.

10.1.3. Theobroma cacao L., CACAO; Mexico, wild and cultivated, probably also in Guatemala. Mesoamerica is the area of highest diversity, represented by three subspecies (Cuatrecasas, 1964): i) cacao, to which correspond the 'Criollo' types; ii) pentagonum or 'Lagarto'; iii) leiocarpum, 'Cumacacao'. These are interbreeding populations being actively replaced by advanced cultivars: hybrids or clones.

11. VEGETABLES

11.1 Bromelia Bromeliaceae

A tropical American genus with around 40 species.

11.1.1. Bromelia pinguin L., PIÑUELA. In El Salvador the young inflorescences and the young leaf buds are eaten; they are collected from plants used as living fences and often sold in the markets.

11.2 Calathea Marantaceae

A tropical American genus of 150 species. C. lutea is cultivated in Guatemala for the leaves used for all kind of wrapping purposes.

11.2.1. Calathea macrosepala K. Schum. CHUFLE, Guatemala - El Salvador; inflorescences are eaten in soups; they are gathered from wild or cultivated plants in the Pacific lowlands, and often taken to the markets.

11.3 Chamaedorea Palmae

Some 60 species in tropical America; many ornamentals.

11.3.1. Chamaedorea tepejilote Liebm., and possibly other species like C. wendlandiana (Oerst.) Hemsl., are widely cultivated from Mexico - El Salvador, for the inflorescenses.

11.4 Chenopodium Chenopodiaceae

Some 100 - 150 species, mostly in temperate regions.

11.4.1. Chenopodium berlandieri ssp. nuttalliae (Safford) Wilson & Heiser, HUAZONTLE. Central Mexico, wild and cultivated (Safford, 1918; Wilson & Heiser, 1979), used for the tender leaves and flower buds; a few cultivars have been selected (Laborde, 1962).

11.5 Cnidosculus Euphorbiaceae

Around 75 species in tropical America; some of the Mexican species have been exploited for the latex.

11.5.1. Cnidosculus chayamansa McVaugh, CHAYA; Mexico and Guatemala, several varieties reported from Yucatán, selected for lacking stinging hairs (Días Bolio, 1974). A promising leaf vegetable for the tropics (Martin, 1978).

11.6 Crotalaria Leguminosae

A large genus, around 500 species, mainly in tropical America and Asia; used as cover crops, green manure, ornamentals, fiber.

11.6.1. Crotalaria longirrostrata Hook. & Arn., CHIPILIN; Mexico - Guatemala, wild and cultivated; the young branches with flowers are often sold in the markets.

11.7 Cucurbita Cucurbitaceae

An American genus with 27 species, five of them in cultivation.

11.7.1. Cucurbita ficifolia Bouché, CHILACAYOTE; known only in cultivation, Mexico - Costa Rica at above 1 000 m; the less variable among the cultivated cucurbits, only two cultivars known: i) melanosperma with black seeds; ii) leucosperma with white to yellow seeds (Bukasov, 1930).

11.7.2. Cucurbita mixta Pang., TAMALAYOTE, Mexico - Guatemala (cultivated in Costa Rica and Panama); two groups of varieties, according to Zhitineva (in Bukasov, 1930): i) stenosperma in Mexico, and ii) cyanosperma in Guatemala. The first has large, pyriform fruits; the second is used chiefly for the seeds, called "pepitoria".

11.7.3. Cucurbita moschata (Duch.) Duch.), CALABAZA, AYOTE; Mexico - Panama, a very polymorphic species, growing from sea level to 1 200 m. Zhitineva (in Bukasov, 1930) divides the cultivars in two groups: i) mexicana (white seeds) Mexico - Costa Rica; ii) colombiana (tan coloured seeds) Panama - Colombia. Within these two groups there are many variants, especially in fruit characters: shape, skin color, thickness and color of the pulp, etc.; a very promising species for selection and improvement. Flowers and tender shoots eaten in Central America.

11.7.4. Cucurbita pepo L. SQUASH; probably originated in Central Mexico, cultivated above 1 500 m in Guatemala and Costa Rica. C. pepo does not offer in this region the striking diversity it shows in Europe or USA. According to Zhitineva (in Bukasov, 1930) the variation in this species does not have a geographic correlation as in C. moschata; in Mexico - Guatemala is reduced to the two types: citrullina and giromontia.

11.7.5. Wild species. North of Mesoamerica there is a group of wild Cucurbita growing in xerophytic areas; one of them, C. foetidissima, is being domesticated for the oil in the seeds. In Mesoamerica there is a group of mesophytic species, Lundelliana, which does not show much affinity with the cultivated species; other group, Sororia, has certain relation to C. mixta (Bemis et al., 1970).

11.8 Fernaldia Apocynaceae

Four species in Mexico and Central America.

11.8.1. Fernaldia pandurata (A. DC.) Woodson, LOROCO; El Salvador - Mexico; gathered in El Salvador and sold in the markets for the flowers, tasty and nutritious.

11.9 Frantzia Cucurbitaceae

11.9.1. Frantzia tacaco (Pittier) Wunderlin, TACACO; Costa Rica, wild and commonly cultivated in the highlands, for the fruits, eaten cooked.

11.10 Lycopersicon Solanaceae

11.10.1. Lycospersicon esculentum Mill., TOMATO, was found in cultivation in Mexico by the first Spaniards, as an unimportant crop. The fruits, according to Dr. Hernández (edition of 1959-60) were as large as in the modern cultivars. The original diversity in Mexico is very likely completely lost, since it was not an important crop for several centuries, and has been replaced by modern cultivars.

11.11 Opuntia spp. Cactaceae

In Central Mexico the flat stem joints of several species of Opuntia are used as vegetable, roasted or cooked. They are an important item in the local markets.

11.12 Physalis Solanaceae

A large genus, 100 species, all over the world.

11.12.1. Physalis ixocarpa Brot. TOMATE; Mexico - Guatemala, probably only in cultivation. Two groups of cultivars could be recognized: i) in Central Mexico, with large fruits; ii) in Guatemala with small fruits, often purplish. In Mexico some selection has been made, and several cultivars are available.

11.13 Sechium Cucurbitaceae

A small genus, two species, in Central America.

11.13.1. Sechium edule Sw., CHAYOTE, Mexico - Guatemala; introduced to many countries for the edible fruits, roots and young shoots. A highly polymorphic species (Maffioli, 1981).

11.14 Solanum Solanaceae

11.14.1. Solanum americanum Miller, YERBA MORA; Guatemala, El Salvador, cultivated; the young shoots are eaten as spinach.

11.14.2. Solanum shannoni Donn. Sm., IXTLAN; Mexico - Guatemala; cultivated for the tender tips.

11.15 Vincethoxycum Asclepiadaceae

Some 20 species of tropical America, often placed in the genus Gonolobus.

11.15.1 Vincethoxycum salvini (Hensley) Standl., CUCHAMPER, cultivated and wild; young fruits eaten fresh, when ripe they are roasted or cooked; also in Costa Rica.

11.16 Yucca Agavaceae

Around 40 species in North America, some ornamentals.

11.16.1. Yucca elephantipes Regel, IZOTE; Mexico - Guatemala, introduced to the rest of Central America; widely cultivated for the flowers, used as a vegetable; it is also planted as living fences and for erosion control in El Salvador.

12. MISCELLANEOUS

12.1 *Salvia hispanica* L., Lamiaceae, CHIA; Mexico - Guatemala; wild, also cultivated for the seeds which are used to prepare a refreshment.

12.2. *Hyptis suaveolens* Poit., Lamiaceae, CHIAN; Mexico - Costa Rica, cultivated in Mexico and in Central America gathered from wild plants; used as *Salvia hispanica*.

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APPENDIX I.

DEFINITION OF GENETIC RESOURCES

The terms "Genetic Resources" or "Germplasm" include:

1. Primitive cultivars (Cultivar is synonymous with variety so far as domesticated plants are concerned). This is a variety of a cultivated species selected and maintained by farmers which has not been subjected to intensive plant breeding, cultivar, or primitive variety, does not usually imply low yield, inferior quality or poor disease resistance. Indeed, in the most advanced countries, many crops planted are primitive cultivars developed simply through prolonged selection of naturally occurring variations.

2. Advanced cultivars. A variety resulting from a intensive programme of selection, hybridization or induced mutation carried out with specific objectives in mind. Advanced cultivars are usually less variable than primitive selections, and usually need more exactly controlled growing conditions.

Clones

Cultivars of varieties, whether primitive or advanced, which are propagated vegetatively. Biological they are parts of a single plant multiplied times.

3. Wild populations. a) wild types descended naturally and directly from the same ancestors as those from which the cultivated varieties have been selected; which may still be found wild in the woods, b) weeds which are descended, like their crop relatives, from a common ancestor which may by now have disappeared; such plants have not undergone deliberate selection but

have evolved spontaneously in sites resulting from human disturbance.

4. Wild relatives. Are wild species of the same genus than the crop plant or from allied genera, which are closely related, and may be crossed with them to produce hybrid cultivars giving better yields or greater resistance to disease. The conservation of these wild relatives is as important as the preservation of primitive cultivars and fundamental to future plant breeding programmes.

5. Genetic lines. In advanced breeding programmes geneticists develop specialized populations of plants, such as true-breeding pure lines or populations which show male sterility. These populations are not themselves used for crop production, but are essential stages and components used to produce new advanced cultivars.