CHAPTER 5

TROPICAL HUMID FOREST FOOD PLANTS AND THEIR DOMESTICATION: EXAMPLES FROM AFRICA AND AMERICA

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INTRODUCTION

African and American tropical forests have received too little attention from scientists working on the origin and domestication of food plants. Vavilov (1951) did not site a "centre of origin" in these continents and Harlan's (1971) "non-centres" – extremely large areas where the domestication of a given plant could have taken place – were confined to the edge of the forest blocks, carefully excluding the Congo basin and the Central Amazon, based more on *a priori* thinking than on evidence. For Vavilov, the centre of origin of a cultivated plant is the geographical region where it shows the greatest genetic diversity. Many authors have emphasized that the "centre of diversity", which is an observation, and the "centre of origin" which is an "interpretation" are not identical (Pernès and Lourd, 1984).

It was often assumed that Forest Man, whether African or Amazonian, must by definition be a hunter-gatherer; when he becomes an agriculturalist, it is because he is fortunate enough to get cultivated plants, tools and agricultural techniques from neighbouring, non-forest populations, implicitly seen as superior. Added to this, forests were always seen as places unaffected by people, travelled through by small, disorganized communities, isolated from one another. Add to this the fact that most of their cultivated plants were neglected by agronomists, because they were not eaten by Whites and were thus not seen as important food crops, and that they were entirely neglected by botanists, who rightly saw them as cultivated rather than wild plants, and we get a picture, albeit deliberately partial and an extreme caricature, which is essentially true to life.

This is not the place to analyse the roots of this attitude. Ideas change and numerous archaeological, anthropological and historical studies (Cooke and Piperno, 1993; Bahuchet, 1993, this volume) are leading

scientists to review their hypotheses about the origin of present day settlements. The idea of a natural environment entirely free of human influence has been abandoned; agronomists faced with today's problems are taking into consideration plants hitherto ignored.

THE AFRICAN FOREST

African agriculture (Chevalier, 1912; Schnell, 1957) is dominated today by non-indigenous plants, which arrived at different times, from the most ancient Asian-African connections, impossible to date accurately, to more recent American introductions which are easier to place in time (although grey areas still exist). Among the most important "exotics" are bananas (*Musa* spp.), manioc (*Manihot esculenta* Crantz), maize (*Zea mays* L.), taro (*Colocasia esculenta* (L.) Schott), cocoyam (*Xanthosoma* spp.) and Asian rice (*Oryza sativa* L.). Other introductions include *Amaranthus* spp., okra (*Abelmoschus esculentus* (L.) Moench), cowpea (*Vigna unguiculata* (L.) Walp.), tomato (*Lycopersicon esculentum* Mill.), chili pepper (*Capsicum frutescens* L.) and several fruit trees, *Citrus* spp., mango (*Mangifera indica* L.) and coconut (*Cocos nucifera* L.). Besides these foreign plants, there are other plants, certainly indigenous, cultivated for tubers, leaves, and fruits which are fundamental to the diet of these populations.

Herbaceous plants, shrubs and lianas, used for food

Herbaceous, shrubby and climbing species that are used for food are domesticated to different degrees (Chevalier, 1912). Some are spontaneous and occasionally cultivated, such as *Aframomum melegueta* (Roscoe) K. Schum., *Crassocephalum montuosum* (S. Moore) Milne-Redhead, *Justicia insularis* T.Anders., and *Solanecio angulatus* (Vahl) C. Jeffrey.

Some species are both spontaneous and cultivated, including *Cucumeropsis mannii* Naud., *Mucuna sloanei* Fawc. & Rendle, *Solanecio biafrae* (Oliv. & Hiern) C. Jeffrey, *Talinum fruticosum* (L.) Juss., *Telfairia occidentalis* Hook.f., and *Vernonia amygdalina* Del. Still other species are only found in a cultivated form, such as *Abelmoschus caillei* (A. Chev.) Stevels, *Hibiscus acetosella* Welw. ex Hiern and *Solanum aethiopicum* L. The latter species has many cultivars and seems to have been domesticated from *S. anguivi* Lam. (Stevels, 1990). The other two species are not known in the wild state.

Some of these species are common throughout the African forest block: *Cucumeropsis mannii*, *Talinum fruticosum*, *Telfairia occidentalis*, *Abelmoschus caillei*, *Hibiscus acetosella*, *Solanum aethiopicum*. Others are only cultivated in limited areas. For example, *Aframomum melegueta* is usually a gathered

wild plant, although in eastern Côte d'Ivoire it is cultivated on a very small-scale around the house. But in a number of forest villages in Ghana where several cultivars are found, it is a cash crop (Lock *et al.*, 1977). Earlier this century, Chevalier (1912) indicated that the *melegueta*, or *paradise seed*, was heavily cultivated in the coastal part of Guinea, Kissi, Sierra Leone, almost all of Côte d'Ivoire, Lower Dahomey (the present-day Benin), etc.

The genus *Dioscorea* presents a surprising diversity, including spontaneous toxic forms restricted to the edge of the forest or open areas, and edible wild species found within the African rain forest (Hladik *et al.*, 1984). These spontaneous species have been developed into innumerable yam cultivars with different properties. The "yam civilizations" are concentrated in the Guinea forest block and surrounding humid savanna from the Côte d'Ivoire to the Cameroon mountains (Ayensu and Coursey, 1972). Besides the Asiatic cultivars of *D. alata*, the African *D. cayenensis* Lam./*D. rotundata* Poir. complex dominates. Although its origin is not entirely clear, the complex originated, at least in part, in the forest or its edges (*D. praehensilis* and/or *D. abyssinica* Hochst probably played a role). Several authors cite *D. cayenensis* as widespread in its wild state in West Africa and elsewhere, but *D. rotundata* as a true cultigen (eg. Coursey, 1976). Next in order of importance is *D. dumetorum* (Kunth) Pax, also known in the wild state (but as a lethally poisonous form). *D. bulbifera* L. (common in Asia and Africa), *D. praehensilis* Benth. and *D. sansibarensis* Pax. are also known in cultivated and wild states.

The origins of the yam species are further discussed by Hladik and Dounias (1993, this volume). *D. burkilliana* J. Miège is a wild species which has probably also participated in the development of the African cultivars: this species has also been observed in cultivation in the Central African Republic and Gabon. The cultivated forms could be recent introductions from stock gathered in the forest. The cultivated form is considered to be a very different entity to the wild form eaten only by the Pygmies (Hladik *et al.*, 1984). We see here the beginning of the process of domestication.

Trees

Arboriculture does not seem to be very developed in the African forest, leading some observers (eg. Chevalier, 1947) to suggest that regulations were put in place favouring agriculture at the expense of the former fruit protoculture, which consists of caring for, maintaining, and even enriching natural populations. *Cola* spp, and *Elaeis guineensis* Jacq., are certainly managed in this way; but as Schnell (1957) noted, all possible intermediate states exist between gathering wild fruits and protoculture, and between protoculture and true cultivation.

The genus *Cola* is a good example in several respects and is discussed here although its seed is not really a food but is used for its stimulant caffeine (Hugh-Jones, 1993, this volume, shows the ambiguity of these two categories). The fruits of several of the 140 known species are gathered in the forest. Four are cultivated. *Cola nitida* (Vent.) Schott & Endl., the most widely distributed in African forest, originates in the west of the forest block as far as Nigeria. Its seeds (cotyledons) vary in colour, form and quality and have been commercially important for centuries. *C. acuminata* Schott & Endl. of Central Africa, has a more local importance. Finally two species not present in West Africa (*C. anomala* K. Schum. and *C. ballayi* Cornu ex Heckel) are cultivated here and there in Cameroon (Nkongmeneck, 1985).

Thus, the genus *Cola* includes (1) spontaneous species whose fruit are gathered in the forest; (2) species cultivated locally (*C. anomala* and *C. ballayi*); (3) one spontaneous species sometimes only protected, but also cultivated in and outside its region of origin *(C. acuminata)*; (4) one species (*C. nitida*) cultivated throughout its area of origin, or "protocultivated" with several known "cultivated races" (Chevalier and Perrot, 1911) widespread throughout Africa and other continents.

The genus *Dacryodes* is somewhat comparable. The fruit of many wild species is gathered, but only *Dacryodes edulis* (G. Don) Lam. is cultivated.

Some forest trees have been successfully domesticated outside the forest. According to Chevalier (1912), *Blighia sapida* Koenig, *Chrysophyllum africanum* DC., *Garcinia kola* Heckel, *Irvingia gabonensis* (Aub.Lec.) Bn., *Pterocarpus esculentus* Schum. & Thonn., *Raphia hookeri* Mann & Wend., *Synsepalum dulcificum* (Schum. & Thonn.) Engler, *Xylopia aethiopica* (Dunal) A. Rich., all common in the west African forest, would be planted around villages in the south of what is today Benin. Many of them have cultivated forms. The centre of origin of these plants *is* the forest, even though their domestication took place outside the forest.

THE AMAZONIAN FOREST

In marked contrast to Africa, Amazonian agriculture is based on indigenous crops, especially manioc. Rare exceptions to manioc cultivation are the central Yanomami with an agricultural system based on the plantain, *Bactris gasipaes* and *Xanthosoma* (Lizot, 1984), the Kayapo with sweet potato (*Ipomoea batatas* L.), the Gaviões on *Cissus gongyloides*, and that of the Arawete on maize (Milton, 1991).

There are a large number of manioc cultivars which fall into two groups, bitter manioc and sweet manioc. The cultivated species, *Manihot esculenta*, and the 98 wild species (Rogers and Appan, 1973), form a gene pool, or species complex (Pernès and Lourd, 1984) which is characterized by a high

degree of phenotypic plasticity. The plant we know today under the name of manioc is in fact a polymorphic group, whose primordial form and place of origin are unknown. In the course of being carried from place to place by people, it would have hybridized spontaneously with wild species, thus producing different cultivars in each region (see further discussion by McKey and Beckerman, 1993, this volume). This phenomenon continues today as people modify the vegetation cover to favour the most light-demanding species of *Manihot*, some of which are commensal with cultivated manioc. Given the present state of knowledge, it is probable that Amazonia is the origin of manioc and thus (*pace* Harlan, 1971) it must be considered as a particularly active "non-centre".

Non-woody plants

Several species of *Xanthosoma* and Marantaceae (*Maranta arundinacea* L., *M. ruiziana* Koern., *Calathea alluia* (Aubl.) Lindl., *C. ovata* Lindl.) are undoubtedly Amazonian. Only one yam, *Dioscorea trifida* L.f., cultivated in many forms, could be American. Its wild ancestors are unknown and spontaneous, and wild yams that are edible are very rare. Several herbaceous and undergrowth plants are cultivated for their fruit, including *Solanum pectinatum* Dunal, *S. sessiliflorum* Dunal, *S. straminifolium* Jacq.. These last two have cultivated forms which are sufficiently different from the wild form to be recognized as sub-species by botanists. *S. sessiliflorum* is a very variable species. Chili peppers, *Capsicum frutescens* Linn. and *C. chinense* Jacq., and pineapple *Ananas comosus* (L.) Merrill, are undeniably Amazonian. There are many other very interesting species in this category, but the great originality of the Amazon region in food plants lies in its palms and fruit trees.

Palms and fruit trees

Palms and fruit trees are found in all stages of domestication (Clement, 1993, this volume). A first group comprises species preserved, or rather maintained in natural conditions: the palms *Astrocaryum* spp., *Orbignya phalerata* Mart., *Maximiliana maripa* (Correa de Serra) Drude, and many fruiting Dicotyledons, left standing in clearings, *Caryocar villosum* (Aubl.) Pers., *Rheedia macrophylla* (Mart.) Pl. & Tr., *Theobroma* spp.. Natural populations can sometimes be enriched with seeds or young plants that are tended and cared for, as in the case of the Brazil nut, *Bertholletia excelsa* HBK.

Other species are deliberately planted, such as the palms *Euterpe oleracea* Mart., and *Oenocarpus mapora* Karst., and numerous fruit trees which have cultivated forms more or less different to their wild forms, for example,

Pouteria caimito Radlk. the fruits of which can exceed 1 kg in cultivated forms in the upper Amazon although they only reach 30 g in the forest. Similar improvements have been recorded in several other species, including *Couma guianensis* Aubl., *Eugenia stipitata* McVaugh, *Poraqueiba paraensis* Ducke and *P. sericea* Tul., *Pourouma cecropiaefolia* Mart. and *Quaribea cordata* (Humb. & Bonpl.) Vischer.

Bactris gasipaes HBK is an excellent example of a domesticated plant found all over the Amazon basin in various forms. Its origins are still uncertain, but it varies in the form, colour, composition and quality of the fruit, in habit and armature, etc.

The genera *Anacardium*, *Inga*, and *Theobroma* serve to illustrate the process of domestication, as do *Cola* and *Dioscorea* in Africa. Of the 22 *Anacardium* species, only one is properly cultivated, *A. occidentale* L. Although it has a fairly wide distribution, it is definitely indigenous to the sandy banks of the Amazon basin. Several species produce edible fruits, though the fruit may sometimes be too acid to be edible. Species such as *A. spruceanum* Benth. ex Angl., *A. giganteum* Hancok. ex Engl. (sometimes cultivated despite reaching almost 15 m in height) are conserved in clearings. All fruits from the genus *Theobroma* are edible. Two species are properly cultivated: *T. cacao* L. (whose success is well known) and *T. grandiflorum* (Willd. ex Spreng.) Schum. almost only in Amazonia. Very large fruits and fruits without seeds have been reported (Cavalcante, 1976). Two species of the genus *Inga* (200–300 species) are cultivated throughout the Amazon basin: *I. edulis* Mart., and *I. macrophylla* Humb. & Bonpl. with certain characteristics distinguishing the domesticated and wild forms. From orchards close to Manaus, four other species can be added: *I. cinnamomea* Spruce ex Benth., *I. falcistipulata* Ducke, *I.nitida* Willd., and an undetermined species (Guillaumet *et al.*, 1990). The Wayãpi in French Guiana care for three species including *I. edulis* and eat thirteen others (Grenand, 1980). There seems to be a real continuum here from the gathered wild plant to the domesticated plant, the study of which presents a wonderful opportunity for understanding the process of domestication.

CONCLUSION

This comparison between the Amazonian and African forests, admittedly over succinct, suggests a few general remarks and conclusions. Although the existence of domesticated food plants in both Africa and America cannot be denied, there is clear supremacy of the the latter over the former. Are differences in domestication attributable to the greater richness in flora of the Amazonian region, or do we have to look for answers in human history? Without doubt, African forest societies were able to bor-

row plants from neighbouring cultures. A whole batch of species is common to the whole of tropical Africa. By contrast, the Andean flora, so rich and so original, was of no help to Amazonians. The ecological conditions are too different to allow the transplantation of a plant from the high mountains to the Amazon basin. On the other hand, Central America certainly played an important role.

Plants are cultivated for their subterranean parts in both continents. But America stands out by its poverty in leafy vegetables and its richness in fruiting species. As for palms, their immense richness in the Amazonian forest (39 genera and 180 species) contrasts with their paucity in the African forest (7 genera, about 20 species; Kahn and Granville, 1992; Uhl and Dransfield, 1987). Is this also characteristic for other edible fruits, as suggested by Patiño (1963)? It is somewhat difficult to believe that there are really fewer potential leafy vegetables in America than in Africa. Could this be a cultural difference on the scale of a whole continent?

The role of the large forest blocks of Africa and America as the sites of food plant domestication cannot be denied. These areas must have functioned as "non-centres" for certain species, the yam (*D. cayenensis/D. rotundata*) in Africa, manioc in America, but also as "centres of origin" of others. The upper Amazon basin would certainly seem to be the centre of origin for many species of fruit trees, Cameroon and the Congo for some *Cola* trees. To these should be added the important role of indigenous agriculture as centres of secondary differentiation. One field can contain many cultivars of the same species, especially for staple crops such as plantain or manioc. This shows the high degree of creativity and technical ability of the forest agriculturalists and underlines the need for more research into indigenous agricultural practices and systems.

The agriculturalists of the African and American forests were at the origin of the process of domestication, starting with the resources available to them, and developing them to fulfill their needs. These processes are perpetuated; the example of *Dioscorea burkilliana* cited by Hladik *et al.* (1984) is particularly important. In Amazonia, agroforestry systems are the favoured sites for the domestication of fruit species (Guillaumet *et al.*, 1990). Present day cultivation of new species is a response to the same imperatives as were the attempts made by the first agriculturalists, even if the means employed are different. Was it not because *Coffea arabica* was cultivated that we moved into the cultivation of other *Coffea* species? Would we have cultivated *Piper guineense* Schum. & Thonn., if *P. nigrum* L. was not already cultivated? Finally, domestication can also begin with the emergence of a new need, when a resource turns out to be insufficient (perhaps the case of *Cola*), scarce, even absent (arboriculture in the south of Benin). Our era is full of examples. Do we need to look for very different motivations than our own for the first agriculturalists?

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