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COVER ILLUSTRATION: Illustration of "teonochtli" ("prickly pear of god" in Nahuatl) from the Barberini Codex of 1552 (De la Cruz and Badiano 1964), apparently a species of *Stenocereus* (Cactaceae). The accompanying Latin text states that the root is used to treat tooth pain (see pg. 79).

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ETHNOBIOTICA

Transitions are never easy. But as I assume the responsibilities of editorship of what has been for many years my favorite journal, I am privileged to acknowledge the excellent work of the outgoing editor, Eugene Hunn, and of the continuing support from the editorial board. Their standards of excellence for the Journal of Ethnobiology have assured its appeal to a wide and growing readership, one I hope will be maintained for years to come. The journal will continue to be a vehicle that expresses the specific intersections of human groups and other organisms and groups or suites of organisms. This editorial transition, in other words, will be marked by an adherence on my part to the original vision of this remarkably interdisciplinary and fertile field of basic research, ethnobiology. I solicit new articles that reflect the intersection of people and organisms in the field, as well as the enmeshing of disciplines concerned with such palpable intersections. I look forward to seeing your work in these pages in the near future.

Bill

Journal of Ethnobiology 19(1): 1-23 Summer 1999

ETHNOBOTANY AND DOMESTICATION PROCESS OF *LEUCAENA* IN MEXICO.

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ABSTRACT.– This paper analyzes ethnobotanical information on the tropical tree legume genus *Leucaena* Benth. It is part of a taxonomical, archaeobotanical, ethnohistorical, and genetical study of the domestication process of these plants in Mexico. In general, uses are food and medicine; the wood is valued as fuel, for construction and for tool manufacturing. Young leaves, flower buds, immature legumes and seeds are eaten fresh, both raw and cooked; seeds are either dry-preserved whole and toasted or ground in a paste that is sun-dried and cooked; the bark is a vulnerary, the leaves and seeds are antiseptic and parasiticide. Within distribution ranges of taxa, local ethnic groups recognize and use natural populations, thus emphasizing the antiquity of this knowledge. Associated with this, there is variable cultural relevance of the taxa. Most important cultivated taxa are *L. esculenta* subsp. *esculenta* and *L. leucocephala* subsp. *glabrata*. The first is cultivated in central and southern Mexico, its biological area of origin and where it is extensively gathered, consumed and stored. The second is widespread under cultivation in warm to temperate zones, and probably originated in coastal southern Mexico. Some taxa have recently been introduced to management systems, which enhances variation of traditional management techniques.

Key words: ethnobotany; domestication process; *Leucaena;* Mexico.

RESUMEN.– Este artículo analiza la información etnobotánica disponible acerca del género de árboles tropicales *Leucaena* (Fabaceae, Mimosaceae), con énfasis en los taxa cultivados. Es parte de un estudio taxonómico, arqueobotánico, etnohistórico y genético del proceso de domesticación de estas plantas en México. Sus usos son como alimento y medicina, la madera sirve como leña, para construcción y para manufacturar utensilios. Las hojas, flores, legumbres y semillas inmaduras se comen frescas, crudas o cocinadas; las semillas se almacenan preparadas enteras -consumidas tostadas-, o molidas y secadas al sol -consumida cocinada-; la corteza es vulneraria; las hojas y semillas son antisépticas y parasiticidas. Dentro del ámbito de distribución de los taxa, las etnias locales reconocen y utilizan las poblaciones silvestres, indicando la antigüedad de este conocimiento. Asociado a esto existe variación en la importancia cultural de los taxa, siendo los más importantes en cultivo *L. esculenta* subsp. *esculenta* y *L. leucocephala* subsp. *glabrata*. La primera, cultivada en el centro y sur de México, su área de origen biológico, donde se recolecta extensivamente, se consume y almacena. La segunda es cultivada en las zonas cálidas a templadas del país, probablemente originaria de la costa sur de México. Algunos taxa han sido recientemente incorporados a sistemas tradicionales de manejo, incrementando la variabilidad de las formas de manejo tradicionales.

Palabras clave: Etnobotánica; proceso de domesticación; *Leucaena;* México.

RESUMÉ.– Cet article analyse l'information ethnobotanique disponible sur le genre des arbres tropicaux *Leucaena* (Fabaceae, Mimosaceae), en particulier sur les espèces cultivées au Mexique. L'etude fait partie d'une recherche taxonomique, archéobotanique, ethnohistorique et genétique, des processus de domestication de ces plantes au Mexique. Générelment, elles sont utilisées comme aliments et remèdes. Le bois sert à la construction, la fabrication d'outils, et comme combustible. Les feuilles, fleurs, gousses, graines, sont mangées à l'état jeune, crues ou cuites. Les graines sont stockées, simplement séchées (puis grillées au moment de la consuomation), ou bien, moulues en galettes séchées au soleil (puis cuits dans un boullion). L'écorce est vulnéraire, les feuilles et le graines sont parasiticides et antiseptiques. Les différentes espèces étaient connues, nommées, et utilisées par chaque ethnie qui cohabitait avec elles, démontrant l'ancienneté de cette conaissance.Les espèces plus répandues sont *L. esculenta* subsp. *esculenta* et *L. leucocephala* subsp. *glabrata*. La première est cultivée au centre et au sud du Mexique (sa zone d'origine biologique) elle est récoltée extensivement, préparée et stockée. La seconde est cultivée dans les zones chaudes à tempérées du Mexique, probablement originaire de la côte sud. Récentement, quelques espèces ont été incorporées aux systèmes de culture traditionels, occasionant de nouvelles conduites de culture.

Mots clefs: Ethnobotanique, processus de domestication, *Leucaena*, Mexique.

INTRODUCTION

This paper analyzes the ethnobotanical information available for species of the genus *Leucaena* Benth. in Mexico. It is particularly directed to examining local people's knowledge of these legume trees, including classification, ecology, utilization and management, with emphasis on the cultivated taxa. It is part of a study of the domestication process of these plants (Zárate 1998), which also includes systematics (Zárate 1994), archaeobotany (Zárate 1999), ethnohistory (Zárate 1997) and genetics (Zárate 1999). The general aim of these studies is to contribute to the understanding of the origins and diffusion of traditional cultivated taxa, and of the evolution of the cultural counterpart of the *Leucaena* spp.-people interrelation.

Domestication.– Domestication is a process occurring in an ethnobiological hyperspace; humans and plants interact, with each one of these entities having its particular and independent principles (e.g., culture and economy vs. genetics and ecology). Plants are an economic incentive needed for human subsistence; however, interaction between people and plants (and the ecosystem in general) occurs as a socially mediated process, which is driven by human work, i.e., management. Like all cultural processes, management evolves through the acquisition, transformation and transmission of information by social groups as part of their economic activities in an ecological context. Management -of both vegetation and each kind of plant- causes changes in both the plant's environment and the genetic structure of plant populations (i.e., evolution, which is analogous to ecotypic differentiation). The historical trends of the cultural aspects of the domestication process may be studied by comparison of ethnobotanical and historical aspects. This cultural sequence of change finds expression in genetic processes which become perceivable as taxonomical identity and morphological, ecological, and genetical variation.

The cultural context.– Mesoamerica has been a distinct center of civilization in which the use of natural resources is characterized by the exhaustive use of biological diversity and by a diverse spectrum of management intensity, both of the vegetation and of individual plant species (Caballero 1994; Casas *et al.* 1997). Thus a number of plant (and animal) taxa have been utilized in this area in conditions of diversified production which range from gathering to full domestication (Hernández-X. 1993), in close interaction with ecological and economic conditions. The results of this long history are a number of valuable and nowadays important crops, and a tradition of diversified ecological use of soil and vegetation (Bye 1993; Hernández-X. 1993). This is the context in which *Leucaena* spp. has been known, used and managed. Within this context, use of these trees as food is noteworthy because tender pods and seeds may be eaten uncooked. Other legume trees are consumed immature today, and maybe were more so in the past (Messer 1978; Felker 1981), but this is not frequent and trees are not cultivated nor extensively gathered. The fleshy legumes of mesquite (*Prosopis* spp.) are chewed to extract the sugar they contain, but seeds only become edible after being toasted and ground; so are seeds of other legume trees, such as *Lysiloma candida* and *Cercidium* spp. (Parra 1983). The soft edible pulp (arils) surrounding seeds of the genera of legume trees *Inga* and *Pithecelobium* are frequently consumed, gathered and commercialized, and the trees producing them are managed.

The appreciable consequences of the Spanish conquest on the ethnobotany of the genus are discussed elsewhere (Zárate 1997, 1998). The importance given by Mesoamerican cultures to *Leucaena* was mostly ignored by Europeans, and thus by the socio-economically dominant class. Because of this, traditional use and management of most taxa of *Leucaena* spp. underwent little acculturation, while partial cultural disjunction is observed in modern uses of some taxa (Zárate 1997, 1998).

Taxonomy and ecology.– According to Zárate (1994), the genus -in Fabaceae, Mimosaceae- comprises about 24 taxa of trees and shrubs -22 in Mexico; including 14 species and 18 subspecies, plus a number of little studied Central and South American taxa- in two sections, Sect. *Leucaena*, and Sect. *Macrophylla* Zárate. It is distributed from the Southern United States to Northern South America (Hughes 1998b). The taxa grow in different tropical environments, from arid to humid, forming part of a range of vegetation types including *matorrales*, low deciduous forests, sub-deciduous humid forests, gallery forests, mangrove edges, sandy shores, and road-side vegetation (Zárate 1994; Hughes 1993; Rzedowsky 1978). In humid environments, *Leucaena* taxa belong mostly to secondary vegetation, their dominance increasing with aridity. Most cultivated taxa belong to section *Leucaena*, characterized by having small leaflets (Zárate 1994).

A number of putative interspecific hybrids have been detected in *Leucaena*, some of which have been formally named (Zárate 1994; Hughes 1998a, 1998b; Hughes and Harris 1994). Some of the suspected hybrids seem to be a part of the biogeographical and genetic process of evolution in the genus, while others have been related to cultivation and human diffusion (Zárate 1994). Among these formally described hybrids, the only one that has been characterized beyond morphology is the hybrid between the *guaje rojo* and the *guaje verde*, *L. xmixtec*

Hughes et Harris (1994). This highly sterile tree has been found only where cultivation of the parental taxa is sympatric (Hughes and Harris 1994).

Ethnobotany.– Most taxa of *Leucaena* in Mexico are reported as edible by people, and some are gathered more or less intensely (Zárate 1994) (Appendix 1). The main cultigens are: the *guaje*[1] *rojo* or *guaje colorado*, "red *guaje*," *L. esculenta* (Moc. *et* Sessé *ex* A. DC.) Benth., with two subspecies, *L. e.* subsp. *esculenta* and *L. e.* subsp. *paniculata* (Britton *et* Rose) Zárate (1994); and the *guaje verde*, "green *guaje*," or *guaje blanco*, "white *guaje*", *L. leucocephala* (Lam.) de Wit subsp. *glabrata* (Rose) Zárate (1987, 1994).

METHODS

Ethnobotanical information was obtained from diverse sources: literature (ethnographical and ethnobotanical), floristic studies, herbarium specimen labels -mainly from the Herbario Nacional de Mexico (MEXU). Field work provided information derived from open and structured interviews (Martin 1995), mainly during rapid surveys beginning in 1979 throughout most of the genus' distribution, and, in some areas, for longer periods (Papantla, Veracruz, 1988, 1993, 1997; Central Guerrero, 1979, 1981, 1984; Chapulco, Puebla: 1982-1984; Oaxaca, 1979-1981). Where possible, ethnographical works were compared with field data. Common names were recorded from literature, herbarium labels and field work. Established phonetic equivalencies were used when available. Transcription of field records followed Spanish phonetic approximations. Whenever possible, the identification of the plants corresponding to ethnobotanical data -i.e, names, uses, knowledge, management- was authenticated by the examination of plant material, vouchers of which were deposited in MEXU. Literature reports were compared with field data, when available. The taxa were identified following Zárate (1994). A comparative analysis was made of the ethnobotanical information thus compiled.

RESULTS AND DISCUSSION

Ethnographic studies of peoples of Mexico give information about the use of most taxa of *Leucaena*. The data range from detailed descriptions of uses to the mention of the plant's names. Field work confirmed the knowledge and uses of species of the genus by indigenous and mestizo groups throughout the country (Appendix 1). This knowledge is seemingly ancient and mostly shows a low degree of acculturation (Zárate 1997).

Local classifications.– Local people living in areas where one or more wild native taxa of *Leucaena* are found, have local names for them, some in native languages. Local people's perception of variation and identification of plants is, in general, precise and usually it agrees with taxonomic criteria. The exceptions to this statement seem to be due to lack of exploration, rather than to people's ignorance of the plants (Zárate 1994) (Appendix 1).

The better known folk classifications of *Leucaena* are the Nahuatl, Mixtec and

Zapotec (Messer 1978; Casas and Caballero 1996; Zárate 1997). The generic names in these languages are respectively, ***uaxin***, ***nduva***, and ***lya***, which are applied with modifiers to species and subspecies in the genus, and to legumes in other genera.

Within the area of cultivation of the *guaje rojo* and the *guaje verde* these are known by the Nahuatl-derived name ***guaje***. A noticeable exception to this is in the Yucatan Peninsula where the putative Maya name for *L. l. leucocephala* is ***uaxim*** or ***xaxim***, probably borrowed from the Nahuatl. Similar Nahuatl derivatives are ***guash*** in Puebla and Veracruz, and ***guashe*** in Chiapas, where Leucaena taxa are also named in non-Nahuatl local native languages. Some designations distinguish local native wild taxa from introductions by epithets denoting this. In Chiapas the native ***guash de monte***, *L. collinsii* Britton *et* Rose subsp. *collinsii* (Zárate 1994), is distinguished from the ***guash de Castilla***, *L. e. esculenta*.

Uses and parts used.– Use for food is consistent, except in a few cases in which it is mostly medicinal. In the Yucatan Peninsula the leaves of ***uaxim*** (*L. l. leucocephala*) are fed to chickens as a systemic ectoparasiticide to kill lice, and for other medicinal applications (Barrera *et al.* 1976; Martínez 1979). Also, in the Balsas River Basin *L. e.* subsp. *matudae* Zárate is not used as food but the bark is used as a remedy for witchcraft and as a vulnerary (Zárate 1994). Flower buds and young leaves of some taxa, and immature legumes and seeds of most taxa are eaten. The seeds, after being salt- or ash-cured and sun-dried, are known as *cacalas* or *guajesquite* - from Nahuatl ***uaxizquitl*** composed of ***uaxin***, guaje and ***izquitl***, toasted seeds (particularly, maize), derived from ***icequi***, to toast something (Simèon 1977). In the native area of *L. e. esculenta*, *guajesquite*, derived mainly from wild trees, is prepared and commercialized. In Morelos, mature seeds gathered from wild trees of *L. macrophylla* Benth. subsp. *macrophylla* are likewise consumed (Zárate 1994). In Baja California Sur, the immature legumes of *L. lanceolata* S. Watson subsp. *lanceolata* are eaten raw, while dry seeds are eaten after being toasted and ground (Parra 1983). The galls produced by insects on the developing legumes of *L. e. esculenta*, called *bolochocos* or *polochocos*, are eaten raw in combination with other foods, such as beans (Messer 1978, Vázquez 1986, Casas *et al.* 1987, Zárate 1994; Casas and Caballero 1996) (Appendix 1).

Culinary tradition includes several recipes, the most relevant being the *guaxmole* -from Nahuatl, ***uaxmolli***, composed of ***uaxin*** and ***molli***, stew (Simèon 1977)- prepared with pork, beef or goat meat. Several kinds of sauces (*salsa de guajes*) are made with or without chili peppers, sometimes including tomato, onion and spices, usually with garlic. The *tortas de guaje* is a "guaje omelet" made with immature seeds beaten with egg and cheese, and fried on a pan. *Guajesquite* is washed and drained, toasted on a flat metal or earthenware pan (*comal*) until they burst like popcorn, and eaten in *tacos* with chili pepper sauces, or alone adding lemon juice, salt and powdered chili pepper (Kennedy 1992). In the Tehuacan Valley, Puebla, during the season when goats are sacrificed (*matanza*), *guaje rojo* seeds are cooked with their meat (Paredes-Colín 1977). In this region, *guaxmole* is flavored with avocado leaves (*Persea americana* Mill.).

In general, when *Leucaena* spp. products are used for food they supplement the diet, due to its content in some important vitamins -and perhaps minerals too (Kelly and Palerm 1952). While this may be valid for most cases, *L. e. esculenta* is

sometimes more important in the diet, supplying protein. Such is the case of the elaborate products which may be stored (the *guajesquite* and the "bread" described below). This alimentary pattern corresponds with a strategy based on main staple foodstuffs, usually crop species, supplemented with seasonally available foods that are frequently gathered.

The wood is used as firewood, and that of *L. esculenta* is used by the Popoloca in Puebla for house construction (Jäcklein 1974). Utensils and tools are also reportedly made from the wood of *L. lanceolata* cultivated by the Huaves (Zizumbo and Colunga 1982). Similar uses and properties of wood of *Leucaena* spp. are known from documents of the sixteenth century (Zárate 1997).

Medicinal uses are also common and widespread. In general, leaves and seeds of these plants are used to fight infections both of the digestive and of the respiratory systems. Topical use of the ground bark of all three subspecies of *L. esculenta* (Zárate 1994) (sometimes mixed with honey) is recommended for infected wounds (vulnerary). The seeds of these last named taxa are considered an eupeptic and aphrodisiac (Díaz 1976, Hernández 1960). In the original illustration of "*Mimosa esculenta*" (slide no. 6331-627, Hunt Institute for Botanical Documentation), which forms part of the *Iconografía de la Flora Mexicana* compiled by Sessé and Mociño (1887, 1893), both the edibility and the aphrodisiac properties of *L. esculenta* subsp. *esculenta* are mentioned. The bark of *L. e. matudae* is used in magic medicine for treatment of witchcraft, which is associated with the Nahuatl invocation repeated in silence by the healer when gathering, preparing, giving the remedy to the patient, and ending the ritual. *Leucaena c. collinsii* from Chiapas is reported as antirheumatic (Díaz 1976) (Appendix 1).

These medicinal uses contrast with reports of toxicity of the leaves, seeds and pods for cattle, a fact already known by Spanish conquerors (Zárate 1997): When eaten, it causes hair-loss and, in ruminants, goiter. The responsible of this effect is the mildly toxic amino acid mimosine, which in ruminants is degraded to the potent goiterogen 3-hydroxy-4-1H pyridone (DHP). Toxic effects in ruminants may be avoided by inoculating cattle with the bacteria *Synergistes jonesii*, which is capable of degrading DHP (Jones and Megarrity 1986). Biological activity of mimosine in animal cells has been attributed to the decondensation of chromatin and nucleolar fibrillar component (Vogt 1991). This highly specific protein synthesis inhibition may explain the loss of hair and the reported properties against infections and a broad range of parasites. This fact suggests that *Leucaena* spp. could have potential in the treatment of tumors.

Economic importance.– Commercialization of products of several species of *Leucaena* is common in markets of many parts of Central Mexico. Among these markets are local weekly and daily marketplaces as well as established markets. In markets, *guajes* are sold in permanent stalls and by temporal vendors. In the main supply centers in Mexico City, *guajes* are traded in large scale by specialized merchants called *acaparadores*, who buy *guajes* from local producers. In this and other large towns and cities *guajes* are usually offered together with ethnic plant and animal foodstuffs. Less frequently, they may be found along with more common vegetables such as potatoes, carrots, celery, tomatoes, and so on. More rarely, *guajes* are sold in supermarkets.

The legumes of the short day plant *L. e. esculenta*, and those of *L. e. paniculata* which mature during the rainy season, are replaced during most part of the year by *L. l. glabrata*, which produces legumes all year round, as long as water is provided. Regionally (State of Mexico), the legumes of *L. m. macrophylla* are offered; so are the leaves, pod galls (*bolochocos*) and dry seeds of *L. esculenta* (*guajesquite*) (Guerrero, Morelos and Puebla); the fresh legumes of *L. cuspidata* Standley are sold in the weekly market of Ixmiquilpan, Hidalgo, during the production season (September). Legumes of *L. confertiflora* Zárate subsp. *adenotheloidea* Zárate (1994), both cultivated and gathered wild at Chapulco, Puebla, and nearby locations, are commercialized in local markets in the area of the Tehuacan Valley. Products in the market come mainly from cultivated populations, but may also have wild or somewhat managed provenance. In the first case are all instances of *L. l. glabrata*, and most examples of sale of *L. esculenta* and *L. c. adenotheloidea*. Wild provenance is dominant in commercialized products of *L. macrophylla* and *L. cuspidata*. *Guajesquite* made from *L. e. esculenta* is mainly from wild trees, although there is evidence of a possibly long history of management of some apparently wild populations (Casas and Caballero 1996). Legumes of *L. c. adenotheloidea* in markets come from both cultivated and wild trees. Most taxa are known to be considered edible and are gathered from wild or somewhat altered populations (Appendix 1).

Leucaena esculenta.– This species is native to the Balsas River Basin at elevations from 850 to 2200 m above sea level, it is found cultivated in this area and in Central Mexico, in Zacatecas, Jalisco, Hidalgo, Puebla, Veracruz, Michoacán, México, Guerrero, Morelos, Oaxaca and Chiapas (Zárate 1994:132, figure 6). Outside this area it is occasionally found cultivated. The subspecies *esculenta* is common in the northern and western part of the distribution, whereas the subspecies *paniculata* is found at higher altitudes in Zacatecas, Puebla, Guerrero, Morelos and Oaxaca. In Oaxaca, the characteristics distinguishing subspecies *esculenta* and *paniculata* -respectively, angled branches and red flowers vs. terete branches and reddish flowers, among others- are frequently combined in cultivated individual trees. Local wild populations of *L. e. paniculata* do not have such mixed characteristics (Zárate 1994). This may be due to hybridization between both subspecies, aided by the above mentioned overlap in phenology, as suggested by the polyploidy of these southern populations of the *guaje rojo*. Archaeobotanical evidence supports that such hybridization would have derived from the diffusion of *L. e. esculenta* to areas with native *L. e. paniculata* populations (Zárate 1994). Subspecies *paniculata* is sometimes cultivated, particularly in the margins of the distribution of subspecies *esculenta*, at or above 2000 m, in the states of Morelos, Puebla and Oaxaca. Subspecies *matudae*, is endemic to the Central Balsas Basin area, and has not been seen cultivated (Zárate 1994).

The *guaje rojo* is gathered from wild and managed trees for consumption of the fresh (green) seeds, which are eaten raw or cooked. The reddish legumes -tied up in bundles- are sold in markets in many parts of Mexico. Subspecies *esculenta* is deciduous, flowering while leafless -an adaptation of tropical dry tropical forest trees. Legumes of most highly prized *L. e.* subsp. *esculenta* trees (*hueyuaxin*) mature in the spring, while other populations -having lower quality- mature later. Thus, the legumes of *guaje rojo* are available from August to March. Subspecies

paniculata matures during the summer and fall. The Valley Zapotec from Mitla, Oaxaca, take advantage of both subspecies, recognizing them as ***lya gusghi*** (***lya***, Valley Zapotec generic name, and ***gusghi***, rainy season; "rainy season *guaje*") and ***lya kures*** (similarly, "dry season *guaje*") (Messer 1978; Zárate 1994).

Within the heartland of the *guaje rojo*, in the Cañada Region of Guerrero, the seeds of subsp. *esculenta* are extensively gathered from wild and managed populations to be prepared as *guajesquite* which may be stored for further use. It is sold in local markets (e.g., Iguala and Huamuxtitlán, Guerrero and Cuernavaca, Morelos) by seed merchants. Within this area, another form of storable preparation is known: the fresh seeds are ground into a bread-like cake and stored wrapped in plastic after being sun-dried. This preparation is consumed in stew-like dishes, with or without meat. According to Casas and Caballero (1996), these two preparations are the only wild food resources stored by the Mixtec people in Guerrero. This "*guaje* bread" may be the same as that noticed during the sixteenth century by Hernández (1960; Zárate 1997).

Management.– These trees (both subspecies) are managed in various agricultural systems, grading in intensity, including *in situ* selection of *L. e. esculenta* in sites under fallow cultivation in dry tropical forests (Casas and Caballero 1996), home gardens, and in high density pure stands. Frequently, it is planted along water channels (*apantles*) and in furrow ridges between *milpas* (*bordos*). Vegetative propagation is not practiced for any species of the genus which are always seed-propagated, commonly by direct planting, but they can also be transplanted. In some cases, the presence of a seedbank makes planting unnecessary.

Diffusion.– Cultigens of the species seem to have been dispersed from some parts of the Balsas Basin to all parts of the range of cultivation. Some places of origin of cultigens known today are the upper valleys of Morelos (Cuernavaca and surrounding areas), an area in the State of Mexico (Temascaltepec area), and the Tierra Caliente region of Guerrero and Michoacán (Teloloapan, Guerrero-Tiquicheo, Michoacán area); these are all regions where Nahuatl is spoken.

Leucaena leucocephala.– Subspecies *leucocephala* is native along the Caribbean Coast of Mexico, the Antilles, and Florida, while the subspecies *glabrata* is widespread in Mexico, but its native area is not completely certain (see below) (Zárate 1987, 1994). The subspecies *glabrata* is cultivated and has recently been dispersed as a weed. While being typical of humid tropical environments, in cultivation it has a broad ecological range. A cultigen initially identified as subspecies *leucocephala* (Zárate 1987, 1994) is known cultivated by the Coast Totonac of Veracruz, and by the Totonac and the Nahua from the Sierra Norte de Puebla region (Zárate 1987, 1994). However, the identity of this plant is questionable, and it is likely that it is a hybrid of the subspecies *glabrata* and *L. pulverulenta*. In the Maya area, the native *L. l. leucocephala* is part of home gardens (Barrera 1980; Rico-Gray *et al.* 1990).

Management. In the Totonac region subspecies *glabrata* is managed in slash and burn milpas, acahuales (managed secondary vegetation) and in managed pastures (Kelly and Palerm 1952; Medellín 1990); elsewhere, within its distribution range, it is mainly found in patios, homegardens and in pure stands (Lazos *et al.* 1988; Zárate 1994). Its establishment and production seem to depend largely on irrigation. In Jalcomulco, Veracruz, pure stands of *L. l. glabrata* are grown on the

Jalcomulco River banks, apparently forming spontaneous hybrids with the native taxon *L. diversifolia* (Schldl.) Benth. subsp. *diversifolia* (Zárate 1994).

Diffusion. This species colonized the tropics of the world through European introduction via the Philippines (Zárate 1987, 1997, 1998). However, the aggressive subspecies *leucocephala* has become a problem for some countries, leading to the introduction of the more useful subspecies *glabrata* (Dijkman 1950, Anonymous 1984, Hughes 1993). This trend has reached Mexico, where importation of germplasm is occurring even today.

Cultigens of subspecies *glabrata* probably originated along rivers in the Sierra Madre del Sur or along the southern Pacific Coast of Mexico. From here, it reached its present area of traditional cultivation along Michoacán, Guerrero, Morelos, Puebla and Oaxaca. Archaeological evidence suggests that *L. l. glabrata* was introduced to the Tehuacan Valley during the Classic period (Palo Blanco phase), and perhaps to the Gulf of Mexico area, and that it was associated with irrigation agriculture (Zárate 1998). The cultivation of *L. l. glabrata* occurs where water is available and low temperatures do not limit its growth. Conversely, however, cultivation of *L. esculenta* does not occur at low elevations and may be damaged by excessive humidity (Zárate 1994).

Other cultivated taxa.– Other taxa are cultivated in lower degree, including some newly introduced cultigens and others that seem traditional. In the first case, the *guaje zacatzin, L. c. adenotheloidea* is a small, multiple-stemmed tree cultivated at 1800-2000 m above sea level in Chapulco, Puebla (Zárate 1984, 1994). The ethnobotanical evidence indicates that this shrubby tree was initially planted at the beginning of the present century. It is grown in home gardens with other trees in borders limiting the corn fields (*milpas*). Native populations exist in the neighboring Sierra de Zongolica, where it has traditionally been gathered for consumption, trade and sale (Zárate 1994). Irrigation seems to be causing the preference of the *guaje zacatzin* over the older cultigens of the *guaje colorado* (*L. e paniculata*), because the latter is damaged by constant moisture while the first responds with luscious growth and abundant legume production (Zárate 1994).

In the same case is *L. cuspidata* Standley, a small tree from arid vegetation in San Luis Potosí, Querétaro and Hidalgo (Zárate 1994), of incipient cultivation at the Mezquital Valley (Hughes 1993). As a tradition, the Otomi people gathered this shrub's legumes (Zárate 1994) and currently are turning to its cultivation.

Of unknown antiquity in cultivation, *L. lanceolata* -belonging to *Leucaena* Section *Macrophylla* Zárate (1994)- is grown in live fences for fodder by the Huaves of San Mateo del Mar, Oaxaca (Zizumbo and Colunga 1982).

Two other taxa are grown in living fences in Southern Mexico: *L. c. collinsii,* and *L. shannonii* J. D. Smith subsp. *shannonii*. Both taxa are of Central American affinity and are Mexican subspecies (Zárate 1994) disjunct from other subspecies in Central America (Hughes 1993). Precise antiquity of their cultivation is unknown.

Management and agricultural systems.– Physical factors such as climate, soil and vegetation influence the decision about which taxa to cultivate, but the choice is also influenced by cultural factors. The degree of intention and the effectiveness of the various managed systems known for *Leucaena* spp. ranges from individual

selection of trees *in situ* (without planting)– *L. e. esculenta* (Casas and Caballero 1996), and *L. l. leucocephala* (Kelly and Palerm 1952; Medellín 1990; Zárate 1994); the favoring and encouragement of volunteer recruits in culture– *L. e. paniculata.* in Chapulco, Puebla (Zárate 1994); to, the planting of seeds either directly to the fields– *L. e. esculenta* (Casas and Caballero 1996), *L. l. glabrata*, and *L. c. adenotheloidea*– or *ex situ* to be transplanted– *L. c. adenotheloidea* (Zárate 1994).

CONCLUSIONS

Relative importance of taxa.– From the data presented here, and from the ethnohistorical analysis (Zárate 1997), it may be concluded that the taxon with most ethnobotanical relevance in Mexico is *L. e. esculenta*, followed in order of importance by *L. l. glabrata.* The native area of *L. e. esculenta* has been approximately outlined, also it has been determined that the highly prized cultigens of this species (the ***hueyuaxin***) originate in the higher portions along the northern border of this region.

The geographic origin of *L. l. glabrata* and of its cultivation is less certain. Most probably, the taxon is native along the rivers draining from the Mexican Pacific slopes. As mentioned, the reviewed archaeological evidence suggests that this cultigen did not originate in the Gulf of Mexico area; rather, it was likely introduced to Eastern Mexico from some place within the Balsas Basin area during the Classic period. However, *L. l. leucocephala* seems native to the Yucatan Peninsula and across the Tehuantepec Isthmus (Zárate 1994).

A Central American cultivation area is recognized which is characterized by management in living fences of native taxa. Mexican subspecies of *L. collinsii* and *L. shannonii* (Zárate 1994) are cultivated in the northern portion of this area extending into Guatemala (Hughes 1993, 1998b). The tradition associated with this area seems to be independent from those in the Balsas River Basin and Gulf of Mexico regions. History of migrations of the Pipil Nicarao (Fowler 1989) could have influenced this cultivation tradition, but that is uncertain. While *L. esculenta* did not diffuse beyond Mexico, knowledge of the genus did: the Pipil language from El Salvador records the word ***wa:xin***, plural, ***wahwa:xin***, meaning *guaje* tree (Campbell 1985).

Ethnobotanical evidence and the domestication of Leucaena.– A model for the process of domestication of the taxa in *Leucaena* has been proposed on a multidisciplinary basis, of which this study forms part (Zárate 1998, 1999). A genetic analysis made of putative isozyme genes of samples from the same wild and *in situ* selected populations morphologically studied by Casas and Caballero (1996), agrees with the differentiation observed by these authors in those characteristics of the fruit which are selected by people (Zárate 1999). This genetic evidence (Zárate 1999), together with inferences coming from phytogeography (distribution of populations) (Zárate 1994), ethnohistory (Zárate 1997), archaeobotany (Zárate 1999), and morphology (Zárate 1994; Casas and Caballero 1996), also suggests that domestication of *L. e. esculenta* must have proceeded, in part, by a form of management similar to that observed by Casas and Caballero (1996), acting during prolonged periods of time,

and over selected ecotypes. This form of selection acts upon locally available variation but is strengthened by diffusion of trees, which have themselves been selected along a historical process acting extensively upon the species' ecological and geographic milieus (Zárate 1999).

The ethnobotany of the genus in Mexico uncovers a geographic mosaic of taxa-cultures composed of wild, native taxa, in areas where local people gather and know each one as part of their knowledge of the environment. Overlapped with this pattern, some taxa are mostly found under more intense forms of management, and genetic variation present is apparently more or less determined by the history of such management. These facts may be observed as ethnobotanical manifestations: people recognize and appraise the quality of their plants, and of those from the region and beyond. Accordingly, people make attempts to improve the quality of their plantings either by introducing genetic material (seeds in this case), by elimination and favoring of present trees, or by a combination of both. Thus land race populations in areas where these were introduced are usually accompanied by introduced, higher quality cultigens. The distribution of these prized cultigens aids in charting their provenance and diffusion patterns.

Culturally, this situation in which a few taxa are widespread and cultivated, while other are gathered and relevant only at a local scale, is a consequence of the historical interaction between economic tradition, species distribution, ecological importance, and relative importance of cultural groups. There is a noticeable cultural identity of the most relevant taxa, their uses and their management by Nahuatl speakers in Central Mexico. The magic-medicinal use of *L. e. matudae* mentioned above is an important geographical and cultural indicator because it matches with the area of major alimentary relevance of the *guajes*, and because it provides cultural identity clues. The context of the use of this magic medicine is similar in many respects to that described by Aguirre-Beltrán (1992) for *Olloloqui* (*Ipomoea corimbosa*). In general, such similarities include invocation, ritual performance, participants attitudes, patient motivations and effects of treatment.

Other clues come from: sixteen century accounts of its importance for Nahuatl speakers (Zárate 1987); phytogeography (Zárate 1994); and, previously discussed archaeological evidence of diffusion of *L. e. esculenta* to neighboring Mixtec and Zapotec peoples (Zárate 1999). Also, evidence of diffusion of *L. l. glabrata* to the Tehuacan Valley, putatively with irrigation, has been associated with Nahuatl or Mixtec speakers on the basis of ceramic findings (MacNeish et al., 1970).

The cultivation of the *guaje verde* is, in general, associated with that of *L. e. esculenta* in the areas where both exist. However due to ecological conditions, *L. l. glabrata* is cultivated in places where the *guaje rojo* would not grow, areas which include many ethnic groups besides Nahuatl speakers. The Nahua identity of this species is weaker than that of *L. e. esculenta*. It seems to have been of relatively secondary importance to the sixteenth century Nahuatl speakers (Zárate 1997), yet its diffusion could have been also associated with these ethnic groups, as suggested by archaeology (Zárate 1998). All this indicates that Nahuatl speakers have been the main diffusers of the knowledge, use and cultivation of *L. e. esculenta* and *L. l. glabrata*. It remains to be seen whether ancient gatherers of *guaje rojo* seeds were actually Nahuatl speakers, since when they did this and whether they learned this from other people are questions that may only be answered by archaeology.

New domestication processes and production systems are being generated for trees and shrubs of the genus *Leucaena* in Mexico, apparently even faster than the promotion of the "modernized" uses, i.e. those praised by some international researchers who are sometimes largely ignorant of traditional uses in Mexico. This brings about incipient domestication of taxa formerly gathered from the wild. In this last instance there are at least two taxa, both from dry environments: *L. cuspidata* in the Mezquital Valley, and *L. c. adenotheloidea* near the Tehuacan Valley. In the former case, innovation is observed as variation in the management techniques used, a diversification which contrasts with more or less fixed traditional management of previously established cultigens in the same place.

NOTES

[1] The Spanish name *guaje* is derived from the Nahuatl ***uaxin***, which is the generic name for *Leucaena* trees; it is also applied to the legumes and to *L. e. esculenta* (Siméon 1977; Zárate 1997). Nahuatl derivatives are known, such as ***uaxin chichiltic*** "red *guaje*", ***calluaxin*** "house *guaje*", etc. Some of these names apply to other genera, such as ***tepeuaxin*** (*Lysiloma* spp.). Gloss variations are found in sixteen century documents: ***uaxi, hoaxin, -huaxin, -oaxin*** (Zárate 1997).

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APPENDIX 1.–Names, uses and distribution of *Leucaena* spp.

Taxon[1]	Common names[2]/ Language/Meaning	Location	Distrubution	Uses	Management Status
L. macrophylla Benth. subsp. *macrophylla*	*guaje blanco*[a]/ Spanish/"white guaje"	Morelos	Sierra Madre del Sur, from Nayarit to Oaxaca, Sierra Norte de Puebla	Dry seeds eaten toasted; tender leaves eaten raw	Wild
	guajillo[b]/ Spanish/ "small guaje"	Guerrero		Tender seeds eaten raw	Wild
	Zacaguaje[b]/ Spanish (from Nahuatl ***zacatl uaxin nduva cualli***[c], and ***nduva cuallo***[d]/ Mixtec/ "horse guaje"	Oaxaca		Tender seeds eaten raw	Wild
	guaje de venado[a]/ Spanish/"deer's guaje"	Mexico		Tender seeds eaten raw; fresh pods sold in local markets[e]	Wild
L. macrophylla Benth. subsp. *nelsonii* (Britton *et* Rose) Zárate	*guaje de risa*[a]/ Spanish/ "laughter guaje"	Guerrero	Sierra Madre del Sur, from Guerrero to Chiapas; Veracruz	tender seeds eaten raw or cooked	Wild
L. lanceolata S. Watson subsp. *lanceolata*	*guajillo*[f]/Spanish/ "small guaje"	Baja California Sur	Baja California Sur, Sierra Madre Occidental and Sierra Madre del Sur, from Chihuahua to Chiapas, Veracruz	Immature legumes eaten raw; dry seeds eaten toasted and ground to powder[f]	Wild
	guajillo[g]/Spanish/ "small guaje"	Sinaloa, Michoacán, Guerrero		Tender seeds eaten raw	Wild
	bolillo[g]/Spanish/ "small balls tree"	Sinaloa		Tender seeds eaten raw	Wild

APPENDIX 1.–Names, uses and distribution of *Leucaena* spp. (continued)

Taxon[1]	Common names[2]/ Language/Meaning	Location	Distrubution	Uses	Management Status
	nasiva or ***vasina***[g]/ Guarigia/"guaje guaje"	Sonora Costa Grande, Guerrero		Forage	Favored in Pastures
	napajteam[h]/ Huave/unknown	San Mateo del Mar, Oaxaca		Forage; living fence; wood for utensils	Cultivated in living fences
	yaga-la-sha-xi[a]/ Coast Zapotec/ "rainy season guaje"	Tehuantepec Isthmus, Oaxaca		Tender seeds eaten raw	Planted along irrigation canals
	angelito[a]/Spanish/ "little angel"	Tehuantepec Isthmus, Oaxaca		Quality firewood	Wild
	guaje sabanero[a]/ Spanish/ "savanna guaje"; *ejote*[a]/Spanish/ "string bean guaje"	Pochulta, Oaxaca		Tender leaves and seeds eaten raw; medicinal for infections	Wild
	guaje de zopilote[a]/ Spanish/ "vulture guaje"	Llano Grande, Oaxaca		Tender seeds and leaves eaten raw	Wild
	da yuuh[a]/Chatino/ "wild guaje"				
L. lanceolata S. Watson subsp. *sousae* Zárate	*guaje; ejote*[a]/Spanish/ "string-bean tree"	Pochulta, Oaxaca	Southern Pacific Coast from Michoacán to Chiapas	Tender leaves and seeds eaten, taste sweeter, less pungent than that of subsp. *lanceolata*)	Wild
L. retusa Benth *ex* A. Gray	golden-ball lead tree[i]/ English	Texas and New Mexico	Texas, New Mexico, Coahuila, Chihuahua	Browsed by cattle	Wild

L. shannonii J.D. Smith subsp. *shannonii*	*cascahuite*[j]/Spanish, from Nahuatl ***uaxcuahuitl***/ "guaje tree"	El Salvador	Chiapas to Nicaragua	Unknown	Wild
	guaje[a,j]	Chiapas, Guatemala, Honduras, El Salvador, Nicaragua		Living Fence	Wild and cultivated in living fences
	frijolillo[j]/Spanish/ "small bean"	Honduras		Unknown	Wild
	guajillo[j]/Spanish/ "small guaje"	Guatemala		Unknown	Wild
	vaina[j]/Spanish/ "legume"	Nicaragua		Unknown	Wild
L. shannonii J.D. Smith subsp. *salvadorensis* (Standley *ex* Britton *et* Rose) Zárate	*gucamaya de montaña*[k]/ Spanish/ "mountain guacamaya"	Joroco, Morazázan, El Salvador, Estelí, Nicaragua	El Salvador, Honduras, and Guatemala	Unknown	Wild
	sepia[l]/Spanish/ probably refers to dye or color				
	guaje[j]				
L. shannonii J.D. Smith subsp. *magnifica* Hughes	*guaje*[l]; *vainillo*[l]/Spainish/ "small legume tree"	El Rincón, Guatemala	Chiquimula Valley, Guatemala	Unknown	Favored

APPENDIX 1.–Names, uses and distribution of *Leucaena* spp. (continued)

Taxon[1]	Common names[2]/ Language/Meaning	Location	Distrubution	Uses	Management Status
L. leucocephala (Lam.) de Wit subsp. *leucocephala*	***huaxi, uaxim, xaxim***[b,n]/ probably derived from Nahuatl/"guaje"	Yucatán	Gulf of Mexico, Yucatán Peninsula and Tehuantepec Isthmus	Medicinal, antiparasitic and used against chicken lice; not eaten	Favored in milpas and intensively managed pastures
L. leucocephala (Lam.) de Wit subsp. *glabrata* (Rose) Zárate	*guaje verde*[a,c,d]/Spanish/ "green guaje"	Morelos, Guerrero	Widespread in lowlands, Central and South Mexico to Nicaragua	Tender seeds eaten raw or cooked; leaves eaten raw; medicinal; sold in markets	Cultivated and probably escaped in disturbed habitats, or native in riparian habitats
	lelekes or ***li.l_k kiwilíliak liliake***[a,m]/ Totonac/ "smelly legume"	Papantla, Veracruz	"		Favored and planted in slash and burn milpas
	guash[a]/Nahuatl/ guaje	Northern Puebla	"		"
	guaje blanco[a]/Spanish/ "white guaje"	Oaxaca	"		Cultivated
	auaxin[a,o]/Nahuatl/ "water guaje"	Guerrerro	"		Cultivated, escaped or native in riparian habitats
	calluaxin[a]/Nahatl/ "horse guaje"				

	nduva cuií[a,c,d]/ Mixtec/"green guaje" *manso*[c]/Spanish/ "tame guaje"				
L. esculenta (Moc. Et Sessé *ex* A. DC.) Benth. subsp. *esculenta*	*guaje rojo; guaje colorado*[a,j]/Spanish/ "red guaje"	Jalisco, Michoacán, Guerrero, Puebla, Oaxaca	Sierra Madre del Sur, Jalisco, Hidalgo, Puebla, Veracruz, Michoacán, México, Morelos, Guerrero, Oaxaca		
	uaxin[a,o]/Nahuatl/ *guaje*	Guerrero, Morelos, Puebla		Seeds and leaves eaten raw; tender seeds cooked; dry seeds eaten toasted; sold in markets	Wild, planted, favored, escaped
	uaxin chichiltic[a]/ Nahuatl/"red guaje"				
	hueyuaxin[a,o]/ Nahuatl/"large guaje"				
	guaje de Castilla[a]/ Spanish/ "Castillan guaje"				
	Iya kures[a,p]/ Mitla Zapotec/ "dry season *guaje*"	Oaxaca			Planted, favored, ruderal
	nduva cuaá[a,c,d]/ Mixtec/"red *guaje*"	Guerrero, Puebla, Oaxaca			planted, favored, wild
	nduva cuaá nanu[c]/ Mixtec/ "wide red *guaje*"	Guerrero			

APPENDIX 1.–Names, uses and distribution of *Leucaena* spp. (continued)

Taxon[1]	Common names[2]/ Language/Meaning	Location	Distrubution	Uses	Management Status
	nduva cuaá cuali[c]/ Mixtec/"thin red *guaje*"				
	libad lo[a]/Coast Mixtec/"red *guaje*"	Oaxaca			Planted, favored
	al pa la[b]/Chontal/ unknown				
	pa la[b]/Chontal/ unknown				
	yaga la[a,b]/ Zapotec/"*guaje*"				
	éfé[a]/Otomi/"*guaje*"	Hidalgo			
L. esculenta (Moc. et Sessé *ex* A. DC.) Benth. subsp. *paniculata* (Britton *et* Rose) Zárate	*guaje barbero*[a]/ Spanish/ "barbers *guaje*"	Morelos	Zacatecas, Puebla, Morelos, Oaxaca	Believed to cause hair to fall when eaten	Wild
	pepetoaxin[o]/Nahuatl/ "mucilaginose *guaje*"				
	guajal de campo[a]/ Spanish/"wild *guaje*"	Oaxaca		Tender seeds occasionally eaten	Wild
	lobada le eg[a]/ Zapotec/"wild *guaje*"				
	Iya gusgih[a,p]/ Zapotec/ "rainy-season *guaje*"				
	guajal de cerro[a]/Spanish/ "wild *guaje* tree"				

	guaje colorado[a]/Spanish/ "red *guaje*"	Puebla		Tender seeds eaten; sold in markets	Favoured and planted
	nduva nduchi[c,d]/Mixtec/ "bean guaje"	Guerrero		"	Wild
	guaje de guanduchi[c]/ Spanish/"bean *guaje*"				
L. esculenta (Moc. et Sessé *ex* A. DC.) Benth. subsp. *matudae* Zárate	*guaje retinto*[a]/Spanish/ "dark red *guaje*"	Guerrero	Central Balsas Basin	seldom eaten; bark vulnerary and in magic medicine	Wild
	chiquimoluaxin[a]/ Nahuatl/ "nightingale *guaje*" or "cleft-wood *guaje*"				
	guaje jilguero[j]/Spanish/ "nightingale *guaje*"				
	guaje chismoso[a]/ Spanish/"gossip *guaje*"				
	guaje brujo[a,j]/Spanish/ "witch *guaje*"				
	nduva ticuandá[q]/ Mixtec/unknown				
	guaje ticuanda; guaje de hielote[q]/ Spanish/unknown				
L. collinsii Britton *et* Rose subsp. *collinsii*	*guaje; guaje colorado*[a]/ Spanish/"red guaje"	Chiapas	Chiapas to Northern Guatemala	Tender seeds eaten raw	Wild and planted in living fences
	guash[a,j]/Nahuatl/ "*guaje*"				
	guash de monte[j]/ Nahuatl and Spanish/ "wild *guaje*"				

APPENDIX 1.–Names, uses and distribution of *Leucaena* spp. (continued)

Taxon[1]	Common names[2]/ Language/Meaning	Location	Distrubution	Uses	Management Status
	chijlip[j]/Tojolabal/ "sweet *guaje*"				
L. cuspidata Standley subsp. *cuspidata* and *L. cuspidata* Standley subsp. *jacalensis* Zárate	***'éfé***[a]/Otomi/"*guaje*"	Hidalgo	San Luis Potosi, Hidalgo, Queretaro	Tender seeds eaten raw; sold in markets	Wild, cultivated
	***'éfé** de cerro*[j]/Spanish/ "wild *guaje*"				
	uaxi[a]/Nahuatl/"*guaje*"				
L. confertiflora Zárate subsp. *confertiflora*	*guaje*[a]/Spanish/"*guaje*"	Oaxaca, Puebla	Oaxaca, Puebla	Unknown	Wild
L. confertiflora Zárate subsp. *adenotheloidea* Zárate	***guaje zacatzin***[a]/ from Nahuatl/ "wild *guaje*"	Puebla	Sierra de Zongolica, Puebla	Tender seeds eaten raw or cooked; sold in markets	Wild, planted
L. diversifolia (Schldl.) Benth. subsp. *diversifolia*	*guaje; guaje blanco*[a]/ Spanish/"white *guaje*"	Jalapa, Veracruz	Central Veracruz	Tender seeds eaten raw	Wild, tolerated
L. diversifolia (Schldl.) Benth. subsp. *stenocarpa* (Urban) Zárate	***La-aye-ti***[a]/Zapotec/ "small guaje"	Oaxaca	Sinaloa, Durango, Jalisco, México, Morelos, Guerrero, Oaxaca, Chiapas, Guatemala, Honduras, El Salvador	Tender seeds eaten raw	Wild
	lobadaviyin[a]/ Zapotec/"bird guaje"				
	shashib; shashibtez; xaxib; ch'ich'nü/ Tzeltal/unknown			"	"

L. pulverulenta (Schldl.) Benth.	***guañas***[a]/Chichimec/ *"guaje"*	San Luis Potosí	Eastern flank of the Sierra Madre Oriental, Nuevo León, Tamaulipas, San Luis Potosí, Hidalgo, Veracruz, Oaxaca	Tender flower buds and seeds eaten raw	Wild
	guaje; guashe; huache[j]/ from Nahuatl/*"guaje"*	Puebla and Hidalgo (Sierra Norte de Puebla)		"	"
	liliakiwi[a,m]/Totonac/ *"guaje* tree"	Totonacapan in Veracruz		"	"
	tze[a]/Mazatec/*"guaje"*	Oaxaca, Sierra de Huautla		"	"
	thuk'[r]/Huastec/*"guaje"*	San Luis Potosí		Tender leaves and seeds eaten raw; leaves in medicinal preparations	
L. X brachycarpa (Urban) Zárate	Unknown	Oacaca, Eastern Sierra Mazateca		Unknown	Wild
L. greggii S. Watson	Unknown	Coahuila, Nuevo León		Unknown	Wild
L. involucrata Zárate	*barra blanca*[j]/Spanish/ "white bar"	Sonora	Sonora	Unknown	Wild

[1]Taxa follow Zárate (1994). Central American taxa are included for completeness.

[2]Sources: a. Field observation; b. Martínez 1979; c. Casas and Caballero 1996; d. Casas et al. 1994; e. R. Bye and E. Linares, personal communication; f. Parra 1983; g. González-Ortega 1929; h Zizumbo and Colunga 1980; i. Vines 1960; j. Herbarium label; k. Standley and Calderón 1925; l. Hughes 1993; m. Kelly and Palerm 1952; n. Barrera et al. 1980; o. Hernández 1960; p. Messer 1978; q. Casas 1992; r. Alcorn 1984.

Ecology and Empire: Environmental History of Settler Societies. Tom Griffiths and Libby Robin. University of Washington Press, Seattle. 1998. Pp. 256. $22.00 (paper). ISBN 0-295-97667-5.

The field of environmental history, concerned broadly with the complex relationship between people and nature through time, has emerged since the early 1970s to become a popular arena of scholarship. Although in its early days environmental history tended to focus on the political history of the conservation movement in the United States, it has since become a powerful interdisciplinary tool used to understand humanity's impact on the earth. The frame of reference in environmental history has widened to cover diverse topics, from the perceptions of urban pollution and environmental racism to the demographic and ecological effects of colonialism. *Ecology and Empire* is a significant and timely contribution to the blossoming literature in environmental history. In general, it is about the relationship between human and natural history over the past five centuries. In particular, it assesses the environmental fallout of European imperialism from the perspective of settler societies, or the colonized peripheries. The principal European player in this tale is Great Britain, and the main settler society is Australia.

After a brief introduction by Tom Griffiths, who co-edits this volume with Libby Robin, *Ecology and Empire* is organized into five parts. Part 1, "Ecologies of Invasion," begins with a chapter by Stephen Pyne about the history of fire in Europe and the subsequent spread of European fire philosophy throughout the world. Pyne points out rather convincingly that Europeans saw very little difference between controlling fires and controlling people. They used fire suppression as a powerful administrative tool to incorporate lands and people into their domain. Pyne's contribution is followed by a chapter written by Eric Rolls, who outlines how ecological invasions and an inadequate understanding of local environmental conditions by the British had devastating consequences for Australia. The third and final chapter in Part 1 is by Timothy Flannery, who examines the destiny of British settlements in Australia. He ties their fate directly to the ecology of the land in which they settle.

Part 2 of *Ecology and Empire* is called "The Empire of Science." Its four chapters examine the tensions between science introduced from the core (Europe) to the periphery (settler societies). Libby Robin discusses ecology not just as a way of describing the natural world, but also as a philosophy and ideology. Ecological research in Australia, as influenced by the British, became a vehicle to make exotic biota economically useful at the expense of understanding indigenous species regardless of their economic and ecological value. Thomas Dunlap follows Robin's piece by outlining the development of ecological concepts in the United States and Great Britain and their transmission to scientists in Australia and New Zealand. William Beinart then takes the reader to South Africa by chronicling the critique of transhumant pastoral practices in the Cape by colonial veterinarians, who promoted investment in sedentary stock raising as a way to bring animal diseases under control. Beinart's case study draws attention to the frequent conflict between those steeped in traditional scientific training and those instilled with intimate knowledge of local environments. The last chapter in Part 2 is by J.M. Powell, who provides a detailed history of water management in Australia, par-

ticularly Victoria, to reveal how the importance of domestic technology has been underestimated in efforts to provide Australians with adequate water supplies.

Part 3, "Nature and Nation," begins with a chapter by Jane Carruthers, who takes us back to South Africa. She examines the imperial dynamic behind the creation of Kruger National Park, Dongola Wildlife Sanctuary, and Pilanesberg National Park. Carruthers shows quite effectively how protected areas can mitigate against, rather than promote, national unity because they are saved **for** people by protecting them **from** people. In the following chapter Richard Grove traces the roots of settler environmentalism in South Africa. Criticism of the environmental impact of British colonialism was primarily a Scottish phenomenon. South Africa's most vocal critic was the Reverend John Croumbie Brown, a Scotsman employed by the Cape Colony in the 1860s to advise on the biological aspects of settlement. The final chapter in Part 3, written by Brigid Hains, is an engaging account of the life of John Flynn, the Australian missionary who created the Flying Doctor Service to serve populations in the remote and inhospitable interior. Hains draws parallels between the life of Flynn and the life of Douglas Mawson, an icon of resourcefulness in Australia for his successful expeditions to Antarctica nearly ninety years ago. Flynn and Mawson subscribed dearly to the values of progressive conservationism, both in their encounters with ecological frontiers and in their visions of defining the relationship between settlers and nature.

Part 4 is called "Economy and Ecology." It contains three chapters, the first by Michael Williams. He compares deforestation in Australia with deforestation in the United States, New Zealand, India, China, and Japan. In all cases, perhaps with the exception of Japan, deforestation has been the most blatant manifestation of ecological imperialism, a term used by Williams in reference to environmental change as a result of the penetration and/or conquest of one group by another. In the following chapter Elinor Melville shifts the stage to Latin America, where she assesses the rise of capitalism and the associated environmental impacts from 1519 to 1810. Melville argues that the capitalist mode of production cannot be used to explain environmental change in Latin America until the nineteenth century, prior to which there was no clear-cut global division of labor. The global system of exchange was rather characterized by inter-oceanic trade controlled by Europeans **and** local trade carried out within and between independent producing regions controlled by indigenous traders, Europeans born in the Americas, and immigrant Spaniards who married locally. Shaun Milton concludes Part 4 with a chapter about the beef frontier in South Africa's Transvaal. State intervention in traditional pastoral strategies created a racially demarcated landscape and did little to promote a commercially viable and environmentally sustainable cattle industry. Milton's chapter, like the two others in Part 4, illustrates how invading market economies and the assertion of colonial authority confront and interact with indigenous or settler livelihoods.

The fifth and final part of *Ecology and Empire* is called "Comparing Settler Societies." It contains two chapters that claim to provide broad historiographical perspectives of material presented in this book. John MacKenzie discusses four tendencies of imperial environmental history: 1) an apocalyptic model fueled by green histories; 2) the neo-Whiggish framework, which is a postmodern antidote to the apocalyptic model; 3) the longer perspective, which evaluates not only local resistance to colonial policy but also indigenous submission and collaboration;

and 4) the fully integrated cultural school, which attempts to place environmental issues into their full socioeconomic, political, and cultural context. The last chapter of *Ecology and Empire* is written by David Lowenthal. He unpacks six interrelated themes in the book by arguing that we need to appreciate: 1) variation when writing imperial environmental history; 2) diverse perceptions about frontiers and peripheries; 3) the multi-faceted dimensions of environmentalism; 4) the swiftness of ecological change brought about by settler societies; 5) the environmental consequences of indigenous livelihoods; and 6) the unavoidability but frequent desirability of biological invasions, as both nature and culture can benefit from intermingling.

Most of the chapters in *Ecology and Empire* are thoughtful and thoroughly researched. Of particular note is the contribution by Melville, which is clearly written, exposes the simplistic seduction of dependency models, and adds immensely to our scarce knowledge of environmental history in Latin America. Melville, however, takes the reader to 1810, when Spanish colonies in the New World began to gain independence. An interesting extension of her work would involve a (post)colonial analysis of the livestock industry in the Southern Cone, in which the British played an extremely influential role. It would have been most welcome in this book given its focus on British imperialism, which incidentally could have been suggested in the title. One exception to a set of otherwise solid contributions is the chapter by Flannery. He casts his comments about Australia's evolutionary and cultural history in terms of environmental determinism, even suggesting that "... without a detailed understanding of the environmental determinants of life, the significance of human cultures must remain obscure" (p. 49).

While *Ecology and Empire* is generally strong in content, it is plagued by organizational deficiencies. The structure of the book is not clearly presented in Griffiths' introduction, nor does Lowenthal's last chapter bring about effective closure. Strong introductory and concluding chapters by the co-editors would provide this volume with much needed cohesiveness, as would cross-referencing among its authors. Few passages in the book lead the reader to believe that the contributors evaluated one another's work as they prepared and revised their manuscripts. *Ecology and Empire* also lacks sufficient tables and illustrations. For example, the first table does not appear until Chapter 11 even though many chapters contain data suitable for tabular presentation, and maps are largely, although not entirely, absent from this book. Many of the authors, while thoroughly addressing the temporal dimension of the material they present, have neglected to convey its spatial dimension adequately. The absence of cohesiveness and largely aspatial perspective in *Ecology and Empire* detracts from what would otherwise be an exceptionally strong book. Nevertheless, despite the shortcomings outlined above, this book is worthy of reading lists for courses dealing with the history of European imperialism, and it would make a useful addition to the personal library of anyone interested in the burgeoning field of environmental history.

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TLEIKW AANÍ, THE "BERRIED" LANDSCAPE: THE STRUCTURE OF TLINGIT EDIBLE FRUIT RESOURCES AT GLACIER BAY, ALASKA[1]

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ASTRACT.– This paper analyzes the structure of a relatively neglected resource in Tlingit and Northwest Coast ethnology: berries. Historically, like salmon streams and other key resource areas among the Tlingit of Southeast Alaska, prime berry patches were named, owned, managed, and celebrated as places. Certain berries, including those found in the vicinity of Glacier Bay National Park, were recognized as being of exceptionally high quality and abundance. Glacier Bay berries were internationally renowned, widely traded, and comprised an important nutritional component of the diet and symbolic element in ceremonial feasts. Maintaining the productivity of prized berry patches involved a variety of techniques and strategies to control supply and demand and thus avoid shortages. Despite National Park Service restrictions on hunting and fishing in Glacier Bay, berry picking remains an important communal subsistence activity in the park—one relatively free from controversy and competition—that continues to bind modern Tlingit groups to their ancient homelands.

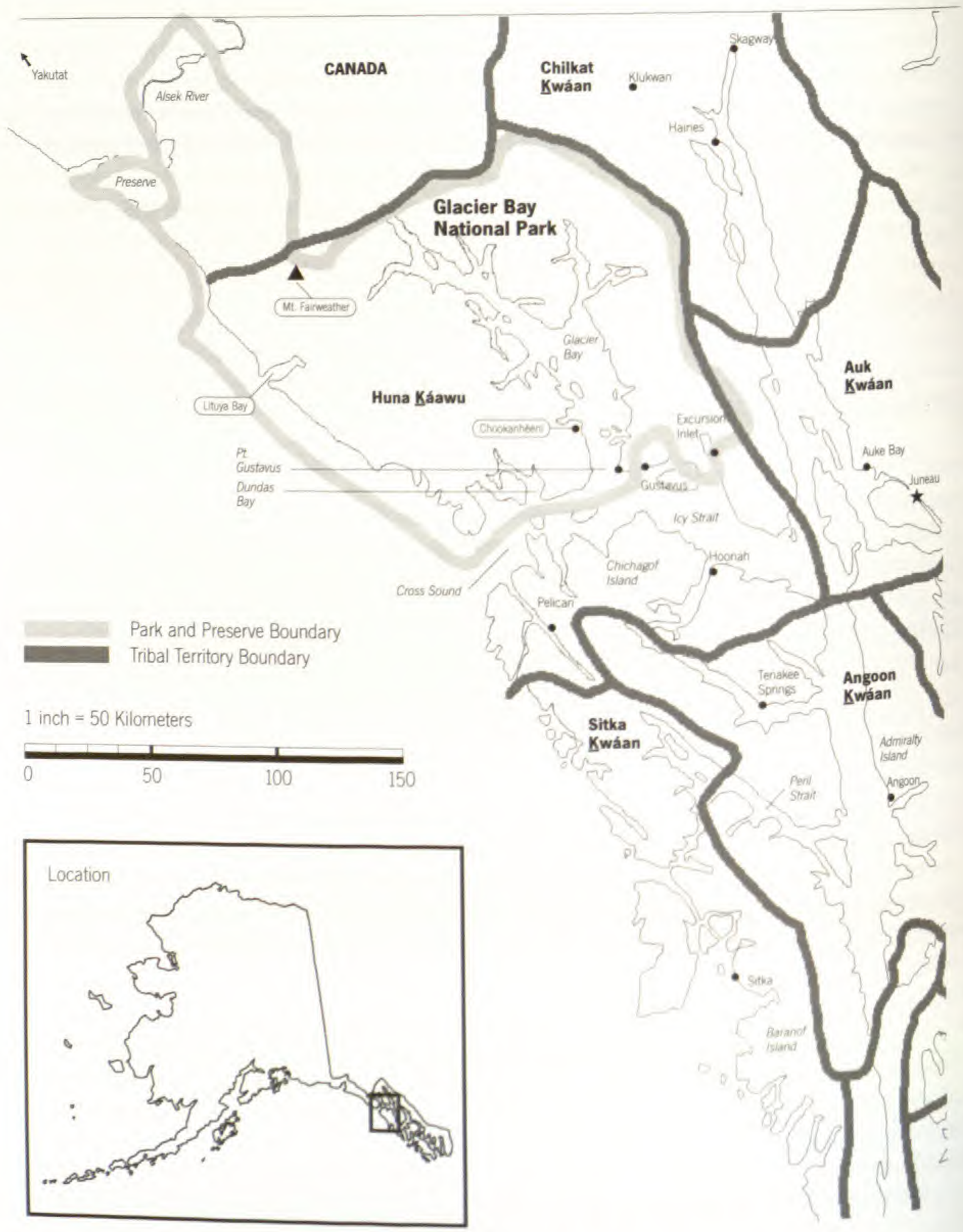
Key words: Tlingit, berries, traditional knowledge, ethnogeography, subsistence

RESUMEN.–Analizo la estructura de un recurso algo descuidado en la etnografía de loso Tlingit y otros grupos indígenas de la costa noroeste de Norteamérica: las bayas. Historicamente, igual que los riachuelos de salmon y otras áreas de recursos claves entre los Tlingit del sureste de Alaska, bancales excelentes de bayas se nombraban, poseían, manejaban, y celebraban como lugares. Ciertas bayas, incluso esas encontradas alrededor del Parque Nacional de Glacier Bay, se reconocían de calidad y abundancia excepcional. Las bayas de Glacier Bay eran renombradas internacionalmente, trocadas por todas partes, y comprendían un importante componente nutricional del dieta y un elemento simbólico de fiestas ceremoniales. El mantenimiento de la productividad de mancales primeros de bayas exigió una variedad de técnicas y estratégias para controlar la oferta y demanda y por eso evitar insuficiencias. A pesar de restricciones del Servicio del Parques Nacionales en la caza y pesca en Glacier Bay, la recolección de bayas se queda una importante actividad comunal de subsistencia en el parque–una actividad relativamente libre de controversia y competencia–que siga atando a los grupos Tlingit de hoy a sus tierras antiguas.

RESUMÉ.– Ce papier analyse la structure socio-écologique d'un produit très important mais peu connu parmi éthnographes des indiens au nord-ouest d'amérique: les baies. Comme des ruisseaux de saumon et d'autres sites de subsistence chez les Tlingit, les parcelles de baie étaient nommées, cultivées, et célébrées comme lieux de mémoire. Certains baies de meilleur qualité étaient abondants, même ceux à Glacier Bay. Traditionellement, une diversité des techniques et des stratégies avait été utilisé de garantir le productivité des parcelles

de baie les plus estimés. D'Autrefois, des baies de Glacier Bay, rénommés de tous pays, servaient d'un moyen d'échange et comprenaient un rôle très important dans la nourriture quotidienne et dans les fêtes cérémoniaux. Aujourd'hui, malgré la réglementation de la chasse et de la pêche à Glacier Bay par le National Park Service, on y continue à cueillir des baies comme une activité de subsistence très importante. Exempt de grand débat politique ou d'intérêt commercial, la cueillette de baies continue à lier les Tlingits moderns à leurs pays anciens et traditionels.

Figure 1: Glacier Bay National Park and Huna Tlingit Territory



INTRODUCTION

"Today as I talk I see my grandfather on that beach, I see my uncle. I see them all because that's where they were in love with. And I can't help but place my love there because it provided for them, like an icebox"– Richard Dalton, Huna Tlingit T'akdeintaan leader, at his homeland, Dundas Bay, in Glacier Bay National Park, 1996 (Thornton 1998).

The Tlingit of southeastern Alaska use a number of related metaphors to depict the role of Glacier Bay National Park in their economy. The Park comprises a significant portion of northern Tlingit territory (see Figure 1), while most of the rest of Tlingit country lies in the Tongass National Forest, the largest temperate rain forest in the U.S. In English Glacier Bay has been described by Huna Tlingits (whose present day village, Hoonah, contains many of the descendants of the original inhabitants of the bay) as their "storehouse," their "icebox," their "refrigerator," even their "breadbasket" (cf. Goldschmidt and Haas 1998:54,131). These seemingly anachronistic container metaphors are consciously employed by these traditional hunter-gatherers to convey to modern Euro-American audiences the importance of Glacier Bay as a vital source of food. In this sense, they stand in stark contrast to the dominant Euro-American metaphor of Glacier Bay as a wilderness landscape, a pristine park that is uninhabited and unspoiled by human intrusions.

Are there analogs to these container metaphors in Tlingit language and culture? Our ongoing research on indigenous place names in Glacier Bay (Thornton 1995) suggests that there is at least one correlative image: Glacier Bay as the "Big Dish." This metaphor derives from a subregional place name, ***S'ix' Tlein***[2] ("Big Dish"), which refers to the lower reaches of Glacier Bay and to Icy Strait, the waterway which feeds the bay and which Huna Tlingits have traversed for centuries to reach their "icebox." According to Tlingit etymologists the moniker springs from the fact that this region is so rich and bountiful in resources that it "supplies all of our food." For some interpreters, there is also the sense that it is a shared dish, like the traditional feast dishes of yore, which could approach the size of a small dugout canoe, and were filled with more than enough food to supply all of the guests at a large memorial feast, or potlatch.[3] In modern Tlingit, these dishes are referred to as ***Gidjidwan s'ix'***, or King George dishes, an obvious post-contact term.

But, unlike refrigerators and iceboxes, feast dishes are deeply rooted in Tlingit culture. In addition to serving as repositories for great gifts of food proffered by host clans to their guests at ceremonies, their contents also communicated important cultural values, such as wealth and generosity (cf. Kan 1983, 1989:209).

Among the most important foods to be served at any winter ceremonial were berries. There is a point in every memorial potlatch, the central ritual of the Tlingit which completes the cycle of mourning for the deceased, where gifts are distributed to guests as thanks for their attendance and participation in the healing and bolstering of the host clan. Traditionally among the most celebrated of gifts were heaping quantities of berries, especially bearberries, blueberries, huckleberries, nagoonberries,[4] salmonberries, soapberries, and strawberries (see Table 1) that had been preserved (typically through drying) and were served with fish oil or

seal grease in huge feast dishes. Always the last to be served and the most esteemed were the whipped soapberries, or "Indian ice-cream"(de Laguna 1972:409-10; Emmons 1991:309; Jacobs and Jacobs 1982; cf. Kuhnlein and Turner 1991:162; 'Ksan 1980), the spectacular multiplying effects of which were a climax of the ceremony. Ritual protocol calls for the hosts to honor prominent guests by providing them with a large feast dish brimming with fruit and then formally inviting them to eat it ***du xwaa x'utín*** (translated as "with pals and buddies"). In this way the honoree and his family and friends are "recognized" and compensated for their role in the ritual cycle. The guests, in turn, respond by acknowledging the gift with rousing thanks and then immediately emptying the dish of its contents.[5]

Some Northwest Coast ethnographers (e.g., Codere 1950 on the Kwakiutl; Olson 1967 on the Tlingit) emphasize the competitive and rivalrous flavor of this potlatch feasting and its relationship to the hierarchical sociopolitical structure of Native Northwest Coast societies. But others have demonstrated that the emotional, communal, and healing dimensions of the ritual consumption are just as important (cf. de Laguna 1972; Kan 1989). Certainly both elements are present. Traditionally, according to Emmons (1991:309), those that "ate the most, however sick it might make [them], honored the host the most." At the same time, the feasting never fails to bring levity and good feelings to an occasion that to this point has been solemn and formal. We get a sense of this from Albin Johnson's (1924, in de Laguna 1972:410) description of the distribution of soapberries at an early twentieth century potlatch in Yakutat, a Tlingit community just north of Glacier Bay National Park.

> At the big potlatch feasts the best dishes are made from these berries. A large tray is employed, fill it half with water, and mix in a piece of the above-mentioned cakes [dried soapberries]. Two young men work the mush till the foam flows over the edges, beautifully rosy red, and then the tray is carried around to the feasting crowd. Everyone presses in the direction of the tray in order to grab a handful of the 'ice cream.' In this way each one is given a chance to taste the dish as long as it lasts, which is not very long. These berries are not delicious, but bitter, and they are eaten mainly according to old custom and because of their beauty.

Thus the presentation of the berries and communal feasting on the summer fruit are linked symbolically not only to the negotiation of status between hosts and guests, but to the raising of peoples' emotions and communal spirits after a wintry period of death.[6] So important are the symbolic values of berries in this alimentary communion-at least in the case of soapberries-that they transcend matters of taste.[7]

Berries also were said to "hold" or represent the landscape from whence they came and thus symbolized Tlingits' material, social, and spiritual ties to the lands that nurtured them. Thus, the spirit of a deceased descendant of Glacier Bay would be especially honored if berries from his homeland were served at his memorial. This organic connection between the deceased and the fruits (or other foods) of the potlatch might even be woven into the ritual oratory that graced the proceedings. These links endure today in potlatches, and though non-local fruits, such as

apples and bananas, are sometimes substituted, Native berries are still preferred for their taste and symbolic values.

As with other key Tlingit resources, such as salmon, halibut, herring, deer, shellfish, and seals, there is a great deal of traditional ecological knowledge surrounding berries. Acquiring large quantities of berries for sustenance and ceremony demanded an intimate knowledge of local habitats, effective organization of labor for harvesting and processing the fruits, as well as some practical measures for controlling the supply and demand of berries. Berries, after all, are the quintessential "patchy" resource (cf. Winterhalder and Smith 1981), and landscapes that possessed abundant and predictable quantities of berries were treated as hereditary property by matrilineal clans and their sub groups (houses), the central units of Tlingit social structure (Emmons 1991:151). Indeed, the matrilineal clan-based social organization provided the basis for acquiring and maintaining berry patches, transmitting traditional knowledge about berrying, organizing labor for harvesting and processing, and, finally, for distributing the resources through sharing, trade, and ceremonial networks. A few special places, like Dundas and Glacier bays within Glacier Bay National Park, were productive enough to earn the nickname ***Tleik̲w Aaní***, "Berry Land," and were known throughout Tlingit country and beyond. These berry patches were not only owned and defended but celebrated and even cultivated by means of ***heix̲wa***, or "magic," and other techniques believed to enhance productivity.

Although Glacier Bay berries are exceptional by Tlingit measures, it is clear that other edible berries and productive berry patches were similarly esteemed and exploited by other Native peoples throughout western North America. In this sense, "the berried landscapes" of Glacier Bay offer an excellent case study for examining the structure of a relatively neglected but key dietary, economic, and symbolic resource among Northwest Coast Natives. After describing the historical development and conceptualization of Glacier Bay berry patches as landscapes among the Tlingit, this article analyzes the structure of berries as non-human persons and "renewable" resources among the Tlingit and other indigenous peoples of the Pacific Northwest. The article concludes that selected berries in Glacier Bay were cultivated and managed and that these resources continue to be an important cultural tie to the area today for local Tlingits.

THE "BERRIED" LANDSCAPE

> *"Glacier Bay is the best place for berries."*– Richard Sheakley, late leader of the Tlingit, T'ak̲deintaan clan, which claims parts of Glacier Bay National Park. (Thornton 1998)

Tlingits harvested wild fruit from a wide range of plants, many of which thrive in Glacier Bay. These fruits are popularly known as berries. In addition to being a major source of sugar and carbohydrates for the pre-contact indigenous peoples, berries contained other important vitamins and minerals, including vitamins A and C, calcium, iron, niacine, riboflavin, and thiamine, many of which were lacking in other foods (see Norton 1981; Newton and Moss 1984:23, 41; Kuhnlein and Turner 1991). Like other prestigious Native foods, Tlingit report "craving" these

berries, especially during the spring and summer. Even berries considered to have a bland, bitter, or sour taste were coveted and often were rendered palatable by combining them with other foods (see Thornton 1998).

Aside from the edible fruit, Tlingits valued other parts of the plants. The leaves of berries, ***kayaaní***, were also consumed and considered to be a vital sign of spring and a potent "spiritual"medicine. At one time, bearberry leaves were smoked as tobacco, and other berry leaves were used to make teas. The roots and stems of berry plants generally were not used, although the shoots of young salmonberries (and, less commonly, thimbleberries) were an esteemed early spring supplement to the diet (Emmons 1991:151). The term ***kayaaní*** is a synonym for medicine in Tlingit. Shamans, in particular, were trained in the arts of ***kayaaní*** and could harness the power of plants to promote healing, awareness, strength, affection, and other ends, including changes in weather. It could be dangerous for one without knowledge of these arts to pick or handle plants casually or to introduce them into new settings.[8] Although much of this traditional knowledge is lost today, many elders, especially elderly women, are still familiar with the medicinal qualities of plants (Thornton 1998).

TABLE 1.– Berries Commonly Harvested at Glacier Bay National Park with Seasonality

Common Name	Tlingit Name	Scientific Name	Spring	Summer	Fall
BERRIES	tléik̲w		x	x	
Bearberry (kinnikinnick)	tínx	Arctostaphylos uva-ursi	x	x	
Blueberry, (generic and oval-leaved)	kanat'á	Vaccinium ovalifolium	x		
Blueberry, Alaskan (ripens later)	naanyaa kanat'aayí	Vaccinium alaskaense	x	x	
Blueberry, bog	ts'éekáx̲k'w	Vaccinium uliginosum	x	x	
Blueberry, dwarf	kakatlaax̲	Vaccinium caespitosum	x		
Cloudberry, yellow	nex̲'w	Rubus chamaemorus	x		
Cranberry, bog	k̲'eishkaháagu	Oxycoccus microcarpus	x	x	
Cranberry, highbush	kaxwéix̲	Viburnum edule	x	x	
Cranberry, lowbush (ligonberry)	dáxw	Vaccinium vitis-idaea	x	x	
Current, gray	shaax̲	Ribes bracteosum		x	x
Current, swamp	kaneilts'ákw	Ribes lacustre	x	x	
Elderberry, red	yéil'	Sambucus racemosa	x		
Huckleberry, red	Tleikatánk	Vaccinium parvifolium	x		
Nagoonberry	neigóon	Rubus Arcticus	x		
Raspberry	tlek̲w yádi	Rubus idaeus (R. pedatus)	x		
Salmonberry	was'x'aan tléigu	Rubus spectabilis	shoots	x	
Soapberry	xákwl'i	Sheperdia canadensis		x	
Strawberry, seaside	shákw	Fragaria chiloensis		x	
Thimbleberry	ch'eix̲'	Rubus parviflorus	shoots	x	

Table 1 shows the berries that are found in abundance in Glacier Bay National Park and Preserve and the seasons of harvest by Tlingits from Hoonah and neigh-

boring communities. In most areas of Southeast Alaska, salmonberries were the most abundant species and the first to be harvested, usually in July. Not surprisingly, the general term for berry is associated with this fruit. Blueberries, cranberries, gray currents, huckleberries, and thimbleberries were also common and could be found on both the islands and the mainland. In contrast, other fruits, including bearberries, nagoonberries, soapberries, and strawberries were largely confined to the mainland (with a few well-known exceptions), making them a desirable commodity for trade to the islands. Glacier Bay was known to be the best source of these mainland berries in Northern Southeast Alaska, and some species, such as soapberries and nagoonberries, were traded internationally as far south as Haida country (cf. Norton 1981).

Historical Ecology.– While Alaska as a whole is renowned as a land of berries, Glacier Bay is a uniquely productive environment for these plants. Both natural and human circumstances have contributed to Glacier Bay's emergence as a coveted berry picking site.

Because of its unique geologic history, Glacier Bay has emerged as particularly productive habitat for berries. Like the bay itself, the plant life in Glacier Bay has been shaped largely by the forces of glacial advance and recession. Just two hundred years ago, in 1794, when George Vancouver's pioneering expedition ventured into Icy Strait, they found nothing but a massive wall of ice and a small bight at the mouth of Glacier Bay. Yet, within the two centuries, a geological instant, this bight has grown to be one of the largest, richest and most dynamic ecosystems within Southeast Alaska.

By the time John Muir arrived in 1879, seeking to understand the dynamics of glaciation, the ice had retreated nearly 50 miles and plants and other species had begun to re-inhabit the land. As he made his way up the bay, Muir (1895) observed the succession of plants in reverse, beginning with the maturing forests of alder and spruce at the mouth and regressing back to the newly uncovered rock and rubble at the foot of the retreating glacier. In between was a rich array of edible plants, including a variety of berries. While newly exposed areas revealed only sand and rubble, berry plants were among the first to return to the sandy soils, making use of the bed laid down by algae and mosses. Tlingit oral history and recent scientific studies of the interstadial forests in the upper reaches of Glacier Bay suggest that the process of plant succession has been repeated at least several times in Glacier Bay. Each time the mature forest was leveled and cleared by glacial advance, only to be exposed again in the subsequent retreat as flattened forelands primed for succession. Two major warming periods-one between 10,000 and 4,500 years ago and the other from 1750 to the present-have each produced habitat conditions stable enough for berry lands, forests, animals, fish, and, therefore, people (cf. Ackerman 1968; Powell 1995, Thornton 1995).

Combined with other features of the landscape, such as well-drained soils, and comparatively favorable exposure to sunlight, these conditions made Glacier Bay an ideal habitat for bearberries, gray currants, nagoonberries, soapberries, and strawberries. With few exceptions, these resources are not found in comparable abundance elsewhere in Tlingit territory, and in some cases were rare. In contrast, the major varieties of blueberries and salmonberries, otherwise the most

common and evenly-distributed of the Tlingit fruits, were not exceptionally productive in Glacier Bay due to their habitat preference for damp woods and moist clearings. These habitat distinctions are reflected in the Tlingit ethnogeography of the Glacier Bay region, and the relative patchiness of key berry resources had important implications for the structure of the foods in the Tlingit economy.

Ethnohistory and Ethnogeography.– Precisely when the human inhabitants of Glacier Bay began to harvest berries is a matter of some speculation. Archeological and ethnohistorical records suggests at least a punctuated human presence in the Glacier Bay area dating back nearly 10,000 years (Ackerman 1968). It is likely that the earliest inhabitants utilized available patches of berries during their initial occupation of the area and took advantage of new concentrations of berries that emerged as the result of succession following glacial retreats. Significantly, elements of the archeological and geomorphological records correspond with Tlingit oral history (cf. Powell 1995; Thornton 1995;).

Tlingit history relates that Glacier Bay was settled originally by what are today four distinct matrilineal clans of two reciprocating moieties: the Chookaneidí ("People of ***Chookanhéeni***" or "Beach Grass Creek," a reference to Berg River / Bay), the Kaagwaantaan ("People of the Burned House"), and the Wooshkeetaan ("People with Houses on Top of One Another") of the Eagle/Wolf moiety; and the T'a<u>k</u>deintaan ("People of the House Toward the Side" [of a particular island on the Outer Coast of Glacier Bay National Park]) of the Raven moiety. A fifth group, the <u>K</u>uyei<u>k</u>eidí ("People of ***<u>K</u>uyei<u>k</u>'***" [Excursion Inlet]), also of the Raven moiety but now extinct (or perhaps transformed into the Lukaa<u>x</u>.ádi of Haines as suggested by Emmons [n.d.]), reportedly dwelled at Excursion Inlet.[9] All of these groups take their names from landmarks or settlements in the vicinity of Glacier Bay. The Eagle groups were said to have migrated to Glacier Bay from the Interior—via the mainland rivers, braving treacherous ice dams on their descent—while the Raven groups trace their origins to the coast (cf. Swanton 1908; de Laguna 1972). Oral histories from these clans suggest that there has been at least one major advance and retreat of the ice during their occupation of Glacier Bay, perhaps corresponding to the so-called "Little Ice Age" which began some 900 years ago and ended around 1750.

These clan histories and stories reflect the deep ties and organic relationships between these Tlingit clans and their homeland. They recall how events happened in the lives of the groups' ancestors, how they came into being and how they evolved at certain places. The narratives themselves are sacred property, or *at.óow* (literally, "owned things") and typically reference other sacred property of the clan, such as crests, spirits, songs, names, and various elements of the geography, which are also considered ***at.óow*** (cf. Dauenhauer and Dauenhauer 1987:14-17). The most vivid account of dramatic glacial shifting in Glacier Bay is contained in the Chookaneidí story of Kaasteen, several versions of which have been published (Dauenhauer and Dauenhauer 1987:245ff; Culp, et al 1995). In this story the young Chookansháa (Chookaneidí girl), Kaasteen, violates her prescribed seclusion at menarche by communicating to a glacier, which responds by advancing rapidly, thus destroying the settlement in the bay, claiming the life of a Chookaneidí woman who remains behind, and forcing the exodus of the Tlingit from Glacier Bay.

Place names provide another important index of the natural and cultural history of Glacier Bay (Thornton 1995, 1997a, 1997b). Both the Tlingit and English toponymies shed light on Glacier Bay National Park and Preserve as berry habitat. While most berrying locales are not identified as such by their names, semantic references to berries do occur in both sets of place names. In all cases these references are based on metonymic associations, wherein a part of the environment-the berry—comes to stand for the place as a whole. Thus, in English we have Strawberry Island and Strawberry Point (a.k.a. Point Gustavus), examples of metonymy based on the salient prevalence of this resource at the site. Similarly, the Tlingit also reference Point Gustavus as "Strawberry Point" (***Shaakw X'aayí***), though the feature is more commonly known as ***S'e X'aayí Lutú*** ("Clay Point"). Interestingly, while it is sometimes referred to as ***Shaakw X'aat'í*** ("Strawberry Island), the original Tlingit name for Strawberry Island is ***L'eiw X'áat'i***, or "Glacial Sand Island," indicative of the island's habitat at an earlier stage of succession, prior to proliferation of strawberries.[10] Another example from the Tlingit is ***Tínx Kayaaní***, literally "Bearberry Leaves" from the bearberries that dominate this Alsek River landscape, which were used in traditional Tlingit tobacco and medicine and gathered in conjunction with the berries themselves. In addition to these well-known place names there are also regional nicknames, such as the aforementioned ***Tléik̲w Aaní*** ("Berry Land"), applied to Dundas Bay and sometimes to the lower portions of Glacier Bay, or ***Shákw Aaní*** ("Strawberry Land"), given to the area between Gustavus and Point Gustavus.[11]

All of this suggests that, from a Tlingit perspective, the shores of Glacier Bay National Park were "berried" landscapes. The ethnogeography and ethnohistory of the region emphasize the significance of berries as a salient presence on the land and corroborate the ethnographic reports detailing Tlingits' strong cultural interest in these plants. Now we turn to a closer examination of the structure of the resource in the traditional social economy from an ethno-ecological and universalist perpective.

THE STRUCTURE OF A "RENEWABLE" PLANT RESOURCE

Despite being recognized as "the most important plant food" (de Laguna 1972:407) and, with salmon, "the staff of life" (Niblack 1890:276) among Natives of the region, berries, like other "gathered" resources (see Moss 1993), have not been the subject of significant anthropological inquiry among the Tlingit.[12] Yet, as an economic resource, berries have much in common with other patchy resources that were hunted and fished. Like the well-studied salmon (cf. Schalk 1977), for example, berries are not only patchy in space but also in time, and their "arrival," like the "return" of the salmon, is subject to a great deal of variation, depending on weather and other factors. We also find that different species of berries, like the five species of Pacific salmon, occur at different frequencies throughout the region, and that each species is valued according to culturally defined criteria, such as taste, aesthetics, and preservation qualities.

Data from throughout the Northwest Coast show that patches of edible plants were not only named and owned but burned, replanted, and weeded, suggesting intentional conservation and resource management (see Norton 1981:435; Turner

1991; Johnson Gottesfeld 1994). If we define conservation and management as *effective practices by humans to ensure a sustainable supply of a resource,* then Tlingits can be said have conserved and managed berries.

However, it can be misleading to think of Tlingit conservation solely in terms of Western ideologies of resource conservation, because, as we will see, Tlingit ideas about the nature of plants stem from a different environmental ideology and worldview.

The Ethno-Metaphysics of Berries.– To assess the value of any food or other resource within the economy of a people, we must evaluate not only its material contribution to the economy but also the metaphysical nature of the resource from an indigenous perspective. For as Hallowell (1955) suggests, cultural beliefs about the nature of any element of the cosmos ultimately help to shape the "behavioral environment" in which individuals act. As a consequence, the ethnographer cannot assume, ethnocentrically, that berries are inherently less animated or potent than creatures that run or swim or have teeth, for an investigation into the ethnometaphysics (Hallowell 1976 [1960]:358) of the resources may reveal that they are not lesser in these respects and that they require comparable levels of knowledge and technique for successful harvest.[13] This is the case among the Tlingit, and in this sense berries may be said to constitute a "salient presence" on the landscape beyond passive foodstuffs—as members of a non-human community of beings. Hence we find that berries are personified in narratives and other cultural forms.[14]

A key aspect of Tlingit metaphysics is that the universe itself is a community of living beings which have inner forms (spirits or ***yeik***) as well as outer forms, all of which (including plants) had to be treated with respect. If plants and animals were not shown proper respect, they would cease to make themselves available to, or in some cases even harm, humans. To violate prescriptions for interacting with various elements of the cosmos was considered ***tligaas*** or taboo—literally "against nature" (cf. Swanton 1908; de Laguna 1972). Combined with other practices of controlling supply and demand of berries, these beliefs and customs can be said to constitute a framework for the conservation and management of resources.

Traditional knowledge concerning the nature of berries is embedded in Tlingit oral history and environmental knowledge that has been passed down from generation to generation. The cultural value of berries is reflected, for example, in the famous Raven cycle of stories, perhaps the oldest and most widespread corpus of narratives, wherein the Trickster bird throws lavish parties featuring fresh berries saturated in seal and fish oils. In one story, the ever-resourceful Raven, finding his seal oil supply depleted, discovers a new delicacy to serve his guests: a combination of salmonberries and *shatu taayí*, the fat from the eyeballs of sockeye salmon. According to the narrator, "The entertainment was a success and the recipe the raven drew up was used for many years until sugar was introduced; no oil, [or] sugar was required when shuntu tyi [***shantu taayí***] was used." (in Newton and Moss 1984:23-24).

Other stories stress the role of berries in survival and renewal. In "The Boy who Shot the Star," for example, the protagonist shoots arrows at a star next to the moon, darkening it. Eventually the arrows form a kind of chain ladder extending down to earth from the above-world, which the boy decides to ascend. Before doing so, however,

> [the boy] took various kinds of bushes and stuck them into the knot of hair he wore on his head. He climbed up his ladder all day and camped at nightfall upon it, resuming his worlds above the earth. When he awoke early on the second morning his head felt very heavy. Then he seized the salmon berry bush that was in his hair, pulled it out, and found it was loaded with berries. After he had eaten the berries off, he stuck the branch back into his hair very much strengthened. About noon of the same day he again felt very hungry, and again his head was heavy, so he pulled out a bush from the other side of his head and it was loaded with blue huckleberries [blueberries]. It was already summer there in the sky. That was why he was getting berries. When he resumed his journey next morning his head did not feel heavy until noon. At that time he pulled out the bush at the back of his head and found it loaded with red huckleberries. (Swanton 1909:210)

Like other Northwest Coast creation stories that detail how the first humans were fashioned from berry leaves (and for this reason die quickly; see Boas 1916:663-664 for a Tsimshian example), this narrative also highlights the organic and corporeal connections between humans and berry plants.

Indeed, aboriginal Tlingit ecology held that humans play an integral role in the maintenance and regeneration of plant and animal species through activities associated with the harvest. One basic tenet of this ecology is that berries are "there to be picked," and if they are not harvested, they may "die off" or fail to bear fruit for a period of time. Thus consumption helped to make the berry a "renewable" resource. This idea evidently stems from an even more basic ethno-metaphysical principle that is found among all Alaska Native groups, namely that berries, like all plants and animals and other elements of the cosmos, possess an agentic spirit or inner form, which must be treated with respect. If treated properly, the plant will be renewed, but if its spirit is ignored or offended, it may withdraw its support of life-sustaining resources. Among the Yup'ik Eskimos (Yupiit), these inner forms of nature's entities are conceptualized as "their persons" (*yuit*) and were treated as such. Thus, Himmelheber (1987:33, cited in Fienup-Riordan 1994:58) observed that, "Before we go berry-picking we always bury some food, for example fish, in the tundra. It is for the little men [***yuit*** "their persons," plural possessed of ***yua***] who live in the berries so that they will provide a rich harvest." In Tlingit these agentic inner forms or spirits are termed ***yeik*** or ***yakwaheiyagu***, and traditional berrying practices included a similar practice of "feeding" salmon eggs to nagoonberry and strawberry patches to nourish the plants and their ***yakwaheiyagu***, thus helping to ensure a bountiful harvests in the future (see below). Fienup-Riordan (1994) suggests for Yupiit that such acts of "feeding the land" also fed the human dead.[15] This connection is also implicit in Tlingit cosmology, where the spirits of deceased ancestors are believed to continue to dwell on their ancestral lands and are honored and nourished with offerings. Moreover, the connection is reinforced in the potlatch, where the ancestral spirits are fed the products of their lands in the so-called "fire dishes" (***gan s'ix'i***), containing renewable and life-enriching resources, such as berries, from the homeland.

Ownership and Management of Berry Patches.– As noted above, berry patches—like other dense and predictable but "patchy" resources, such as salmon streams,

halibut banks, and clam beds—were celebrated, owned, and defended as material property by matrilineal clans and house groups. Even when patches were not situated near an established village, the possessing clans or sibs that held title to these areas exercised their regulatory powers over them (contra Oberg 1973:40; compare Garfield n.d.). These regulatory powers were aimed at controlling both the supply and demand of resources.

Perhaps the most effective way to control demand on patchy resources like berries was through the development of the territorial system itself. The economic defendability hypothesis, as put forth by Dyson-Hudson and Smith (1978:23; see also Richardson 1982), predicts that territorial systems will develop, "when the costs of exclusive use and defense of an area are outweighed by the benefits gained from this pattern of resource utilization." Such a situation generally develops "under conditions of high density and predictability of critical resources" without a "superabundance" (meaning more than enough resources for all users, thus rendering territorial behavior unnecessary). Many berry patches in Glacier Bay and elsewhere met these conditions and thus were claimed as property. Such patches were defended only in the harvest period, during which slaves or other sentinels might be stationed to guard against intruders or early birds. Shotridge (1984: 172) records that in Klukwan, "if any violator was caught picking...before the day set for all, he never escaped his punishment at the hands of the authorized guards, which was, sometimes, besides losing all that he had picked, to have his canoe destroyed."

While exclusive ownership ostensibly carried with it the power to regulate access, in practice outsiders rarely were forbidden from gathering. In fact almost anyone could harvest berries in owned areas, provided that he or she "paid tribute" by asking permission and, if possible, citing a kinship link to the owners. As de Laguna notes (1960:70), "The last was usually easy to do." Among older Tlingits harvesting berries in Glacier Bay, this protocol is still practiced, as evidenced on a recent gathering trip to Glacier Bay where elders made long speeches relating themselves to the bay's T'akdeintaan owners before commencing to pick nagoonberries (see Thornton 1997a, 1998).

Yet, while "paying tribute" often involved nothing more than asking permission or citing one's genealogical relationship to the possessing sib, there were stern consequences for failing to do so. De Laguna (1972:407-08), for example, cites a case in Yakutat where the owners caught a trespasser in their Knight Island strawberry patch and cut the berry basket from the offender's neck. But the norm was for the outsider to seek permission and for the owners to grant it. During her fieldwork in the 1950s, de Laguna (1972:407) also reports having heard accusations that some women in Yakutat "were still attempting to exercise exclusive control over strawberry patches on sib lands, although this may have been only unfriendly gossip." In cases where a superabundance existed, or patches were too remote to physically defend, territoriality might still be expressed though legal means or through communicative structures such as visual art, narratives, or even gossip.

But communicative structures were used for inclusion as well as exclusion. For example, in 1946 a Chilkat Tlingit elder told land claims investigators that a "chief who owned a berrying area would send a man up to decide when the people should go after berries, and they would set a date to go up there, and he would send an invitation to the people to come up" (Suzie Nasook in Goldschmidt and

Haas 1998:102). From this testimony, it appears that clan leaders also used their knowledge and authority over local patches to facilitate others coming to gather when the berry picking conditions were peak and the supply abundant. By his extending the invitation, it could be argued that the leader was enhancing his prestige and "credit" in exchange for surplus berries, and by responding to the invitation other pickers were, in effect, legitimizing the possessing clan's prerogatives over the territory.

In the contemporary period traditional clan property rights have sometimes given way to individual or community based rights. Individual rights to berry patches in Glacier Bay began to be asserted through western legal means. One such means was the Indian Allotment Act, which required individuals, as opposed to sibs, to file for title to tracts of land and to support their claims based on past occupancy and use. Allotment petitions in Glacier Bay clearly show that certain lands were selected on the basis of traditional rights to important patches of berries, especially highbush cranberries, gray currants, nagoonberries, salmonberries, soapberries, and strawberries. In 1920, for example, a Huna man filed for a tract of land at the mouth of Dundas River. In a letter to the Commissioner of the U.S. Department of Interior's General Land Office recommending rejection of the petition, the supervising agent (GBNPAF) noted that he "was informed by the applicant's nephew that the applicant wants this allotment only so that he can have the exclusive right to pick the wild berries which grow on the land." In the agent's mind, such gathering did not constitute sufficient occupancy or improvement of the lands for the applicant to qualify for title. A similar rejection was recommended for another Tlingit man's allotment application to a tract further up the west side of Dundas River. Here the petition focused on control of coveted strawberry patches:

> The entire tract is covered with wild strawberry plants and during the summer seasons the berries grow abundantly°Several natives employed at the Dundas Bay Cannery stated that the applicant-[name omitted], had made a practice of keeping other people off the strawberry patch during the summer and had charged them $5.00 for picking berries there. It is believed that the applicant's sole purpose in obtaining the land is for revenue from the strawberries which grow there. It was also ascertained that the applicant earns his living by working at the various canneries during the fishing season and by trapping during the winter, and that he only lived on the land applied for during the strawberry season.

Although the agent emphasizes the applicant's intent to capitalize on the strawberry patches by imposing a rent on alien users, territorial systems traditionally also served to limit access-and thus demand-on limited resources. Consequently, the phenomenon known as the "tragedy of the commons," wherein self-interested harvesters seek only to maximize their share of common resources that they cannot control, thereby decimating the supply, was avoided.

But is there any evidence that local supplies of berries were ever stressed by Native demand? Localized shortages and seasonal variation of food resources along the Northwest Coast has been well-documented and could be especially dramatic in the northernmost areas, including Tlingit country (cf. Suttles 1968, 1974; Richardson

1982). In the case of berries, these shortages could be exacerbated, if not precipitated, by periods of high demand. Garfield (n.d.7-8) for example, notes that:

> Preparations for a potlatch were often such a drain on the resources of a group that they asked and received, the privilege of picking berries, fishing, or hunting on the territories of others. For the privilege the owners were compensated in goods, usually during the potlatch itself. Swanton ...describing preparations for a particular potlatch of the Queen Charlotte Haida, says that the members of the house group giving the potlatch went to Telel and Rose Spit to gather berries, paying the owners of the ground five blankets for permission to gather them. Oberg ...states. " In more recent times the Taku [Tlingit] clans are said to have rented their fishing rights to other clans but this is undoubtedly due to white influence."°The Tsimshian have definite rules about the extension of such privileges and payment for them, and the writer is certain that investigation would show that the Tlingit and Haida also have them.

The Huna man's scheme to charge $5.00 to outsiders desiring to pick berries in his patch was thus not unprecedented in Northwest Coast resource tenure, although the individualized nature of his scheme (and perhaps his currency and prices) may have represented a departure from the traditional norm.

While in both of the above allotment cases applicants failed to meet the Western (continuous) occupancy and improvement (building) standards, such standards were unrealistic for a hunting and gathering society like the Tlingit. As Goldschmidt and Haas (1998:17) point out:

> The Native economy of the Tlingit and Haida peoples was geared to this seasonality in a manner no different from the seasonality of a farm enterprise. Indeed, so close is the analogy, that certain groups report hunting and trapping practices which might best be succinctly described by the agricultural analogy "leaving the hunting area *lie fallow* for a season or two." Neither Native life nor modern means of livelihood is possible to the Natives if their territories were limited to those areas that they utilize the year round. The differential production of separate areas means that different portions of their territory complement one another and offer to the people a portion of their total means of livelihood. For this reason any discussion of "continuous" use must recognize the necessary intermittence made requisite by the seasonal limitations on the usefulness of the area.

In Tlingit property law, then, such seasonal occupancy and use patterns, combined with inherited rights, clearly did constitute a sufficient proof for title. Indeed, 62 years after these decisions, on our 1996 field trip to Glacier Bay, Huna elders were still aware of these claims and one pointed out the areas claimed by one of the allotment applicants and explained the stewardship practices he employed to ensure an adequate supply of berries.

Just as important as endeavors to control demand on key berry patches through territoriality and behavioral prescriptions were efforts to maximize the supply. Supply side efforts can be divided into three broad categories: environmental manipulation, redistribution, and technological fixes. Environmental manipulations involve human actions on the land to increase berry productivity. Among Native Americans, such techniques include manipulating ecological succession

(e.g., the use of fire to control forest succession), reducing competition (e.g., weeding), adding inputs (e.g., irrigation or fertilizer), and selection (e.g., domestication). Although there are no documented examples of fire use at Glacier Bay, it was practiced by Natives in the Pacific Northwest to enhance the habitat for favored plants (cf. Norton 1981; Hunn 1990; Turner 1991, Johnson Gottesfeld 1994). However, it seems that Tlingits on occasion did attempt to reduce competition through "weeding" of unwanted plants and brush. One middle-aged Huna man remembered being instructed by his elders to clear alder and other brush from favored strawberry patches so as to prevent the fruits from being choked off by the competitors, and observed others engaging in similar practices at Glacier Bay and Point Adolphus. Yet these practices apparently were not widespread and may have only been adopted along with the advent of gardening in the post-contact era.

Undoubtedly the most important traditional technique employed by the Glacier Bay Tlingit was the addition of inputs to enhance berry production. The most important additive was the egg of the dog salmon (*Oncorhynchus keta*), a resource which to my knowledge has not been previously documented in this context. Especially in Dundas Bay there was a tradition of ensuring the abundant regeneration of nagoonberries and strawberries by "feeding" these plants dog salmon eggs. The eggs, typically obtained from Dundas River, were conceived as an offering to the spirits of the berries, or ***tleikw yakwaheiyagu***. The belief was that these nourishing gifts would enhance the productivity of the berries in succeeding years, for although the plant's outer form may wither and die, its inner spirit endures and gives life to new plant the following year. In western agricultural terms, the eggs could be said to constitute a kind of "fertilizer;" but Tlingits were not satisfied with this analogy, as it does not do justice to the spiritual mechanics of the act. In Tlingit, the term used to describe such acts is ***héixwa***, which is loosely translated as "magic" and broadly refers to any instrumental techniques used by individuals to influence nature for human ends. Thus, although berries were not domesticated, the landscapes they inhabited were, and the fruits themselves were cultivated by means of environmental manipulation.

Other efforts at controlling berry supply, such as transplantation, suggest that Tlingits have tinkered more directly with domestication as a cultivation technique, though perhaps only since the nineteenth century. Enterprising island Tlingit have been trying to transplant the coveted soapberry to their shores for years, apparently with little success. But transplants up and down the mainland were more successful. As de Laguna (1972:409) observed, "Soapberries can now be found in Nunatak Fjord but are apparently a recent intrusion. In the last century they were imported from southeastern Alaska, probably derived from the interior via the Chilkat." More recently, when an island Tlingit elder prepared cuttings of Chilkat soapberries to take back to his home in Sitka, a local relative jokingly reminded him of property rights: "You'd better watch out," he said, "or they're [Chilkat people are] going to carve you on a pole" (i.e., a totem pole intended to ridicule a violator of Tlingit law).

Finally, redistribution of berries in space, through trade (as opposed to transplantation), and in time, through storage, also helped to mitigate issues of supply. Storage and preservation techniques allowed the Tlingit to capitalize on an otherwise fleeting resource and convert it into a year-round resource and trade

commodity. This, in turn, fueled demand and led to increased efforts to boost berry production through the effective organization of labor. Contrary to the common ethnographic interpretation, berrying was not only women's work. Although women typically handled processing duties, men, women, and children harvested, especially when large quantities needed to be obtained (Shotridge 1984; Thornton 1998). As noted above, Tlingit labor was organized along lineage lines, but productivity was enhanced by the matrilineage's possession of non-kin slaves, who assisted with harvesting and processing. This labor allowed surplus supplies of berries to be generated for purposes beyond consumption, such as gifts, ceremonial exchange, and trade.[16]

CONCLUSION

Glacier Bay National Park is a special place for berries, and the berries of Glacier Bay are special to the Tlingit descendants of Glacier Bay. Berries not only formed a significant portion of the overall diet, they were a key source of nutrition, medicine, symbolic capital, and trade goods. Glacier Bay berries were considered of exceptionally high quality and abundance and thus were a celebrated feature of the Tlingit landscape, cultivated to a higher degree than any other plant. A fine-grained analysis of both the ethno-metaphysics and social economy of berries shows why these potent but patchy resources were so valued and carefully managed. Huna Tlingits employed a variety of resource management strategies to maintain or enhance supplies and to control demand in ways that ensured the survival of the resource and, whenever possible, boosted the prestige of owners. Especially important were those berries that could be found in quantity in close proximity to Hoonah—bearberries, nagoonberries, soapberries, and strawberries. These fruits came to stand for Glacier Bay itself, especially in the context of memorial potlatches and other ceremonial gatherings.

Despite displacement from Glacier Bay, first by an advancing glacier and later by an advancing federal government and National Park system (the so-called "Second Ice Age," by Hoonah Tlingit; see HIA 1994), Tlingit ties to Glacier Bay remain strong. And while hunting and many kinds of fishing are outlawed today within park boundaries, berry picking is still legal, and thus represents among the most vital Tlingit subsistence links to their traditional homeland. Indeed, a recent survey by the Alaska Department of Fish & Game among Huna Tlingit seal hunters found that 81 percent those sampled used berries from Glacier Bay, a figure exceeded only by use of king (chinook) salmon and halibut among the dozens of foods harvested for subsistence (Schroeder 1995:287). Economic models alone cannot explain this perseverance, as expenses to obtain them are high and substitute fruits are readily available. Social and ideological factors must be factored into the analysis, for Glacier Bay fruits are still considered special gifts from the homeland, the "Big Dish" (*S'ix' Tlein*), the "Icebox" for Hoonah Tlingit. As elder Frank White (1998) put it, "Glacier Bay was special. When you tell them [Huna Tlingit guests] this is Glacier Bay [food], it meant more to them-more to us than any other place°.We've been there for centuries. It was our home."

NOTES

[1] A preliminary version of this paper was presented at the 1998 American Anthropological Association Meeting in Philadelphia as part of an invited session titled, "Ethnoecology and Kinds of Place—An Examination of Understanding of Landscape." I am grateful to participants of that panel for their constructive comments on the paper, especially Eugene Hunn, Leslie Main Johnson and Eugene Anderson. Madonna Moss and another, anonymous reviewer also provided very constructive suggestions. The initial field research for this study was supported by Glacier Bay National Park through a Cooperative Agreement (CA 9910-6-9027) with the University of Alaska Southeast. I am particularly grateful to Wayne Howell and Mary Beth Moss of Glacier Bay for their assistance. Finally, I want to express my sincere appreciation to the Huna Tlingit Tribe and the many knowledgeable elders who helped me develop a Tlingit perspective on the fruits of Glacier Bay, particularly Ken Austin, Richard Dalton, Ken Grant, Herman and Martha Kitka, Andrew and Alice Johnny, John Marks, Amy Marvin, George Obert, Frank See, Winnie Smith, and Frank White, but also others too numerous to mention. ***Gunalchéesh!***

[2] The spelling of Tlingit words follows the popular orthography developed by Naish and Story and later refined (see Dauenhauer and Dauenhauer 1987:38-47). Tlingit possesses both velar and uvular consonants. Velar consonants are represented in English by the letters g, k, and x, though the latter is pronounced more like the German "ch." The uvular consonants are represented by g̲, k̲, and x̲. Tlingit also features a set of glottalized consonants which are "pinched" between the vocal cords and the mouth. The pinch is symbolized by an apostrophe (e.g., *t'a*, king salmon), whereas a complete glottal stop is represented within a word by a period (e.g., *Ta.aan*, Sleep Town, a place name).

Coastal Tlingit has four long vowels and four short vowels, represented and pronounced as follows:

Tlingit Vowel	As in the English
a	was
aa	Saab (a Swedish car)
e	ten
ei	vein
i	hit
ee	seek
u	push
oo	moon

Vowels may be pronounced with either a high (á) or low (à) tone. In northern Tlingit the low tone is unmarked.

[3] The term "potlatch," apparently derived from the Nuu-Chah-Nulth word *pach'itl* ("to give") and popularized through Chinook jargon, is not a term most Tlingit favor. Tlingits generally use the English word "party" rather than potlatch, or they employ the Tlingit term *k̲u.éex'* ("to invite").

[4] Pojar and Mackinnon (1994:80) observe of *Rubus arcticus*, "The origin of the common name 'nagoonberry' remains a mystery." For Tlingits it is no mystery, however, because nagoonberries take their name from the Tlingit term for the species, ***neigóon***. This is one of the few instances where an English noun is borrowed from Tlingit.

[5] Today the fruits are typically distributed in smaller, commercially made bowls, such as the large stainless steel mixing-type bowls, and while the guests are still required to empty the bowl immediately, the contents are typically packed and taken home for later consumption.

[6] In addition to the memorial potlatch, the ethnographic literature includes references to special "berry feasts" that were held in August in some Tlingit communities (see Emmons 1991:323). And aside from their prominence in ceremonials, berries played an important role as everyday gifts. Carrie Willard (1995), who with her husband, Eugene, served as a missionary in Chilkat territory and resided at Portage Bay near Haines in the early 1880s, was regularly regaled with gifts of berries by local Tlingits. She narrates one visit to an "old chief's" house where her party was graciously received and given "the honorable end of the room," whereupon the chief said:

> He wished that the white man liked the Indian's food; then he show us how they loved us. He had salmonberries: would we eat some? We consented, and a servant brought the wash bowls before the chief's wife, who with her hands filled up the bowl with the beautiful berries°We took up our bowls and, after grace, began to eat with our fingers (1995:24).

This description is important because it details some of the protocol that surrounds non-ceremonial gatherings and the gifting of berries in particular.

[7] This is not to say that all Tlingits do not prefer soapberries for their flavor. Some do. However, many suggest that they are an acquired taste, especially when not properly sweetened with sugar or other berries. Moreover, it seems clear that their value stems more from other qualities, such as their scarcity, performative preparation, aesthetic multiplying effect when whipped, and communal consumption. I was told by several elders that kinesthetic elements of soapberry processing, particularly the whipping motion, were incorporated into Tlingit ceremonial dances.

[8] For example, I was told by one Huna man that his father used to get upset when his sister brought hand-picked wildflowers onto the fishing boat, for he feared they would "jinx" his fishing luck.

[9] In addition, according to Emmons (n.d.) and others, a group called T'ikanaa, or "People of the Pacific side" at one time may have occupied Taylor Bay (***T'ixaa***) and parts of the outer coast.

[10] I have noted elsewhere (Thornton 1995) that "The relative dearth of plant names in both toponymies may be a reflection of glacial scouring and the lack of culturally significant plants in Glacier Bay as compared to other habitats."

[11] An interesting footnote on the whole question of naming is the 1940 attempt by the Washington office of the National Park Service to rename Netland Island in Berg Bay as "Berry Island." The rationale was that, "Between Pt. Carolus and Berg Bay the natives pick soap berries and strawberries. While it is not known if these berries are especially abundant on the island in question, it is felt that the suggested name is appropriate because it refers to one of the activities of the local natives" (Demaray 1940).

[12] There is no comprehensive ethnobotany on the Tlingit, for example, although there are ethnographic sources that speak to various ethnobotanical topics (e.g., de Laguna 1972; Emmons 1991; Newton and Moss 1984; Turner 1995). As one would expect, when we narrow the focus to berry plants, the paucity of information is even more striking. Moss (1993:631-2), attempting to correct a similar disregard for shellfish, suggests that they have been underplayed in the ethnographic literature due to (ethno- and anthrocentric) biases toward more "the dramatic, technologically complex, and male-dominated activities of fishing and sea mammal hunting." This may be true for berries as well. However, her conclusion that shellfish were also ignored because of their low-status as "beach" food certainly does not hold for berries, which, as we have already seen, were highly esteemed.

[13] For example, Richard Nelson (1983: 54) reports the belief among the Koyukon Athabaskans of interior Alaska that, because they grow low to the ground and are nurtured by the soil, berries are pregnant with potent "spiritual powers (***sinh taala'***)" that emanate from the earth, "and so they are potentially dangerous. This is especially true in the evening and at night, so people must not gather berries (nor should they pick flowers or harvest any kind of plant) in dusk or darkness."

[14] For example, it is said that berries may hide themselves from disrespectful harvesters. This belief is also documented in traditional stories elsewhere on the Northwest Coast, including the Nuxalt (Bella Coola) story of "The Woman Who Befriended a Wolf" (see McIlwraith's 1948, I:691; Turner 1997:291-92). In this story berries, which are personified as "a host of goggle-eyed little boys sitting on the berry shoots," attempt to hide from a woman who violates a prohibition against munching on berries while picking. "Thanks to her sight of the berries in human form, she was thenceforth able to see them in their hiding places and was accordingly always fortunate. She respected the wishes of the fruit, never eating as she picked, but chewing dried salmon instead." Leslie Main Johnson of the University of Alberta (personal communication 1999) reports similar stories among the Witsuwit'en Athabaskans of northern British Columbia, where cranberries are said to be capable of "hiding themselves in the moss" and "covering themselves with moss at dark to go to sleep."

[15] See Active (1998:36) for another first-hand account of this practice.

[16] In some cases, material technologies, such as wide-mouthed baskets (***taal*** from the verb "to flatten"), and innovative harvest techniques, such as shaking or striking of soapberry and huckleberry bushes to release the fruits into these baskets (or in some cases onto mats or sheets) rather than picking individual berries, also facilitated production (cf. Shotridge 1984). Johnson (personal communication 1999) notes similar efforts to mobilize and organize labor among the Gitksan of British Columbia, including reconnaissance missions to determine the most productive berry patches in which to concentrate picking effort, a strategy also employed by the Tlingit. It should also be noted that the laborious aspects of picking were mitigated to some extent by the festive nature of the harvest itself. Shotridge (1984:173), a Chilkat Tlingit, described the "pickers' stampede" as a euphoric occasion inspiring widespread participation "somewhat as the white man's patriotic celebration does him," an analogy that also was drawn by my Hoonah consultants. But production of large quantities of surplus berries for ceremonial gifts and trade required additional means of labor and organization to succeed.

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A COMPARATIVE ANALYSIS OF FIVE MEDICINAL FLORAS

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ABSTRACT.– We report a striking similarity in the selection of medicinal plants by widely separated non-western peoples. People across the northern hemisphere (in Chiapas, North America, Korea and Kashmir) have selected similar plant species — members of the same plant families — for medicinal use; the sunflower family (Asteraceae), for example, ranks first in 3 of 4 regions and second in the fourth. Only 9 plant families are needed to delineate the 5 most important medicinal plant families in these 4 regions. Likewise, there is striking similarity in the plants neglected for use as medicine: the grass family (Poaceae) ranks last in 3 of 4 regions and second in the fourth. These patterns may be due to the relatedness of the northern floras and to the cultural transmission of knowledge through time and space; they may demonstrate the existence of a global pattern of human knowledge.

Key words: plant selection, medicinal floras, regression analysis

RESUMEN.– En este trabajo se reporta que en poblaciones no occidentales claramente separadas unas de otras, existe una similitud asombrosa en cuanto a la selecciióón de plantas medicinales. En Chiapas, América del Norte, Corea y Kashimir, cuatro regiones del hemisferio norte, la gente ha seleccionado especies parecidas – esto es, representantes de las mismas familias de plantas – para usos

medicinales. Por ejemplo, la familia de los girasoles (Asteraceae) ocupa el primer lugar en tres de estas cuatro regiones y el segundo en la otra. Por otro lado, se necesitan sóólo nueve familias para clasificar a las cinco familias máás importantes en estos lugares. Ademáás, tambiéén existe similitud entre las plantas desechadas para este mismo uso, la familia de los pastos (Poaceae) ocupa el úúltimo lugar en tres de las regiones y el segundo en la cuarta. Esto puede deberse tanto al tipo de flora existente en el hemisferio norte como a la transmisióón cultural de conocimientos a travéés del tiempo y del espacio, esbozando la existencia de un patróón global de conocimiento humano.

RÉSUMÉ.– Cet article expose une ressemblance frappante entre les selections de plantes médicinales par des peuples non-occidentaux largement dispersés. Les populations de quatre régions de l'hémisphère Nord (Chiapas, Amérique du Nord, Corée, et Kashmir) ont sélectionné des espèces botaniques similaires—c'est-à-dire appartenant aux même familles botaniques—pour leur emploi médicinal. Par exemple, parmi toutes familles sélectionnées, la famille des tournesols (Asteraceae) s'emploie le plus fréquemment dans 3 des 4 régions, et est en deuxième place dans la 4e région. En fait il ne faut que 9 familles botanique pour définir les 5 plantes medicinales les plus importantes dans ces 4 regions. De même il y a une ressemblance frappante entre les plantes qui n'ont pas été choisies pour leur vertu pour l'emploi médicinale. La familles des herbes (Poaceae) est classée la dernière dans 3 des 4 régions, et avant derniere dans la 4e région. Ces motifs pourraient s'expliquer par la parenté entre les flores nordiques et par la transmission culturelle des savoirs à travers le temps et l'espace; il se peut qu'elles démontrent l'existence d'un motif global des savoirs humains.

INTRODUCTION

Identification of the plant species used as medicine by many individual cultures has long been an active area of research (Berlin and Berlin 1996; Johns 1990; Moerman 1998). A few studies have sought to relate the medical plant species selected to the floras to which the plants belong in order to understand what kinds of plants are more or less important (Moerman 1991; Moerman 1996; Phillips and Gentry 1993). However, almost nothing is known about possible patterns of medicinal plant selection by human beings across cultures, regions, and hemispheres. In this paper, we report research showing significant similarities (and some differences) in patterns of selection and avoidance of plants for medicine for 5 well-separated peoples and floras.

In 1992, Moerman, in collaboration with others, compared the medicinal flora of the Majouri-Kirchi forests of Jammu and Kashmir State, in India, with the medicinal flora of the native peoples of North America (Kapur et al. 1992). Utilizing data from that paper and new data from 3 other regions — from Korea, the Chiapas Highlands of Mexico, and Eastern Ecuador — we extend that comparison.

METHODOLOGY

The comparison utilizes the regression and residual analysis developed by Moerman (Moerman 1991) wherein one carries out a regression analysis of the number of medicinal species per family on the total number of species in each family; a regression analysis for the data from North America is displayed and explained in Figure 1. Lacking any particular selectivity, such an analysis would show that large families had large numbers of medicinal species and that small ones did not. In previous publications, it has been shown that some families were used much more often than simple chance would allow, and others were used less often (Moerman 1991; Moerman 1996). In particular, in such an analysis, families can be ranked by the size of their "residuals." The residual is the difference between the regression analysis prediction of number of medicinal species and the actual, ethnographically determined, number of medicinal species. Large, positive residuals indicate families favored for use as medicines while large, negative residuals indicate families generally ignored. Ranking families by residual allows us to compare the medicinal floras of peoples separated in space and time.

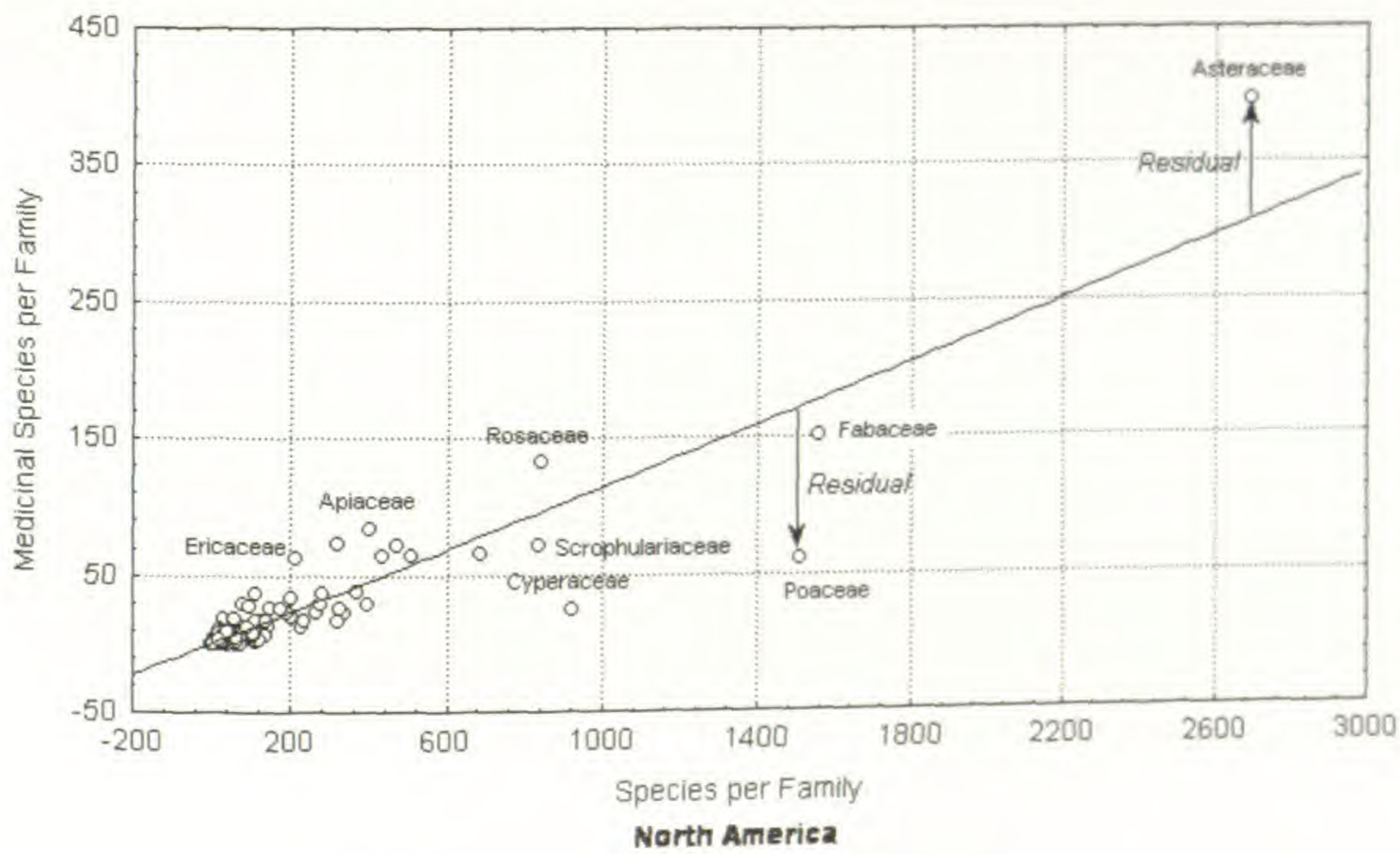

FIGURE 1.– Regression plot for North America.

In this graph, each point represents two values for a plant family, the total number of species in North America (north of the Rio Grande) along the horizontal axis (TSp), and the number of species in each angiosperm family used medicinally by native American peoples along the vertical axis (MSp). The graph line from lower left to upper right is the line represented by the regression equation, calculated from a standard least-squares regression (Runyon and Haber 1984). [2]

Another way to determine the relationships between these different medicinal floras is to calculate the Pearson correlation coefficients (Runyon and Haber 1984:140-155) between the residuals from the five regions, taking two regions at a time as shown in Figure 2.

The Regression Analysis.– Appendix 1 gives all the numerical data considered in this paper. Table 1 summarizes the results of the 5 least-squares regression analyses (Runyon and Haber 1984:164-183). In each case in the table, the predicted value (Pv) for the number of medicinal species in a particular family which has N species is determined by the equation:

$$Pv = Constant + (N * Coefficient)$$

The residual (R) is the actual number of medicinal species in that family (Av) less the predicted value (Pv):

$$R = Av - Pv$$

Calculating this figure for each family for each of the 5 regions allows us to rank the families in terms of decreasing residuals. Families with large positive residuals — with more species used medicinally than the size of the family would predict — are at the top of such a list, while families with large negative residuals — with fewer species used medicinally than the size of the family would predict — are at the bottom of the list. We number the families in each area from 1 to n — where n is the number of families in the region — from top to bottom, and from bottom to top. The top 5 families and the bottom 5 families of each region are indicated in tables 2 and 3.

TABLE 1.– Basic data and equation parameters for regressions of number of medicinal species on total number of species per family for 5 regions. "Coefficient" and "Constant" are described in the text, and in the caption to Figure 1.

	Families (angiosperms)	Species	Medicinal Species	Coefficient	Constant
North America	225	20,669	2,428	.114	.284
Korea	136	2,506	591	.155	1.49
Kashmir	100	739	466	.541	.662
Ecuador	118	1,729	133	.054	.342
Chiapas Highlands	144	6,606	1,639	.230	.829

DATA

The analysis presented here rests on 5 different sets of data, in each case a listing of all the families of angiosperms found in the particular region, with counts of the total number of species in each family, and the number of those species utilized as medicines by native peoples in the regions. While there are many interesting medicinal gymnosperms, data for them were not available for all the regions, so this analysis is only of angiosperms.

As taxonomists do not necessarily agree on the family-level classifications of the world's plants, we have had to adopt some simplifying conventions in order

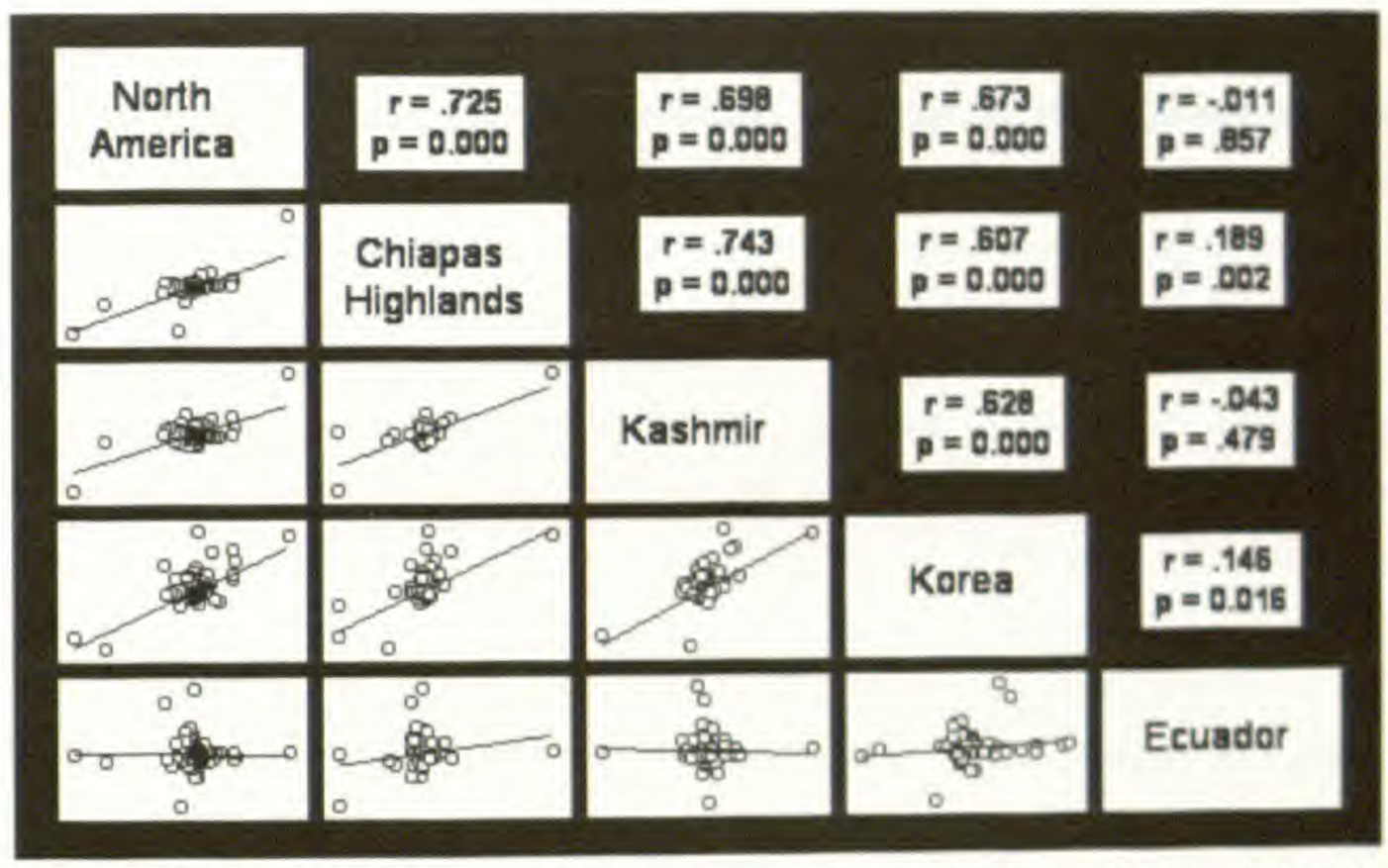

FIGURE 2.– Pearson Product Moment Correlation Coefficients for residuals by family. These graphs represent the correlations between residuals by family for all pairs of the five regions. A Pearson correlation coefficient demonstrates the degree of relationship between two variables (Runyon and Haber 1984). If the two variables are identical, the correlation is 1. If there is no relationship at all, the correlation is zero. Generally, as the correlations are nearer to one, it means that the residual on regression for a particular family in each of two places was alike. In cases where a family exists in one location but not in the other, it is not considered in making the calculation.

TABLE 2.– Ranking by residual for the most selected families in 5 regions. The table lists the 5 most utilized plant families in 5 regions (the top 5 are listed in **bold face)**. A dash (Araceae in Chiapas, for example) indicates that the family doesn't exist there. There is a substantial overlap of families in 4 regions. Asteraceae ranks first on the list of families in North America, Kashmir, and Chiapas; it ranks second in Korea. The top 5 families in Ecuador are very different from the other 4 regions; none of the top 5 in Ecuador appear on the list of the top 5 in 4 other regions. The families are listed in the order of the sum of the rankings for the four similar regions (Asteraceae = 5, Lamiaceae = 17, etc.), and by their order in Ecuador.

FAMILY	North America	Korea	Kashmir	Chiapas Highlands	Ecuador
Asteraceae	**1**	2	1	1	47
Lamiaceae	8	3	4	2	95
Apiaceae	2	**5**	11	**5**	71
Ranunculaceae	5	4	3	17	-
Liliaceae	20	1	5	12	-
Solanaceae	14	24	6	3	16
Rosaceae	4	13	37	4	-
Ericaceae	3	17	60	13	79
Euphorbiaceae	234	12	**2**	21	85
Araceae	39	8	90	-	1
Fabaceae	253	7	85	131	2
Bignoniaceae	223	-	56	128	3
Loganiaceae	211	110	35	52	4
Malvaceae	238	118	13	19	5

to make these comparisons. Generally, we follow Kartesz' terminology for families which occur in North America (Kartesz 1994) and Mabberley for families outside North America (Mabberley 1993).

North America.– The North American data have been described and analyzed using similar techniques (Moerman 1996). These data represent the uses of medicinal plants by some 291 different native American groups north of the Rio Grande. These data are fully published elsewhere (Moerman 1998). There are in this region a total of 20,669 species of angiosperms from 255 families of which 2,428 (from 160 families) are used in some way or other as a medicine by at least 1 of some 216 native American groups. The 5 most utilized angiosperm families in a residual analysis are Asteraceae, Apiaceae, Ericaceae, Rosaceae and Ranunculaceae. The 5 least utilized families are Poaceae, Cyperaceae, Fabaceae, Scrophulariaceae and Rubiaceae.

Kashmir.– The Indian data represented here have been described before (Kapur et al. 1992). Kashmir, in northeastern India, has a "hilly topography ranging from 300 meters to 2,780 meters above sea level. The region consists of limestone, quartzites, grit and earthy clay," (Kapur et al. 1992: 87) and contains dense forests in an extremely hilly, arduous and rugged terrain.

Collected in a much smaller region than the North American data, there are 739 angiosperm species from 100 families of which 466 species (from 100 families) are used medicinally.[1] The 5 most utilized medicinal families in Kashmir are Asteraceae, Euphorbiaceae, Ranunculaceae, Lamiaceae and Liliaceae. The 5 least utilized families are Poaceae, Urticaceae, Anacardiaceae, Brassicaceae and Cucurbitaceae..

Korea.– The Korean data were collected and edited by Robert Pemberton. Those data represent a total of 2,506 species of angiosperms from 136 families of which 591 species (from 97 families) were used medicinally in Korea. The sources for the data are 2 Korean language floras, one a medicinal flora (Lee 1971) and the other a flora of the higher plants of Korea (Lee 1979). Both floras cover the whole Korean Peninsula which encompasses both South and North Korea. The Korean Peninsula is quite mountainous and varies in altitude from sea level to more than 2,700 meters in the mountains along the border between North Korea and China. The Peninsula and associated islands lie between 33° and 37° N latitude. It has a strongly seasonal climate with hot monsoonal summers and cold, dry winters. The natural vegetation is composed of broad-leaved, evergreen forests along the southern coast and islands; warm temperate, deciduous forests with pine (primarily *Pinus densiflora* Sieb. et Zucc.) in the lowlands and middle elevations; and cool temperate, deciduous-conifer forests in the mountains. Plants used as medicine grow in natural forests, occur as "weeds" in agricultural fields and on other disturbed sites, and some are cultivated.[1] The 5 most heavily utilized families for medicinal purposes according to the regression analysis in Korea are Liliaceae, Asteraceae, Lamiaceae, Ranunculaceae and Apiaceae. The 5 least heavily utilized are Cyperaceae, Poaceae, Orchidaceae, Saxifragaceae and Salicaceae.

Chiapas Highlands.– The material from the Chiapas Highlands was collected and

arranged by Brent Berlin. Chiapas is a botanically complex mountainous region with elevations ranging from sea level to 4000 meters in the Sierra Madre mountains near the Guatemala border. In the central plateau region where the ethnobotanical data were obtained, summits range from 2100 meters to 2900 meters. The area is generally comprised of tropical deciduous forest and pine-oak forest with moister rain forest cover on the eastern escarpment. The summits and eastern slopes have diverse evergreen cloud forests with many endemic species. The botany and ethnobotany of Chiapas is described by Berlin, Breedlove and Raven (Berlin et al. 1974). The data considered here include 144 angiosperm families[1] with a total of 6617 species of which 1645 species (from 138 families) are used medicinally. The 5 families most heavily utilized for medicines by the regression analysis in Chiapas are Asteraceae, Lamiaceae, Solanaceae, Rosaceae and Apiaceae. The 5 least utilized are Poaceae, Orchidaceae, Cyperaceae, Bromeliaceae and Arecaceae.

Ecuador.– The material from Ecuador was collected and arranged by David Kiefer. The material represents the botany and ethnobotany of the Upper Napo River valley of the eastern tropical lowlands of Ecuador, and includes Napo river and the 2 rivers – Río Anzu and Río Jatun Yacu – which unite to form it, as well as several tributaries downstream. The terrain is an ecological transition zone be-

TABLE 3.– Rankings of the families least utilized for medicines in 5 regions. Poaceae is least used in 3 regions, and second least in one. A dash (Salicaceae in Ecuador, for example) indicates that the family does not occur there. One of the bottom 5 in Ecuador (Orchidaceae) appears on the bottom 5 list in 2 other regions, but the remaining 4 do not. The families are listed in the order of the sum of the rankings for the four similar regions (Poaceae = 5, Cyperaceae = 12, etc.), and by their order in Ecuador.

FAMILY	North America	Korea	Kashmir	Chiapas Highlands	Ecuador
Poaceae	1	2	1	1	67
Cyperaceae	2	1	6	3	16
Bromeliaceae	23	-	-	4	10
Arecaceae	37	-	52	5	110
Orchidaceae	10	**3**	85	2	**1**
Fabaceae	**3**	130	16	6	117
Urticaceae	41	16	2	122	101
Brassicaceae	9	83	4	126	-
Scrophulariaceae	4	14	86	138	41
Rubiaceae	5	71	91	62	9
Saxifragaceae	238	**4**	82	41	-
Cucurbitaceae	228	56	**5**	102	66
Salicaceae	250	**5**	25	112	-
Anacardiaceae	237	115	**3**	116	33
Moraceae	222	116	92	30	2
Lauraceae	192	105	34	7	3
Clusiaceae	231	72	84	22	4
Annonaceae	44	-	-	44	5

tween the Andes Mountains and the Amazon Basin lying about 400 to 500 meters above sea level. This area has only recently been surveyed by botanists, and some portion of the flora remains to be identified. A flora for the region has recently been prepared for the Jatun Sacha Biological Station, a private reserve and research facility located on the south bank of the Upper Napo River, 8 km east of Misahualli and 25 km east of the base of the Andes.[1] Approximately 1900 vascular plant species have been identified in the region (Neill 1995).

The Upper Napo River valley is inhabited by a Quichua-speaking indigenous group numbering about 25,000 (Marles et al. 1988), along with colonists from elsewhere in the country. Their medicinal plant use has been described by several investigators (Iglesias 1985; Kohn 1992; Marles et al. 1988). The data considered here include 118 angiosperm families with a total of 1729 species of which 133 species (from 62 families) are used medicinally.[1] The 5 most utilized families for medicines in this region of Ecuador are Araceae, Fabaceae, Bignoniaceae, Loganiaceae and Malvaceae. The 5 least utilized are Orchidaceae, Moraceae, Lauraceae, Clusiaceae and Cecropiaceae.

DISCUSSION

Table 2 shows that it requires only 9 families to list the top 5 in 4 of the 5 regions (all but Ecuador). If there were no overlap at all, and the botanical selections were unique in the 5 regions, it would take 20 families to make such a list. If there were total overlap, it would take 5. Asteraceae is first in 3 of the 4 regions, and 2nd in the fourth, and is undoubtedly the most important medicinal plant family by this analysis. In those 4 areas, the one obvious anomaly is the apparent neglect in North America of the Euphorbiaceae (where it is ranked 234); that family ranks second in Kashmir, 12th in Korea and 21st in Chiapas. Otherwise, there is a remarkable overlap of these important families. With only 3 exceptions, families in the top 5 of any of the 4 regions rank in the top quarter of the lists of the other 3 ; most rank within the top tenth of the other 3. The exceptions are the Euphorbiaceae, as already mentioned, and the Rosaceae and Ericaceae, which are both in the middle third of the list in Kashmir. Ecuador, where none of the top 5 appears in the top 5 of any other region, is obviously very different: a substantially different gropu of families provide the largest number of medicinal species.

Table 3 shows that there is less agreement about which families are ignored than about which ones are utilized. Again, setting Ecuador aside, Poaceae is at the bottom of 3 lists and 2nd from the bottom in a fourth. Cyperaceae is also ignored for medicinal use in the 4 regions (and is low even in Ecuador).

Orchidaceae is a curious case. This is perhaps the largest family of plants in the world — one estimate suggests there are 17,500 species worldwide (Mabberley 1993) — yet it generally has few uses other than as an ornamental, as the source for vanilla and salep, and occasionally as a medicine. The distribution of the family is obviously skewed to the tropics; only 322 of those species occur in North America and only 26 of these are used medicinally. Only 2 of the 132 species in Ecuador are used medicinally, where it is listed last on the regression; it is listed near the bottom of the list in 3 other regions, but is relatively high in Kashmir.

Another anomalous family is Fabaceae which is very low in 3 samples (North America, 3rd from the bottom; Chiapas, 6th from the bottom; and Kashmir, 16th from the bottom) but quite high on 2 others (Ecuador, 2nd from the top; Korea; 7th from the top). Both Orchidaceae and Fabaceae might repay close comparative analysis in these different ethnographic and biogeographic contexts.

An alternate statistical test confirms this visual interpretation of regression residuals. Figure 2 shows a series of correlations, and correlation plots, between residuals on the regressions described earlier. In the 4 similar floras, the correlation coefficients range from 0.607 (Chiapas/Korea) to 0.743 (Chiapas/Kashmir). The 4 correlations between the residuals on regression in Ecuador with the other areas are much lower and vary from -0.043 (Ecuador/Kashmir) to 0.189 (Ecuador/Chiapas).

Generally, then, the medicinal floras of 4 areas considered here — North America, Korea, Kashmir and the Highlands of Chiapas — are remarkably similar, particularly in the plant families selected for intensive use, and somewhat less in the families particularly ignored. The situation in Ecuador is, however, distinctly different than in the other 4 areas.

CONCLUSIONS

How might one account for this extraordinary overlap of plant use in such widely divergent parts of the world? Two factors may be at play, one botanical and the other ethnological. The 4 more similar regions are all part of what Good (1974) called the "Boreal Kingdom," and what Takhtajan (1986) calls the "Holarctic Kingdom" while Ecuador is part of what both call the "Neotropical Kingdom." It may be worth noting that although Chiapas seems to be far enough south that it might have a tropical flora, it does not. Good, for example, quite explicitly includes Chiapas at the southern end of the "Pacific North America" floristic region of the Boreal Kingdom.

Insofar as the 4 northern floras are related at the family and genus levels, then there will likely be a common chemistry that would encourage the selection of related species in different floras for medicine. This factor would be enhanced by taking a long view on the relatedness of peoples and knowledge in Asia and North America, and recognizing that knowledge of medicinal species may have been transmitted via migrating peoples throughout Asia, from Asia to North America, and south to Chiapas. Koreans are thought to have migrated from Mongolia which shares floristic characteristics with Tibet and with Kashmir. Northern Asians migrated to North America and then southward. It seems likely that as related peoples moved through related floras, they were able to select similar species (in different parts of Asia and in far northern areas of Asia and North America, since the floras are very similar in the far north), and then select different but obviously related species as they moved south to Korea or to more southern areas of North America and to Chiapas. By the time people reached the tropical regions of Ecuador, where the floristics were dramatically different than they were further north, people had to develop a new range of ethnobotanical knowledge.

The genus *Achillea* ("yarrow") serves as a good example (Figure 3). *Achillea*

FIGURE 3.– *Achillea millefolium*, L., Asteraceae, yarrow. By Marie Cole. From Daniel E. Moerman, *Geraniums for the Iroquois*. (Reference Publications, Algonac MI. 1982). Used by permission.

millefolium L., a member of the Asteraceae family, has more medicinal uses (359) in a standard listing of native North American plant use (Moerman 1998) than any other single species. *Achillea* is also found, and used medicinally, in Kashmir, Korea and Chiapas. It was probably known in ancient times as it was the most common of the pollens found in the famous 60,000 year old Neanderthal burial of Shanidar IV in northern Iraq (Leroi-Gourhan 1975). It was named after Achilles who is said by classical authors (Apollodorus, Homer, Pliny) to have discovered its virtues for healing wounds (Graves 1960:285). The genus is not reported in Amazonian Ecuador (Renner et al. 1990). Yarrows are perennial forbs with distinctive flowers, scent and foliage which contain a broad range of chemicals which have been of interest to scientists throughout the 20th century (Miller 1916); a recent compilation lists over 150 compounds (Buckingham 1994(7):377-79) including 3 forms of achimillic acid which have recently been shown to be active against leukemia (Tozyo et al. 1994). Knowledge of the utility of this plant is broad and deep, as it is for other closely related members of the Asteraceae occuring in Asia and North America, and as far south as Chiapas (e.g., *Artemisia*, *Aster*, and *Lactuca*).

The similarity of medicinal plant use we have found suggests that human knowledge is deeply rooted. While it seems unlikely that there is a continuous skein of knowledge of individual species back to the Middle Paleolithic, these data suggest that non-Western peoples speaking unrelated languages have somehow generated similarly useful knowledge over broad geographic regions, or carried the knowledge of drug plants with them throughout Asia and to America

in their migrations since the Upper Paleolithic, or both. Recognizing such patterns could increase the efficiency of contemporary prospecting for useful phytochemicals at the same time as they demonstrate the existence of a global pattern of human knowledge.

NOTES

2. The equation for the line is a constant (.284) plus a coefficient (.114) multiplied times the number of species in the family. The constant indicates where the graph line intercepts the vertical axis, and the coefficient represents the slope of the graph line:

$$MSp = .284 + (.114 * TSp)$$

This equation represents what the distribution of points would be if everything were distributed randomly, and gives us what is called the "predicted values" of the analysis. For example, there are 2,688 species of Asteraceae in North America. If plant selection were random, one would predict that the number of species of Asteraceae used medicinally would be .284 + (.114 * 2688) = 306.7. However, native American peoples used 397 species of Asteraceae medicinally, many more than the regression analysis predicts. The "residual" is the actual value minus the predicted value, 397 - 306.7 = 90.3. On the graph, the residual is represented by the vertical distance from the regression line to the data point, shown by the upward pointing arrow. The regression analysis predicts that native Americans would use 171.8 species of Poaceae medicinally; however, they used only 62. The residual, -109.8, is represented on the graph by the downward pointing arrow.

Why use this method? One might simply rank the families in terms of the number of medicinal species native peoples used. If we did this, the top 3 medicinal families would be Asteraceae, Fabaceae and Rosaceae. But these are all large families which we might expect to produce many medicinal species. That suggests that we might want to rank the families not by the number of medicinal species, but by the proportion or percentage of them. However, there are a number of very small families of plants in north America in which all of their species (e.g., 100% of them) are used medicinally. Among these are Butomaceae (1 of 1), Datiscaceae (1 of 1) and Saururaceae (2 of 2). Ranked this way, the families which appeared at the top of a list by simple enumeration, are lost in the middle of the list: Asteraceae is in 81st place, Fabaceae is in 111th, and Rosaceae is 73rd. The regression-residual system has the advantage of not overemphasizing small families, and, most valuable, it differentiates among large families which produce relatively larger and relatively smaller numbers of medicinal species (like Asteraceae and Poaceae).

Note that this method is not meant to suggest that a particular medicinal species, or family, (like Datisca glomerata (K. Presl) Baill. Durango-Root, Datiscaceae) is not "important." But it is meant to allow analysis of the uses of large numbers of plants using some technique other than simply considering them one at a time.

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APPENDIX 1.– Number of medicinal species per family, and total species per family, for angiosperms in 5 regions.

	North America		Korea		Chiapas Highlands		Kashmir		Ecuador	
FAMILY	Med	Total	Med	Total	Med	Total	Med	Total	Med	Total
Acanthaceae	2	111	1	3	21	93	11	17	2	31
Aceraceae	10	19	4	12	1	1	2	2	0	0
Achatocarpaceae	0	1	0	0	0	0	0	0	0	0
Acoraceae	1	2	0	0	0	0	0	0	0	0
Actinidiaceae	0	0	4	4	4	15	0	0	1	2
Adoxaceae	0	1	0	1	0	0	0	0	0	0
Agavaceae	11	94	0	0	0	0	0	0	0	0
Aizoaceae	0	22	0	3	0	0	0	0	0	1
Alangiaceae	0	0	0	1	0	0	0	0	0	0
Alismataceae	5	37	2	5	0	0	0	0	0	1
Aloaceae	0	2	0	0	0	0	0	0	0	0
Amaranthaceae	4	112	3	9	12	38	11	13	0	4
Anacardiaceae	11	35	5	6	7	17	2	9	0	4
Annonaceae	1	22	0	0	5	24	0	0	0	22
Apiaceae	85	397	23	59	25	48	12	18	0	1
Apocynaceae	7	62	2	5	11	45	4	7	2	16
Aponogetonaceae	0	1	0	0	0	0	0	0	0	0
Aquifoliaceae	6	29	1	5	2	12	2	2	1	1
Araceae	8	46	12	14	0	0	2	5	11	77
Araliaceae	9	36	14	15	15	18	1	1	0	6
Arecaceae	3	45	0	0	1	47	1	1	3	21
Aristolochiaceae	7	38	3	4	0	15	0	0	0	3
Asclepiadaceae	26	149	8	13	18	78	5	7	0	4
Asteraceae	397	2688	55	226	264	602	54	64	2	27
Balanophoraceae	0	1	0	0	0	0	0	0	0	1
Balsaminaceae	2	11	1	2	1	4	2	2	0	0
Basellaceae	0	5	0	0	0	0	0	0	0	0
Bataceae	0	1	0	0	0	0	0	0	0	0
Begoniaceae	0	10	0	0	7	39	1	1	0	3
Berberidaceae	17	33	6	7	1	5	2	3	0	0
Betulaceae	19	31	5	22	4	4	0	0	0	0
Bignoniaceae	1	32	0	0	7	56	1	1	4	20
Bixaceae	0	5	0	0	2	4	0	0	1	2
Bombacaceae	0	5	0	0	1	9	1	1	1	15
Boraginaceae	30	392	2	21	21	51	5	12	2	13
Brassicaceae	67	685	9	51	11	28	6	16	0	0
Bromeliaceae	1	43	0	0	3	115	0	0	0	17

	North America		Korea		Chiapas Highlands		Kashmir		Ecuador	
FAMILY	Med	Total	Med	Total	Med	Total	Med	Total	Med	Total
Brunelliaceae	0	1	0	0	0	9	0	0	0	0
Burmanniaceae	0	8	0	0	0	0	0	0	0	2
Burseraceae	1	6	0	0	2	14	0	0	0	16
Butomaceae	1	1	0	0	0	0	0	0	0	1
Buxaceae	0	6	1	1	0	0	1	1	0	0
Cabombaceae	0	3	0	0	0	0	0	0	0	0
Cactaceae	20	199	0	0	1	40	1	1	1	4
Callitrichaceae	0	12	0	2	0	0	0	0	0	0
Calycanthaceae	2	3	0	1	0	0	0	0	0	0
Calyceraceae	0	1	0	0	0	0	0	0	0	0
Campanulaceae	12	228	10	26	8	26	1	1	0	5
Canellaceae	0	2	0	0	0	0	0	0	0	0
Cannabaceae	2	3	2	2	0	0	1	1	0	0
Cannaceae	0	8	0	0	1	5	0	0	0	0
Capparaceae	2	45	0	0	2	28	0	0	1	5
Caprifoliaceae	30	80	4	41	9	14	4	8	0	0
Caricaceae	1	1	0	0	1	5	0	0	0	1
Caryocaraceae	0	0	0	0	0	0	0	0	0	3
Caryophyllaceae	23	336	8	56	11	29	5	7	0	1
Casuarinaceae	0	4	0	0	0	0	0	0	0	0
Cecropiaceae	0	2	0	0	0	0	0	0	0	22
Celastraceae	7	40	3	16	7	47	1	2	1	13
Ceratophyllaceae	0	3	0	1	0	0	0	0	0	0
Cercidiphyllaceae	0	1	0	0	0	0	0	0	0	0
Chenopodiaceae	23	188	2	16	5	5	2	3	0	0
Chloranthaceae	0	1	0	3	1	1	0	0	0	0
Chrysobalanaceae	2	4	0	0	0	0	0	0	0	12
Cistaceae	3	37	0	0	1	2	0	0	0	0
Clethraceae	1	2	0	1	5	10	0	0	0	0
Clusiaceae	13	70	2	8	5	29	3	3	0	25
Combretaceae	0	8	0	0	2	14	1	3	0	6
Commelinaceae	6	56	1	5	15	47	1	1	2	9
Connaraceae	0	1	0	0	0	0	0	0	0	0
Convolvulaceae	12	141	5	13	23	97	6	12	0	5
Coriariaceae	0	0	0	0	1	1	0	0	0	0
Cornaceae	11	20	2	9	3	3	1	1	0	0
Corynocarpaceae	0	1	0	0	0	0	0	0	0	0
Costaceae	0	3	0	0	0	0	0	0	0	0
Crassulaceae	10	113	5	25	4	25	2	2	1	1
Crossosomataceae	0	4	0	0	0	0	0	0	0	0
Cucurbitaceae	13	73	1	6	14	53	2	8	1	18
Cunoniaceae	0	1	0	0	1	2	0	0	0	0
Cuscutaceae	4	52	0	0	0	0	1	1	0	0
Cyatheaceae	1	19	0	0	0	0	0	0	0	0
Cycadaceae	0	2	0	0	0	7	0	0	0	0
Cyclanthaceae	0	0	0	0	0	0	0	0	2	17
Cymodoceaceae	0	2	0	0	0	0	0	0	0	0
Cyperaceae	25	918	5	210	13	184	4	11	1	27

	North America		Korea		Chiapas Highlands		Kashmir		Ecuador	
FAMILY	Med	Total	Med	Total	Med	Total	Med	Total	Med	Total
Cyrillaceae	0	3	0	0	0	0	0	0	0	0
Datiscaceae	1	1	0	0	0	0	0	0	0	0
Davalliaceae	0	11	0	0	0	0	0	0	0	0
Diapensiaceae	1	5	0	1	0	0	0	0	0	0
Dichapetalaceae	0	0	0	0	0	0	0	0	1	3
Dilleniaceae	0	2	0	0	1	6	0	0	0	9
Dioscoreaceae	1	15	5	7	7	19	2	2	0	0
Dipsacaceae	1	13	0	2	0	0	1	2	0	0
Droseraceae	2	8	0	3	0	0	1	1	0	0
Ebenaceae	1	7	2	2	1	7	0	0	0	3
Elaeagnaceae	4	10	1	6	0	0	1	2	0	0
Elaeocarpaceae	0	3	0	0	1	9	0	0	2	5
Elatinaceae	0	11	0	1	0	0	0	0	0	0
Eleocarpaceae	0	0	0	1	0	0	0	0	0	0
Empetraceae	1	4	0	1	0	0	0	0	0	0
Epacridaceae	1	1	0	0	0	0	0	0	0	0
Eremolepidaceae	0	2	0	0	0	0	0	0	0	0
Ericaceae	63	213	11	33	18	44	1	1	0	3
Eriocaulaceae	0	16	2	9	0	0	0	0	0	1
Erythroxylaceae	0	5	0	0	0	0	0	0	1	4
Euphorbiaceae	38	368	10	20	52	204	17	19	3	60
Fabaceae	152	1557	24	85	147	676	37	69	12	121
Fagaceae	28	94	7	16	9	27	1	2	0	0
Flacourtiaceae	0	22	0	2	7	27	2	3	1	26
Fouquieriaceae	1	1	0	0	0	0	0	0	0	0
Frankeniaceae	0	5	0	0	0	0	0	0	0	0
Garryaceae	2	8	0	0	1	2	0	0	0	0
Gentianaceae	17	117	7	23	11	25	1	4	0	3
Geraniaceae	9	64	8	14	4	13	4	5	0	0
Gesneriaceae	0	64	0	0	7	62	0	0	3	27
Goetzeaceae	0	1	0	0	0	0	0	0	0	0
Goodeniaceae	1	10	0	0	0	0	0	0	0	0
Grossulariaceae	19	56	0	0	0	0	0	0	0	0
Gunneraceae	0	3	0	0	0	0	0	0	0	0
Gyrocarpaceae	0	0	0	0	1	2	0	0	0	0
Haemodoraceae	1	3	0	1	0	0	1	1	0	1
Haloragaceae	3	19	0	4	0	0	0	0	0	0
Hamamelidaceae	2	5	0	2	1	2	0	0	0	0
Heliconiaceae	0	6	0	0	0	0	0	0	0	0
Hernandiaceae	0	1	0	0	0	0	0	0	1	1
Hippocastanaceae	4	7	0	0	1	1	1	1	0	0
Hippuridaceae	0	3	0	0	0	0	0	0	0	0
Hydrangeaceae	5	51	0	0	0	0	2	2	0	0
Hydrocharitaceae	1	19	0	6	0	0	0	0	0	0
Hydrophyllaceae	18	234	0	0	4	7	0	0	0	0
Icacinaceae	0	2	0	0	1	6	0	0	1	6
Illiciaceae	0	2	1	1	0	0	0	0	0	0
Iridaceae	17	111	4	10	18	24	1	1	0	0

	North America		Korea		Chiapas Highlands		Kashmir		Ecuador	
FAMILY	Med	Total	Med	Total	Med	Total	Med	Total	Med	Total
Joinvilleaceae	0	1	0	0	0	0	0	0	0	0
Juglandaceae	9	23	2	2	1	5	0	0	0	0
Juncaceae	6	135	1	23	1	15	0	0	0	0
Juncaginaceae	1	6	0	0	0	0	0	0	0	0
Krameriaceae	2	5	0	0	2	2	0	0	0	0
Lacistemataceae	0	0	0	0	0	0	0	0	0	3
Lamiaceae	72	469	27	60	59	129	25	37	0	5
Lardizabalaceae	0	1	2	2	0	0	0	0	0	0
Lauraceae	6	40	5	12	10	82	2	3	0	39
Lecythidaceae	0	0	0	0	0	0	0	0	3	9
Leeaceae	0	0	0	0	0	0	1	1	0	0
Leitneriaceae	0	1	0	0	0	0	0	0	0	0
Lemnaceae	1	19	2	2	0	0	0	0	0	0
Lennoaceae	0	2	0	0	0	0	0	0	0	0
Lentibulariaceae	2	29	0	7	3	14	0	0	0	0
Liliaceae	65	509	40	98	26	78	9	9	1	4
Limnanthaceae	0	10	0	0	0	0	0	0	0	0
Limnocharitaceae	0	2	0	0	0	0	0	0	0	0
Linaceae	5	50	0	1	5	5	1	2	0	0
Loasaceae	6	76	0	0	1	7	0	0	0	0
Loganiaceae	3	39	0	3	7	25	2	2	3	6
Lophosoriaceae	0	1	0	0	0	0	0	0	0	0
Loranthaceae	0	4	1	4	10	47	1	2	1	12
Lythraceae	3	38	2	7	20	54	2	2	0	4
Magnoliaceae	5	11	4	5	0	0	0	0	0	1
Malpighiaceae	0	33	0	0	17	54	0	0	2	11
Malvaceae	23	263	0	4	32	116	7	9	3	8
Marantaceae	0	8	0	0	0	0	0	0	0	20
Marattiaceae	0	8	0	0	0	0	0	0	0	0
Marcgraviaceae	0	2	0	0	0	0	0	0	0	1
Mayacaceae	0	1	0	0	0	0	0	0	0	0
Melastomataceae	1	71	0	0	18	108	0	0	4	71
Meliaceae	1	10	0	0	7	20	3	3	1	27
Menispermaceae	2	8	4	4	0	0	3	3	2	21
Menyanthaceae	2	6	0	0	0	0	0	0	0	0
Molluginaceae	0	7	0	0	0	0	0	0	0	0
Monimiaceae	0	0	0	0	2	4	0	0	2	13
Moraceae	7	30	6	11	12	57	7	7	1	60
Morinaceae	0	0	0	0	0	0	1	1	0	0
Moringaceae	0	1	0	0	0	0	0	0	0	0
Musaceae	0	3	0	0	1	11	0	0	1	10
Myoporaceae	0	3	0	0	0	0	0	0	0	0
Myricaceae	3	10	1	1	1	1	0	0	0	0
Myristicaceae	0	0	0	0	0	0	0	0	1	22
Myrsinaceae	0	34	2	3	25	82	2	3	1	5
Myrtaceae	3	120	0	0	16	81	0	0	0	11
Najadaceae	0	8	0	3	1	1	0	0	0	0
Nelumbonaceae	0	2	0	0	0	0	0	0	0	0

	North America		Korea		Chiapas Highlands		Kashmir		Ecuador	
FAMILY	Med	Total	Med	Total	Med	Total	Med	Total	Med	Total
Nyctaginaceae	17	124	0	0	9	26	2	2	0	3
Nymphaeaceae	2	14	4	5	0	0	0	0	0	0
Ochnaceae	0	5	0	0	0	0	0	0	2	4
Olacaceae	1	5	0	0	3	12	0	0	2	6
Oleaceae	9	66	6	24	4	17	5	9	0	1
Onagraceae	29	276	10	17	16	31	2	2	1	4
Orchidaceae	26	322	6	82	25	444	3	3	2	132
Orobanchaceae	6	24	1	5	0	0	0	0	0	0
Oxalidaceae	5	30	3	3	5	16	3	5	0	1
Paeoniaceae	2	4	0	0	0	0	0	0	0	0
Pandanaceae	2	4	0	0	0	0	0	0	0	0
Papaveraceae	13	97	9	17	3	9	2	4	0	0
Passifloraceae	1	35	0	0	8	40	0	0	0	9
Pedaliaceae	3	10	0	1	1	1	1	1	0	0
Phytolaccaceae	1	14	2	3	6	9	0	0	2	6
Piperaceae	2	64	0	1	21	94	0	0	3	39
Pittosporaceae	0	15	0	1	0	0	0	0	0	0
Plantaginaceae	9	35	4	5	3	4	2	3	0	0
Platanaceae	2	4	0	0	1	1	0	0	0	0
Plumbaginaceae	4	13	0	1	1	3	1	1	0	0
Poaceae	62	1505	5	178	28	460	24	79	2	34
Podocarpaceae	0	2	0	0	0	0	0	0	0	0
Podostemaceae	0	1	0	0	0	0	0	0	0	0
Polemoniaceae	37	284	0	1	3	11	0	0	0	0
Polygalaceae	8	64	1	4	10	33	2	3	0	1
Polygonaceae	65	433	18	66	13	45	12	16	0	8
Pontederiaceae	2	13	0	2	0	0	0	0	0	2
Portulacaceae	7	105	1	1	0	6	1	1	0	0
Posidoniaceae	0	1	0	0	0	0	0	0	0	0
Potamogetonaceae	1	42	1	14	0	0	0	0	0	0
Primulaceae	9	97	2	26	1	9	4	7	0	0
Proteaceae	0	4	0	0	0	0	0	0	0	0
Punicaceae	0	1	0	0	0	0	1	1	0	0
Quiinaceae	0	0	0	0	0	0	0	0	0	4
Rafflesiaceae	0	1	0	0	0	0	0	0	0	0
Ranunculaceae	74	319	33	104	10	18	18	22	0	0
Resedaceae	0	6	0	0	0	0	0	0	0	0
Rhamnaceae	18	110	2	14	14	21	6	7	0	6
Rhizophoraceae	0	3	0	0	0	0	0	0	0	0
Rosaceae	133	836	26	126	34	71	13	23	0	0
Rubiaceae	17	318	6	34	54	232	11	16	6	130
Rutaceae	8	103	9	11	10	41	4	6	1	6
Sabiaceae	0	2	0	2	1	4	0	0	0	5
Salicaceae	37	112	2	37	4	6	1	2	0	0
Santalaceae	3	14	1	1	0	0	0	0	0	0
Sapindaceae	2	34	1	2	16	60	1	4	2	23
Sapotaceae	2	30	0	0	0	29	0	0	1	38
Sarraceniaceae	1	9	0	0	0	0	0	0	0	0

	North America		Korea		Chiapas Highlands		Kashmir		Ecuador	
FAMILY	Med	Total	Med	Total	Med	Total	Med	Total	Med	Total
Saururaceae	2	2	1	2	0	0	0	0	0	0
Saxifragaceae	27	175	3	53	1	7	3	3	0	0
Scheuchzeriaceae	0	1	0	3	0	0	0	0	0	0
Schisandraceae	0	1	0	0	0	0	0	0	0	0
Scrophulariaceae	72	832	9	65	28	85	12	19	0	3
Simaroubaceae	1	11	0	0	2	12	0	0	0	4
Simmondsiaceae	1	1	0	0	0	0	0	0	0	0
Smilacaceae	8	22	0	0	5	18	1	1	0	0
Solanaceae	34	202	5	9	60	164	10	11	4	47
Sparganiaceae	1	9	0	3	0	0	0	0	0	0
Sphenocleaceae	0	1	0	0	0	0	0	0	0	0
Staphyleaceae	1	3	0	2	1	5	0	0	0	2
Stemonaceae	0	1	0	0	0	0	0	0	0	0
Sterculiaceae	2	28	0	3	7	37	0	0	3	13
Strelitziaceae	0	1	0	0	0	0	0	0	0	0
Styracaceae	0	10	0	3	2	7	0	0	0	0
Surianaceae	0	1	0	0	0	0	0	0	0	0
Symplocaceae	1	4	0	4	1	8	0	0	0	1
Taccaceae	0	1	0	0	0	0	0	0	0	0
Tamaricaceae	0	8	0	0	0	0	0	0	0	0
Taxodiaceae	1	7	0	0	0	0	0	0	0	0
Theaceae	1	13	1	6	4	9	0	0	0	0
Theophrastaceae	0	7	0	0	1	4	0	0	1	3
Thymelaeaceae	2	21	2	7	3	10	2	4	0	1
Tiliaceae	1	17	0	11	8	44	3	6	1	4
Trapaceae	0	1	1	1	0	0	0	0	0	0
Triuridaceae	0	0	0	0	0	0	0	0	0	1
Tropaeolaceae	0	1	0	0	1	3	0	0	0	0
Turneraceae	0	8	0	0	1	7	0	0	0	0
Typhaceae	2	3	2	2	1	3	0	0	0	0
Ulmaceae	5	23	4	17	0	0	1	3	0	6
Urticaceae	5	60	3	24	16	52	1	8	2	12
Valerianaceae	6	35	3	7	8	13	2	3	0	0
Verbenaceae	17	136	5	10	25	76	5	11	2	16
Violaceae	13	90	4	42	5	26	2	2	1	8
Viscaceae	9	45	0	0	0	0	0	0	0	0
Vitaceae	10	40	2	7	5	16	0	0	1	7
Vochysiaceae	0	0	0	0	0	0	0	0	0	6
Winteraceae	0	0	0	0	1	1	0	0	0	0
Xyridaceae	2	24	0	0	0	0	0	0	0	0
Zannichelliaceae	0	1	0	0	0	0	0	0	0	0
Zingiberaceae	2	15	0	0	0	15	3	3	3	12
Zosteraceae	1	5	0	4	0	0	0	0	0	0
Zygophyllaceae	4	19	1	1	1	5	1	1	0	0
Total	2428	20669	591	2506	1639	6606	466	739	133	1729

1. In order to reconcile variation in the naming of upper level taxa, some modifications have been made in some of the published work on which this paper is based. These differences are itemized here.

Kashmir. A number of families reported earlier have been combined (Mimosaceae, Caesalpiniaceae and Papilionaceae have been combined as Fabaceae; in the following 4 pairs, the former has been combined with the latter: Ehretiaceae, Boraginaceae; Fumariaceae, Papaveraceae; Parnassiaceae, Saxifragaceae; Podophyllaceae, Berberidaceae; and in the following 3 pairs, the former has been renamed the latter: Hypericaceae, Clusiaceae; Martyniaceae, Pedaliaceae; Philadelphaceae, Hydrangeaceae). In this account, then, there are 100, not 106 families as in the original publication. Two Kashmir families are not represented in any of the other data sets: Leeaceae and Morinaceae.

Korea. For the following pairs of families, the former was included in the latter: Fumariaceae, Papaveraceae; Hypericaceae, Clusiaceae; Lobeliaceae, Campanulaceae; Nepenthaceae, Lamiaceae; Pyrolaceae, Ericaceae; Amaryllidaceae, Liliaceae. Several other minor spelling changes were made, like Brassicaceae rather than Brassiacaceae. Only 2 small families found in Korea are not found in any of the other samples considered here, Alangiaceae and Eleocarpaceae.

Chiapas Highlands. Only minor changes in the published family data had to be made to match the remaining data: Cruciferae is treated here as Brassicaceae, for example.

Ecuador. Amaryllidaceae has been folded into Liliaceae, and Hippocrataceae has been included in Celastraceae. Four families have had minor changes in the spellings of their names. Nine families found in Ecuador are not present in any of the other 4 areas indicating something of the uniqueness of the flora.

Advances in Historical Ecology. William Balée, Editor. Columbia University Press, New York. 1998. $65 (hardcover). Pp. xvi, 429. Maps, figs., index. ISBN 0-231-10632-7.

Understanding the mutual relations between social processes and environmental change in space and time is now a central concern among researchers across disciplines. Approaches vary, however, and often reflect disciplinary labels such as historical geography, environmental history, landscape ecology, and now historical ecology. Edited by William Balée, *Advances in Historical Ecology* provides a timely introduction to an emerging research agenda.

Thirteen of the book's 17 contributors, exclusive of Carole Crumley's Forward, initially presented their chapters at a 1994 conference on historical ecology hosted by Tulane University and the Columbia University's Graduate Anthropology Association. Fourteen of the 17 contributors are anthropologists, and 9 of the 17 chapters focus on indigenous peoples in Amazonia. The notion of landscape, conceptualized here as the holistic interface and the material artifact of human-environmental interactions, provides a fundamental unit of analysis and unites many of the articles.

In his introduction, Balée declares that historical ecology is not a methodology but an attempt to span the artificial dichotomy separating culture from nature, the social from the natural sciences. Four postulates underscore the approach. First, the non-human biosphere is affected by human activities. It follows that what we often call the 'natural environment' has been subjected to progressive human management and, in effect, has become landscape: "that is, culturally and historically determined physical environments" (p.16). Second, human activity does not necessarily lead to environmental degradation. Third, different societies in particular regional contexts have dissimilar affects on the biosphere. And finally, human "communities and cultures together with the landscapes and regions with which they interact over time can be understood as total phenomena," and therefore "amenable to regional analysis using the paradigmatic concepts and tools of historical ecology" (p.24).

While these premises are increasingly embraced by historical-ecological researchers, Balée's notion of landscape as contingent nature diverges in many respects from cultural geographers who tend to view landscape as a particular image of reality that achieves its cultural meaning through lived experiences and social processes which reproduce or contest that meaning. If our definition of landscape includes built landscapes, as it must, then we also need to pay attention to, and ideally theorize, how landscapes constitute and reflect the cultural and social values that created them over time and space. Neil Whitehead–the book's lone dissenting voice to the historical ecology approach–shares my concern about the use of landscape in this way, but for different reasons. Whitehead insists that "human decision-making, and the consciousness that drives it," should be the independent variable in the analysis of human-environmental dynamics (p.36). According to Whitehead, since historical anthropology already examines all structures of human activity, historical ecology represents a mixed metaphor that does not present something new.

The Amazonianist contributors explicitly integrate their research into an historical ecology approach. In his chapter, Darrell Posey uses his work among the Kayapó Indians of Brazil to contest the consciousness of conservation. Like Balée, Posey argues that "indigenous peoples" carry out everyday, common sense, and unconscious acts of conservation that increase their environment's biodiversity. Such evidence, Posey argues, has been grossly ignored by conservationists. In an excellent essay, Anna Roosevelt demonstrates that current subsistence patterns among Amazonian foragers reflect historical circumstances associated with the European conquest. Roosevelt argues that human evolution is not a linear affair and that we need to rethink the ecology of "hominization" (p.207). Laura Rival, in another stellar chapter, demonstrates that historical ecology is social history plus biocultural dynamics. Rival details how the Huarani Indians of Ecuador have made political choices and practical engagements with their environment in ways that they have created 'cultural forests' and 'wild gardens.' In his chapter, Ted Gragson applies a landscape ecology analysis to the Manxuj Indians of west-central Paraguay. Focusing on systemic relations between people and their environment, Gragson argues that the Manxuj organize their landscape horizontally and vertically on the basis of socially and geographically contingent beliefs about the world. Working with the Piaroa Indians of Venezuela, Stanford Zent shows that their dispersed and mobile settlement pattern reflects a spatial adaptation to a poor resource environment that is sparsely populated. R. Brian Ferguson analyzes Yanomami subsistence in the 18th and 19th centuries in cases of no-axes, stone axes, and steel axes. He finds that prehistoric subsistence did not reflect a single pattern, but combined with hunting and gathering with short visits to small gardens, and also regular trekking with longer stays at larger gardens. Examining mission activity on the upper Rio Negro of Brazil from 1680 to 1980, Janet Chernela, uses a cultural-environmental analysis to show that elites maintained the missions for political reasons long after their economic viability had waned. Concentrating on indigenous peoples in the tropical lowlands, the Amazonianist anthropologists demonstrate the need to consider historical contingencies when examining human-environmental relations and biogeography, in addition to concepts such as biodiversity, conservation, and nature.

This book's remaining eight chapters are more diverse in topic, scope, and region, and in some respects do not mesh well with their Amazonian counterparts. In her chapter, Linda Newson examines the history of epidemics by exploring the interrelationships among parasites, human hosts, and their environments. She shows that the interaction of these three variables will produce different effects in time and space. Stephen Pyne convincingly shows that anthropogenic fire has produced a wholesale modification of the biosphere. Reversing the stereotypical image of *Homo devastans*, Pyne shows that human use of fire has strengthened rather than depleted biodiversity. For Pyne, images of pristine nature are best thought of as human artifacts associated with the "hominid revolution" (p.70). Elizabeth Graham uses her soil work in Belize to show that the Belizean landscape has been extensively molded by the activities of pre-Columbian peoples. Tristam Kidders's archaeological work in the Mississippi Delta region shows that prehistoric peoples were a dynamic part of their environment, and that their activities show impor-

tant landscape effects to this day. Robert Bettinger traces the history of approaches to the late prehistoric Numic-speaker displacement in the Great Basin region of the American West. Elinor Melville uses her work in Central Mexico to show that Otomí adoption of pastoralism as a parallel system of resource exploitation allowed them to adopt livestock raising while maintaining traditional agricultural practices, and hence their distinct identity. Carol Henderson shows that the cattle boom in the northwest Indian state of Rajasthan between 1951-1991 reflects institutional changes associated with the shifting costs and benefits related to resource access. In the final chapter, Leslie Sponsel finds that John Bennett's concept of the ecological transition "describes and explains to some extent the historical ecology of Thailand" (p.395). With mixed results, these works attempt to expand the historical ecology approach of the Amazonianists to other times, themes, places, and scales.

Advances in Historical Ecology provides a stimulating overview to its topic and demonstrates that the culture-nature dichotomy is indeed arbitrary and dangerously misleading. However, if we seek a genuinely inter-disciplinary approach to society-nature dynamics in time and space, scholars from across disciplines will need to explicitly engage one another and clearly state how their research advances a common theme. For the next historical ecology collection, I recommend that the anthropologists invite the historians, geographers, and landscape ecologists to the conference, not just solicit a sample of their research after the fact.

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USE, MANAGEMENT AND DOMESTICATION OF COLUMNAR CACTI IN SOUTH-CENTRAL MEXICO: A HISTORICAL PERSPECTIVE

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ABSTRACT.— Ethnohistorical and ethnobotanical information on columnar cactus species utilized and managed by peoples of the south Pacific slope in south-central Mexico is presented. This region comprises the highest diversity of species of columnar cacti in the world, with 45 of the 70 Mexican species of Pachycereeae and Cereeae, all of them being useful species. Although columnar cacti have been used by local people for thousands of years, no archaeological or historical records have been found on human manipulation of these plants in the past. At present, most of the columnar cactus species are only gathered from wild populations, but wild populations of 18 species are managed *in situ* and 12 species are cultivated. Quality and availability of useful products, their importance in human subsistence and the viability of manipulation of plants are all factors influencing the way of management of columnar cacti. The pattern of domestication *ex situ* and *in situ* acting simultaneously, observed in *Stenocereus stellatus* is hypothesized to occur also in other columnar cactus species with relatively fast growth and vegetative propagation, whereas a pattern of domestication *in situ* acting alone is hypothesized to occur in giant columnar cactus species. Comparative biological studies of wild and manipulated populations could give information on trends and extent of changes under domestication and, then, to lead to a better understanding on the nature and antiquity of the process.

Key words: columnar cacti, domestication, ethnobotany, Mixteca, Tehuacán Valley

RESUMEN.— Se presenta información etnohistórica y etnobotánica sobre las especies de cactáceas columnares utilizadas y manejadas por pueblos indígenas de la vertiente del Pacífico Sur de México. Esta región comprende la mayor diversidad de especies de cactáceas columnares del mundo, con 45 de las 70 especies mexicanas de Pachycereeae y Cereeae, la totalidad de las cuales son especies útiles. Aunque las cactáceas columnares han sido usadas por la gente de la región durante miles de años, no se han encontrado registros arqueológicos o históricos sobre su manipulación por seres humanos en el pasado. En la actualidad, la mayor parte de las especies de cactáceas columnares son exclusivamente

recolectadas a partir de poblaciones silvestres. No obstante, poblaciones silvestres de 18 especies son manejadas *in situ*, y 12 especies son cultivadas. Aspectos tales como la calidad y disponibilidad de los productos útiles de las cactáceas columnares, su importancia en la subsistencia humana, así como la viabilidad con la que pueden ser manipuladas, son todos factores que influyen sobre el tipo de manejo de estas plantas. Con base en un patrón de domesticación *ex situ* e *in situ* actuando simultáneamente, observado en *Stenocereus stellatus*, se propone la hipótesis de que tal patrón podría presentarse también en especies de cactáceas columnares de crecimiento relativamente rápido y con propagación vegetativa. Se discute también un patrón hipotético de domesticación *in situ* actuando solo en especies de cactáceas columnares gigantes. Estudios de biología comparativa de poblaciones silvestres y manipuladas podrían dar información sobre las tendencias y magnitud de los cambios bajo domesticación, y así conducir a un mejor entendimiento de la naturaleza y antigüedad del proceso.

Palabras clave: cactáceas columnares, domesticación, etnobotánica, Mixteca, Tehuacán

RÉSUMÉ.— Information etnohistorique et etnobotanique sur les espèces de cactacées columnaires utilisées et manipulées par les peuples indigènes du versant Pacifique du sud du Mexique est présentée. Cette région comprend la plus grande diversité d'espèces de cactacées columnaires du monde, avec 45 des 70 espèces mexicaines de Pachycereae et Cereeae, dont la plupart son des espèces utiles. Bien que les cactacées columnaires ont été utilisées par les habitants de la région pendant des milliers d'années, des registres arquéologiques ou historiques sur sa manipulation par des êtres humains dans le passé n'ont pas été trouvés. Dans l'actualité, désormais, même si la plupart des espèces de cactacées columnaires son exclusivement récolectées a partir de populations sauvages, certaines espèces sont en plus manipulées par les gens. En fait, les populations sauvages de 18 espèces son manipulées *in situ*, et 12 espèces sont cultivées. Des aspects tels comme la qualité et la disponibilité des produits utiles des cactacées columnaires, leur importance pour la subsistence humaine, et la viabilité avec laquelle elles peuvent être manipulées, son les facteurs qui agissent sur le genre de manipulation de ces plantes. Des modèles de façons de domestication qui pourraient avoir lieu *ex situ* ou *in situ* pour certaines espèces de cactacées columnaires son discutées. Des études de biologie comparative de populations sauvages et manipulées pourraient donner de l'information sur les tendences et la magnitude des changements sous domestication, et nous mener ainsi à une meilleure comprehension de l'antiquité de ce procesus.

Mots-clés: cactacées columnaires, domestication, etnobotanique, Mixtec, Tehuacan.

INTRODUCTION

Cacti and human cultures in the south Pacific slope of Mexico.— The south Pacific slope in south-central Mexico, including part of the states of Michoacán, México, Morelos, Guerrero, Puebla and Oaxaca (Figure 1), has been identified as the richest area in species of columnar cacti of the world, with nearly 45 of the approximately 70 species of the tribes Pachycereeae and Cereeae of Mexico occurring there (Valiente-Banuet *et al.*, 1996). Thorn-scrub and tropical deciduous forests constitute the most

common vegetation types in the area, and these are commonly dominated by columnar cacti. Archaeological studies in the Tehuacán Valley (MacNeish, 1967, 1992) and Guilá Naquitz, Oaxaca (Flannery, 1986), suggest that the region was inhabited by human beings probably from 12,000 years B. P. These studies also found in the area evidence of the earliest signs of plant domestication in the New World. At present, nearly 19 indigenous ethnic groups live there (Table 1) (see Valdés y Menéndez, 1987). This information thus reveals that the south Pacific slope includes landscapes with a high diversity and abundance of columnar cacti, as well as a considerable diversity of human cultures with a long history of experience in plant management to which columnar cacti have been important resources and cultural elements.

Since ancient times, peoples of the south Pacific slope used a broad spectrum of plant and animal resources with cacti being among the most important because of their abundance, easy accessibility and diversity, offering a great variety of resource options to the ancient gatherers. For example, in the Tehuacán Valley alone, Dávila *et al.* (1993), as well as Arias, Gama and Guzmán (1997) identified nearly 81 cactus species, all of them offering actual or potential edible products (Casas and Valiente-Banuet, 1995).

FIGURE 1.– The South Pacific slope of Mexico.

TABLE 1.— Indigenous ethnic groups from the southern Pacific slope of Central Mexico.

Ethnic group	Distribution within the region
Amuzgo	Guerrero, Oaxaca
Chatino	Oaxaca
Chinantec	Oaxaca
Chontal de Oaxaca	Oaxaca
Cuicatec	Oaxaca
Huave	Oaxaca
Ichcatec	Oaxaca
Mazahua	Michoacán, México
Mazatec	Oaxaca
Mixtec	Oaxaca, Puebla, Guerrero
Mixe	Oaxaca
Nahua	Oaxaca, Puebla, Guerrero, Michoacán, México, Morelos
Otomi	Puebla, México
Chocho-Popoloca	Puebla, Oaxaca
Purépecha	Michoacán, Guerrero
Tlapanec	Guerrero
Triqui	Oaxaca
Zapotec	Oaxaca
Zoque	Oaxaca

Smith (1967) reported remains of nine cactus species (Table 2) from archaeological excavations in the Tehuacán Valley and remains of *Opuntia* sp. from Guilá Naquitz (Smith, 1986). Among the species identified, the columnar cacti are at present important plant resources in the region. However, because archaeological remains of these cacti were not abundant in the floor of the caves studied, Smith (1967) considered that they were not significant items of the diet of ancient people. But this information contrasts with that found in human coprolites by Callen (1967) who, based on characteristics of seeds and crystals in stem tissue, distinguished the following types of cactus remains: 1) "*Opuntia* spp.", 2) "*Lemaireocereus*" (species of the columnar cacti genera *Pachycereus* and *Stenocereus* according to current nomenclature) and 3) "cactus tissue" (unidentified cacti, including possibly columnar cacti). In the earliest coprolites found, from the El Riego phase (6,500-5,000 B. C.), Callen identified the three types of cactus remains to be part of a wild food diet along with *Setaria* seeds, pochote roots (*Ceiba parvifolia* Rose), maguey leaves (*Agave* spp.) and meat. In the Coxcatlán phase (5,000-3,500 B.C), stem tissue and fruits of "*Opuntia*" and "*Lemaireocereus*" were equally dominant material. According to Callen (1967), in the Abejas (3,500-2,300 B.C.), Ajalpan (1,500-900 B.C.), Santa María (900-200 B.C.), Palo Blanco (200 B.C.-A.D. 700) and Venta Salada (A.D. 700-1,540) phases, consumption of "*Lemaireocereus*" stem tissue, fruits and seeds could be more important than products of "*Opuntia*", and during Ajalpan and Santa María phases, "*Lemaireocereus*" could be the principal plant constituents in human coprolites.

TABLE 2.—Archaeological remains of cacti from the Tehuacán Valley (based upon MacNeish, 1967 and Smith, 1967).

Phase	Ajuereado	El Riego	Coxcatlán	Abejas	Purrón	Ajalpan	Sta. María	Palo Blanco	Venta Salada
Radiocarbon date (years B.P)	14 000-8 800	8 800-7 000	7 000-5 400	5 400-4 300	4 300-3 500	3 500-2 800	2 800-2 150	2 150-1 300	1 300-500
Cephalocereus hoppenstedtii[1]		X	X			X	X		
Echinocactus platyacanthus		X						X	
Escontria chiotilla[1]			X					X	
Ferocactus latispinus								X	X
Myrtillocactus geometrizans[1]		X	X						X
Opuntia spp.	X	X	X	X	X	X	X	X	X
Pachycereus hollianus[1]		X	X	X					
Pachycereus weberi[1]		X	X	X			X	X	
Stenocereus stellatus[1]				X				X	

[1]Columnar cacti

According to Callen (1967), remains of raw stem tissue and fruits of *"Lemaireocereus"* were found in all the phases, suggesting a direct consumption of these plant products. However, in the Coxcatlán phase seeds of *"Lemaireocereus"* appear to have been eaten after having been roasted. In the Palo Blanco phase, Callen observed evidence of stems of *"Lemaireocereus"* without epidermis suggesting that they were roasted to discard the charred epidermis.

Cacti and plant domestication in the south Pacific slope.— Domestication is an evolutionary process determined by human beings (see Darwin, 1859, 1868; Schwanitz, 1966; Harlan, 1992). This process results from the continuous manipulation of morphological and physiological variation of plant and animal populations by people according to their social, economic, cultural, and technological needs. As a consequence of domestication, populations of organisms that are manipulated by people are under a continuous process of genetic divergence with respect to the original wild populations (see Hancock, 1992; Casas *et al.*, 1997a). Domestication therefore involves forms of manipulation of plant or animal populations through which people make possible the action of evolutionary forces such as artificial selection (favoring survival and reproduction of desirable phenotypes whereas undesirable phenotypes are eliminated), genetic drift (resulting from isolation of small fractions of genetic variation within manipulated populations), migration (resulting from the movement of plants and animals among localities, regions and/or continents as consequence, for instance, of human migration or commercial exchange), as well as manipulation of reproduction systems.

There is no evidence from archaeological remains that any of the cactus species were cultivated nor that their populations were manipulated in any other form within the south Pacific slope. However, ethnobotanical research in the study area by Caballero & Mapes (1985); Casas, Viveros and Caballero (1994); and Casas *et al.* (1996, 1997b) has revealed that at present there here exists a wide spectrum of forms of interactions between humans and plants, including columnar cacti, and that some of them could have derived from similar forms of plant management practiced by people in the past. Casas *et al.* (1996) group these forms of plant management into those occurring in wild plant populations *in situ* and those occurring *ex situ*. Through management *in situ*, humans may take products from nature without significant perturbations, as in some types of gathering. But also, they may alter the structure of plant populations thereby increasing the quantity of target species or particular phenotypes. These are cases of 1) "tolerance", or practices directed to maintain within man-made environments useful plants that existed before the environments were transformed by humans; 2) "enhancement", which includes the sowing of seeds or the propagation of vegetative structures of plants in the same places occupied by wild populations in order to increase numbers of useful plant populations; and 3) "protection" or conscious activities such as the elimination of competitors and predators, fertilization and/or pruning to safeguard critical wild plants (see examples of these forms of management in Casas and Caballero, 1996; Casas *et al.*, 1996, 1997a; 1997b). On the other hand, plant management *ex situ* includes interactions taking place outside natural populations, in habitats created and controlled by humans. They usually occur with domesticated plants, but it is also possible to find them occurring with wild plants. The

main forms of plant management *ex situ* are: 1) transplantation of complete individuals and 2) sowing and planting of sexual or vegetative propagules (see Casas *et al.*, 1996).

Domestication commonly occurs among plants cultivated *ex situ*, although not all cultivated plants are necessarily under domestication processes (see Harlan, 1975, 1992). However, some forms of artificial selection have been identified to occur also under *in situ* forms of plant management. Gatherers usually distinguish individual plants of some species which are different in features related to quality of food, such as flavor, size, color, presence of toxic substances, etc., and choose the best plants to use (Casas and Caballero, 1996; Casas *et al.*, 1996, 1997a, 1997b). The edible wild plant species and the preferred variants, are tolerated, enhanced and/or protected *in situ* when they are found during the clearing of forest areas, whereas those species and variants whose edible parts are not preferred by people, are eliminated. The effect of this form of artificial selection, as well as other evolutionary forces determined by human beings under forms of management *in situ*, is yet to be documented. However, in the cases of *Anoda cristata* (L.) Schl., *Crotalaria pumila* Ortega, *Leucaena esculenta* (Moc. Et Sessé ex A.DC.) Benth. and *Stenocereus stellatus* (Pfeiffer) Riccobono which have been studied in the region, Casas *et al.* (1997a) found evidence that artificial selection *in situ* has produced significantly higher frequencies of favorable phenotypes in tolerated populations when compared with wild populations. Particularly in the cases of *L. esculenta* (Casas and Caballero, 1996) and *S. stellatus*, (Casas, Valiente-Banuet and Caballero, 1998; Casas *et al.* 1998, 1999a), through multivariate statistical analyses it was found a significant morphological divergence between wild, managed *in situ* and cultivated *ex situ* populations. These analyses also revealed that such divergence is strongly determined by morphological characters used by people in folk classification of variants, in assessing quality of products, and in selecting individuals for preferential propagation, that is, those characters that are direct targets of artificial selection. This information strongly suggests that artificial selection is causing morphological (and presumably also genetic, see Casas *et al.*, 1999a, 1999b) divergence through both cultivation *ex situ* as well as management of wild populations *in situ*, and that domestication *in situ* and *ex situ* are ongoing processes in some plant species in the south Pacific slope.

Objectives.— This research aimed at examining in a historical perspective cultural aspects about use, management, traditional classification and role of columnar cacti in the economy of peoples of the region. The purpose was to document and analyze possible processes of artificial selection occurring on these plant species, how such processes might be operating, which factors are influencing this process at present, and how this could have occurred in the past.

METHODS

Ethnohistorical information.— Codices and chronicles of the Conquest and the Colonial periods for the region were reviewed to extract the historical information on use and management of columnar cacti. In some cases, attempts to identify the

species referred to in such documents were carried out based upon the descriptions and illustrations included on them.

Ethnobotanical studies.— A survey was conducted among indigenous peoples of the south Pacific slope in order to investigate patterns of management and mechanisms of artificial selection on different species of columnar cacti. Information on factors influencing the different ways of management such as forms of use, spatial and temporal availability and role in human subsistence of their useful products was emphasized. This information stressed morphological features of the different species and variants preferred for different purposes, as well as the destination of products of columnar cacti and their role in the economy of the household. Semi-structured interviews were conducted with a total of 12 Nahua, Mixtec and Chocho-Popoloca key native consultants in order to elicit folk classification of cacti among these indigenous ethnic groups of the Tehuacán-Cuicatlán Valley. People interviewed were from the Nahua villages of Coxcatlán and Rancho El Aguaje, Municipality of Coxcatlán, Puebla; the Mixtec village of Santa Catalina Chinango, Municipality of San Pedro y San Pablo Tequixtepec, Oaxaca, in La Mixteca Baja; and the Chocho-Popoloca villages of Los Reyes Metzontla and San Juan Raya, Municipality of Zapotitlán de las Salinas, Puebla.

The ethnobotanical information was complemented with data for the species studied from the Banco de Información Etnobotánica de Plantas Mexicanas (BADEPLAM) of the Botanical Garden at the Instituto de Biología, Universidad Nacional Autónoma de México and from bibliographical sources, especially from Bravo-Hollis (1978), Casas (1997) and Casas *et al.* (1997b).

RESULTS

Historic records on use and management of columnar cacti.— The "General and Natural History of the Indies" is one of the earliest written documents including information on columnar cacti. It was published by Hernández de Oviedo y Valdés, the first chronicler of the New World, in 1535. In chapter XXVI, this author wrote in old Spanish: "De los Cardones en que nasce la fructa que llaman pitahaya. No es mala fructa ni dañosa y es de buen parecer a la vista. Los cardones en que nascen estas pitahayas, es cosa fiera e de mucha salvajez la forma de ellos, los cuales son verdes e las espinas, pardas o blanquecinas, y la fructa colorada°" ("About the thistle-like plants on which the fruit called pitahaya is produced. It is not a bad nor harmful fruit and it is good looking. The thistle-like plants on which the pitahayas are produced are fierce and very savage in form. The plants are green and the spines brownish or whitish and the fruit is red°"). And in another chapter: "De unos cardos altos é derechos mayores que lanzas de armas (é aun como picas luengas) quadrados y espinosos, é a los cuales llaman los Chripstianos cirios por que parecen cirios o hachas de cera, excepto en las espinas. Los cardones que los Cripstianos llaman cirios en esta isla, hay los assi mismo en otras muchas y en Tierra Firme. Estos son una manera de cardos muy espinosos é salvajes que no hay en ellos parte donde se puedan tocar sin muy fieras espinas, non obstante que la Natura se las pone por órden é á trechos una de otras con mucho concierto

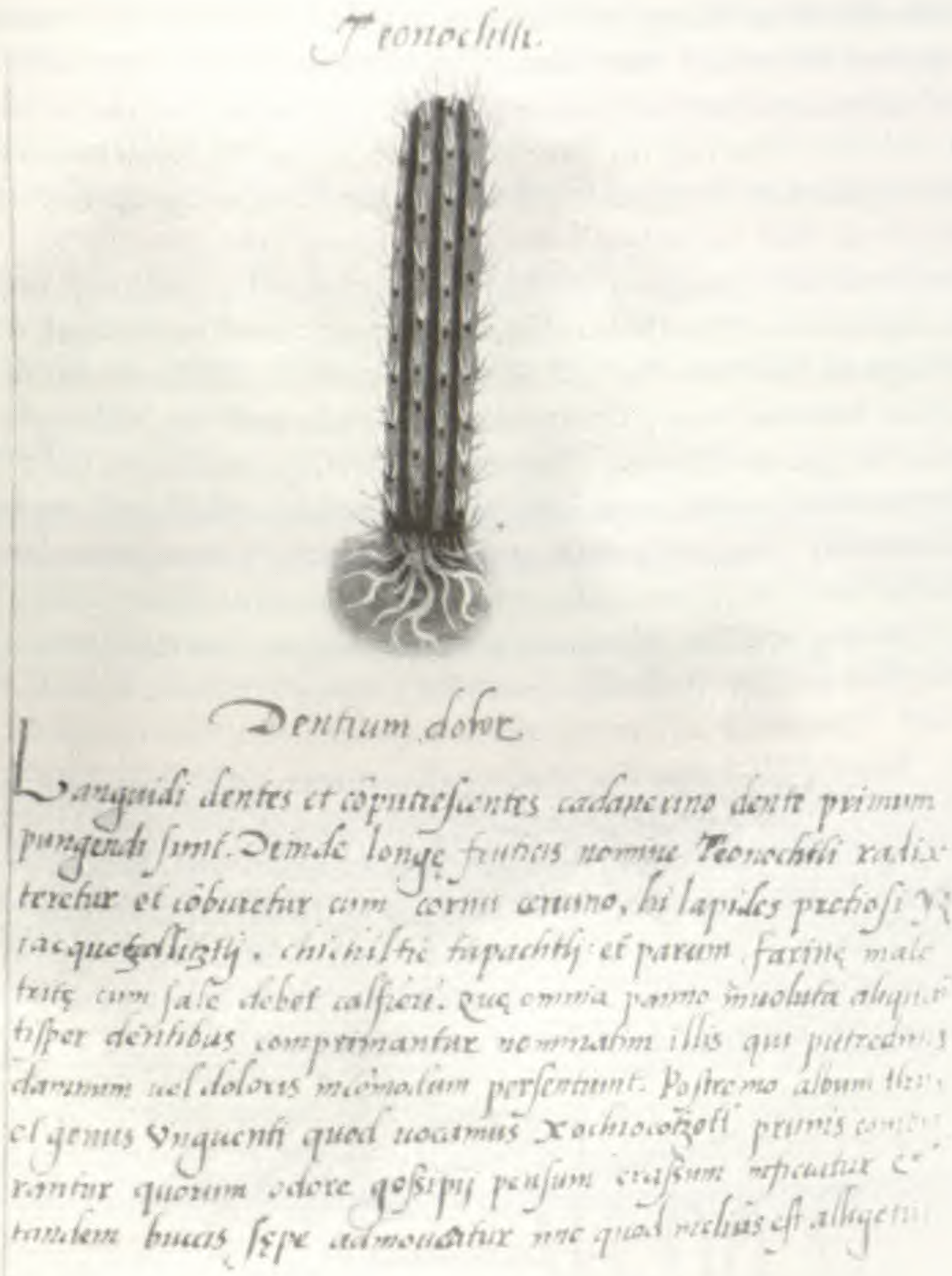

FIGURE 2.– ***Teonochtli,*** from the De la Cruz-Badiano Codex.

é compas repetidas en su composición." ("About some thistle-like plants tall and more upright than lances of the army, squared and spiny which are called "wax candles" by the Christians because they look like candles, with the exception of the spines. The spiny plants called cirios by the Christians in this island are also present in many other islands and on the continent. These are a kind of thistle-like plant very spiny and savage, which have no part that can be touched, because of the spines. However, Nature puts the spines in order and in spaces one behind the other in a very ordered and repetitive composition").

The Barberini Codex from 1552 (De la Cruz and Badiano, 1964), included a plant called "**teonochtli**" ("prickly pear of god" in Náhuatl). This plant has been identified as a species of *Stenocereus* by Bravo-Hollis (1978). Below the drawing (Figure 2), the text in Latin can be translated as: "TEETH PAIN. The ill and carious teeth have to be picked first with a tooth of a cadaver. Then, the root of a tall shrub called ***teonochtli*** is milled and roasted, along with deer antler and the following fine stones: ***iztac quetzaliztli*** and ***chichiltic tapachtli,*** with a small portion of flour

mixed with salt. All these things are heated. All this mixture is covered with a cloth and is applied for a brief time clenching with the teeth, especially the ill or carious ones. Finally, a mixture is made with white incense and a kind of oil called ***xochiocotzol*** and this is burned on live coal and its odor is collected in a piece of cotton which is applied to the mouth with a certain frequency; or, better, it is tied to the cheek".

The Florentino Codex, made in 1547 by some of the first Náhuatl writers, was translated into Spanish by Fray Bernardino de Sahagún and published in the "History of the things of the New Spain" (Sahagún, 1970, 1985). In book II of the Florentino Codex there are many references to the use and the Náhuatl classification of plants of the genus *Opuntia*. Only two drawings and texts (not translated by Sahagún) refer to columnar cacti. Neither can be identified with certainty. The first is called "***netzolli***" (Figure 3) with an inscription in Náhuatl that can be translated as: "***Netzolli***: tasty fruit, twist, many spines, it has arms, spiny plant, hurting". Based on the drawing and the reference to the character "twist" (referring to the branches) this plant is most probably *Escontria chiotilla* (F.A.C. Weber) Rose. The second is called "***teunochtli***" ("sacred prickly pear") and the inscription can be translated as: "***Teunochtli***: It has big fruits with spines, light and dark green, it is cold, it calms thirst". Based on the general appearance of the plant (Figure 3) and the character "big fruits", this could be a species of *Stenocereus*. Sahagún (1985), as well as Del Barco (1988) described how harvest of fruits of columnar cacti was crucial for subsistence of some pre-Columbian and post-conquest peoples from northern Mexico with a nomadic or semi-nomadic life, who migrated from zone to zone following the seasonal abundance of cactus fruits.

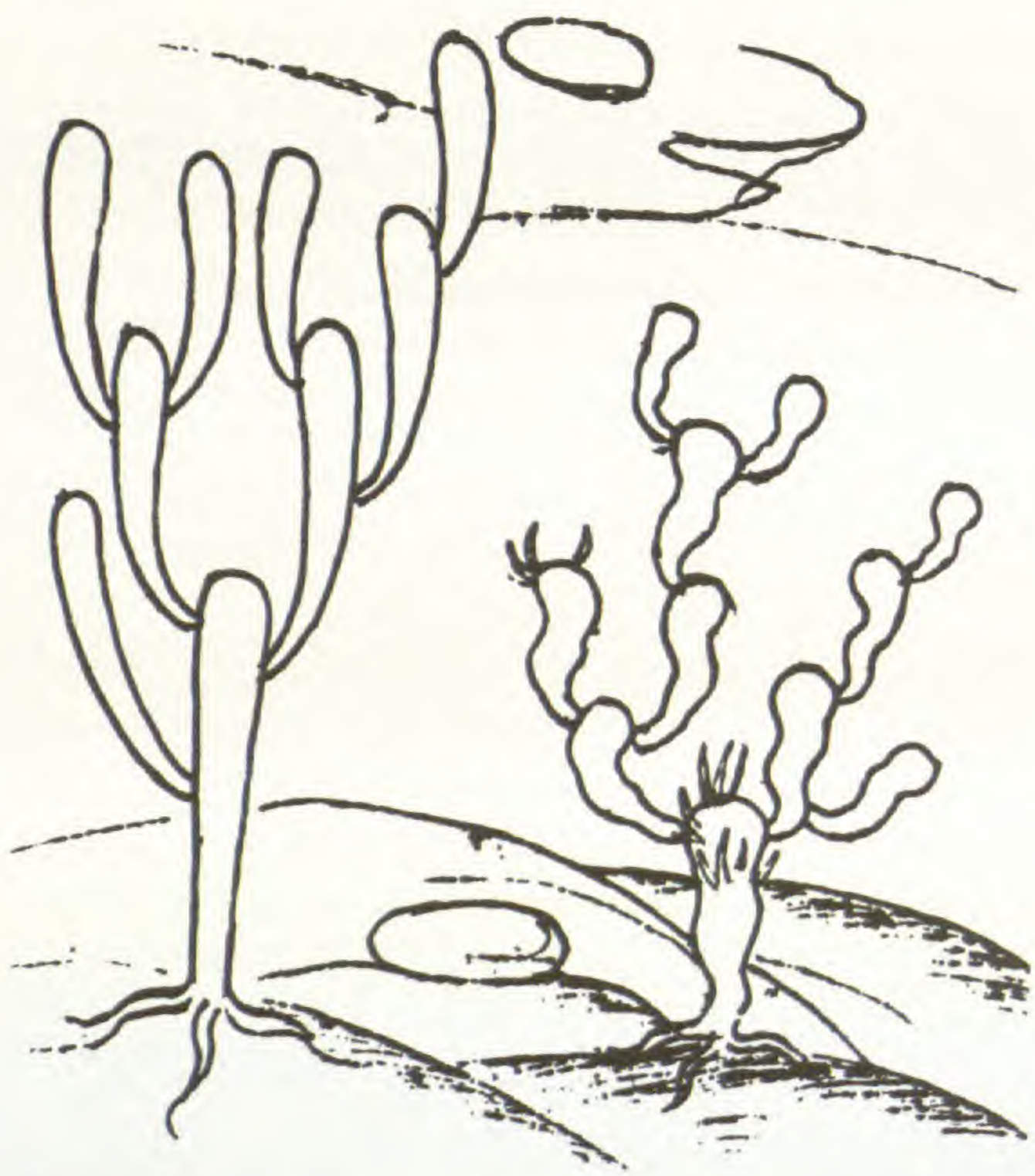

FIGURE 3.– ***Netzolli*** and ***Teunochtli***, from the Florentino Codex

Francisco Hernández (1959), the official physician of the Spanish King Felipe II, described several species of *Opuntia, Ferocactus, Mammillaria, Hylocereus,* as well as *Myrtillocactus geometrizans* (C. Martius) Console and a possible *Stenocereus* species called also "***teonochtli***".

In the "Geographic Relations of the XVI Century" there are several references on the presence, use and management of *Opuntia* as well as toponymic names referring to this genus. However, the only reference to columnar cacti within the area of the south Pacific slope is found in the "Relation of Acatlán", a village near Tehuacán. This Relation, written by Juan de Vera in 1581 (Acuña, 1985), refers to the "***teonochtli***", which is found in chapter 22 in which the wild trees are described: "Hay otro árbol silvestre llamado ***teonochtli***, que son unos cardones grandes, que lleva una fruta llamada pitahayas, muy gustosa y agradable, su madera arde como tea, y se sirven della para alumbrarse." ("There is another wild tree called ***teonochtli***, which is a big spiny plant with a fruit called pitahayas, very tasty and nice; its wood burns like a candle, and people use it for lighting"). This plant could be *Polaskia chichipe* (Rol.-Goss.) Backeberg, the only local columnar cactus species used at present as a candle.

Ethnobotanical information.— In the study area, nearly 40 species of Pachycereeae can be found (Bravo-Hollis, 1978; Dávila *et al.*, 1993; Valiente-Banuet *et al.* 1996) (Table 3). All of these species produce edible fruits that may be collected and consumed by people. Nearly half of these species are giant columnar cacti, 10-15 m tall, characterized by a slow vegetative growth, flowering for the first time several decades after seed germination and, according to local people, for these reasons they have not been cultivated (species with habit "G" in Table 3). However, 20 species are of smaller height (2 to 8 m), relatively fast vegetative growth (the first flowering occurring 6 to 10 years after seed germination or 2 to 4 years after vegetative propagation), with most of these having clonal propagation and, according to local people, for these reasons they have been viable for cultivation (species with habit "S" in Table 3). Among these species, an exceptional morphological variation, apparently associated with human management, can be observed in fruits of *Stenocereus stellatus, S. pruinosus, S. griseus, S. fricci, S. queretaroensis, S. treleasei, Escontria chiotilla, Pachycereus hollianus, P. marginatus* and *Myrtillocactus geometrizans*.

Uses.— Food. Columnar cacti are used mainly for their fruits, which may be consumed as both fresh and dried "pasados" fruits, used for preparing jams (use "1" in Table 3). Although fruits of all species are sometimes consumed by people, it is possible to distinguish: 1) those species producing juicy sweet fruits, which are considered in this study to be "good quality fruits" which are preferred for harvesting; 2) those species considered as "regular quality fruits", which are only occasionally gathered. These include species whose fruits are difficult to obtain due to scarcity of individual plants or populations, or because branches are too tall. Also included are those species whose fruits are difficult to consume because of long or abundant spines and persistent areoles, or with not very good flavor; and 3) those species whose fruits lack juicy pulp and are rarely consumed.

Seeds of the columnar cactus species indicated in Table 3 (use "2") are con-

TABLE 3.— Species of Pachycereeae from the southern Pacific slope of Central Mexico. Uses: 1 = edible fruits (*regular quality, **good quality); 2 = edible seeds; 3 = edible stems and flowers; 4 = fodder; 5 = alcoholic beverages; 6 = house construction; 7 = living fences. Habits: G = giant columnar cacti; S = small columnar cacti. Cultural status: W = wild; M = managed *in situ*; C = cultivated. Destination of products: H = consumption by household; C = commercialization.

Genus	Species	Common Spanish name	Uses	Habit	Cultural status	Destination of products	Distribution within the area
Backebergia	*B. militaris* (Audot) Bravo ex Sánchez-Mejorada		1, 4	G	W	H	Gro, Mich
Cephalocereus	*C. apicicephalium* Dawson		1, 4	G	W	H	Oax
	C. chrysacanthus (Weber) Britton & Rose		1*, 4	G	W	H	Pue, Oax
	C. collinsii (Britton & Rose) Knuth		1*, 4	S	W	H	Oax
	C. guerreronis (Backeberg) Buxbaum		1, 4	S	W	H	Gro
	C. hoppendstedtii (Weber) Schumann	cardón viejo	1*, 4, 6	G	W	H	Pue
	C. nizandensis (Bravo et MacDougall) Buxbaum		1, 4	G	W	H	Oax
	C. palmeri Rose var. *Sartorianus* (Rose) Krainz		1*, 4	G	W	H	Oax
	C. purpusii Britton & Rose	viejo	1, 4	S	W	H	Mich
	C. quadricentralis Dawson		1, 4	S	W	H	Oax
	C. totolapensis (Bravo et MacDougall) Buxbaum		1, 4	G	W	H	Oax
Escontria	*E. chiotilla* (Weber) Rose	chiotillo	1**, 2, 3, 4, 5, 7	S	W-M	H-C	Pue, Oax, Gro, Mich
Mitrocereus	*M. fulviceps* (Weber) Backeberg ex Bravo	cardón	1*, 4, 6	G	W	H	Pue, Oax
Myrtillocactus	*M. geometrizans* (Martius) Console	garambullo	1**, 4, 5, 7	S	W-M	H-C	Gro Oax, Mich
	M. schenkii (Purpus) Britton & Rose	vichishovo	1**, 4, 5, 7	S	W-M	H-C	Pue, Oax
Neobuxbaumia	*N. macrocephala* (Weber) Dawson	cardón	1, 4, 6	G	W	H	Pue
	N. mezcalaensis (Bravo) Backeberg	cardón	1**, 2, 3, 4, 6	G	W	H	Pue, Oax, Mor Mich, Gro
	N. multiareolata (Dawson) Bravo		1, 4	G	W	H	Gro

	N. scoparia (Poselger) Backeberg		1, 4	G	W	H	Oax
	N. tetetzo (Coulter) Backeberg	tetecho	1**, 2, 3, 4, 6	G	W	H-C	Pue, Oax
Pachycereus	*P. grandis* Rose	cardón	1**, 2, 4	G	W	H	Mor, Mex, Pue
	P. hollianus (Weber) Buxbaum	baboso	1**, 2, 4, 5 7	S	W-M-C	H	Pue
	P. marginatus (DeCandolle) Berger et Buxbaum	malinche	1**, 4, 7	S	W-M-C	H	Pue, Oax, Mex
	P. pecten-aboriginum (Engelmann) Britton & Rose	hecho	1**, 2, 4, 6	G	W-M	H	Mich, Gro, Oax
	P. weberi (Coulter) Buxbaum	cardón	1**, 2, 4, 5, 6	G	W-M	H-C	Pue, Oax, Gro, Mich
Polaskia	*P. chende* (Gosselin) Gibson & Horak	chende	1**, 2, 4, 7	S	W-M-C	H-C	Pue, Oax
	P. chichipe Backeberg	chichipe	1**, 2, 4, 7	S	W-M-C	H-C	Pue, Oax
Stenocereus	*S. dumortieri* (Scheidweiler) Buxbaum	pitayo	1**, 2, 4, 5, 6	G	W-M	H-C	Oax, Mor, Gro. Mich
	S. griseus (Haworth) Buxbaum	pitayo de mayo	1**, 2, 3, 4, 5, 7	S	C	H-C	Pue, Oax, Gro
	S. pruinosus (Otto) Buxbaum	pitayo de mayo	1**, 2, 4, 5, 6	S	W-M-C	H-C	Pue, Gro Oax
	S. stellatus (Pfeiffer) Riccobono	xoconochtli	1**, 2, 3, 4, 5, 7	S	W-M-C	H-C	Mor, Pue, Oax, Gro
	S. treleasei (Vaupel) Backeberg	tunillo, pitayo	1**, 2, 4, 7	S	W-M-C	H-C	Oax
	S. fricii Sánchez-Mejorada	pitayo de aguas	1**, 2, 4, 7	S	W-M-C	H-C	Mich
	S. queretaroensis (Weber) Buxbaum	pitayo	1**, 4, 7	S	W-M-C	H-C	Mich
	S. quevedonis (González Ortega) Bravo	pitire	1**, 2, 4, 7	S	W-M-C	H-C	Mich, Gro
	S. chacalapensis (Bravo et Mac Dougall) Buxbaum	pitayo	1**, 4	G	W	H	Oax
	S. chrysocarpus Sánchez-Mejorada	pitayo	1**, 4	G	W-M	H	Mich
	S. beneckei (Enrenberg) Buxbaum	pitayo	1*, 4, 7	S	W	H	Gro, Mor, Méx,
	S. standleyi (González Ortega) Buxbaum	pitayo marismeño	1**, 2, 4, 7	S	W-M-C	H	Mich, Gro

sumed by people. In general, seeds obtained from fresh or dried fruits are washed, dried and roasted. The roasted seeds are ground with chiles, onion and tomatillo or "husk tomato" (*Physalis philadelphica* Lam.) or red tomato for preparing traditional sauces which are among the main components in the daily diet of indigenous peoples of the area. The roasted cactus seeds may also be ground into an edible paste.

Stems and flowers of the species indicated in Table 3 under use "3" are occasionally eaten. Stems of columnar cacti seem to have been a common food in the past (Callen, 1967) but at present these parts are usually eaten during seasons of food scarcity. Young stems are prepared by removing the spines, cutting them in longitudinal pieces and removing the medullar portion, then roasting them in order to remove the cuticle. The flower buds are more commonly consumed during the flowering seasons. These buds are eaten boiled and then fried with eggs, but the boiled flower buds may also be prepared with onion and vinegar. This is particularly common with *Neobuxbaumia tetetzo* but occurs also with flower buds of other columnar cacti (Table 3).

In the Tehuacán Valley, economic value of edible parts is as follows, 3-5 fresh fruits or 6-10 dried fruits of *Stenocereus stellatus* (see also Casas *et al.*, 1997b), *S. pruinosus* or *Escontria chiotilla*; 8-10 fresh fruits or 10-15 dried fruits of *Polaskia chichipe*, *P. chende* or *N. tetetzo* and 1 liter of both fresh or dried fruits of *Myrtillocactus geometrizans* are exchanged for one liter of maize; one liter of flower buds for three liters of maize; and one liter of seeds for fifteen liters of maize. These columnar cacti seem to be at present the most economically important ones in the region.

Fodder. In general, branches of columnar cacti are cut and fed to domestic donkeys, cows and goats, after removal of the spines (use "4" in Table 3). Complete fruits or their peel are also used as fodder for pigs. Pulp, seeds and chipped peels without spines are used for feeding chickens and turkeys.

Alcoholic beverages. An alcoholic drink called "***colonche***" or "***nochoctli***" ("prickly pear pulque" in Náhuatl) may be prepared from fruits of *Opuntia* spp., as well as from the species of columnar cacti indicated in Table 3 (use "5"). For preparation of "***nochoctli***", fruit juice is separated from seeds and then left for fermentation. Flavored spirits are also prepared by mixing fruits of *Myrtillocactus geometrizans*, *M. schenki*, *Stenocereus pruinosus*, and *S. stellatus* with the sugarcane alcohol "aguardiente".

Material for construction. Wood of giant columnar cacti is commonly used in construction of house roofs and fences (use "6" in Table 3). People generally collect the hard vascular tissue from decayed stems and branches of old giant columnar cacti that naturally fell down in the forest.

Living fences. Individuals of 11 species (use "7" in Table 3), are commonly grown as living fences in home gardens and as barriers for soil protection in terraces of cultivated slopes.

Fuel. Dry branches of all species of columnar cacti are collected to use as fuel for cooking. However, branches of *Polaskia chichipe* and *Stenocereus stellatus*, along with wood of other plant species, mainly *Ipomoea arborescens* G. Don, are especially used

for firing pottery, because the specific heat and low amount of smoke produced when burning branches of these species are considered by people to be particularly efficient for this activity.

Traditional management.— Gathering. Peoples of the area commonly gather fruits and other useful products of columnar cacti from wild populations (cultural status "W" in Table 3). In general, people said that they gather fruits selectively, preferring larger fruits of species or variants with juicy pulp, sweeter flavor, thinner pericarp, shorter and fewer spines and deciduous areoles.

Forms of management *in situ*. Additional forms of interaction can also be observed with some of the columnar cactus species. For instance, people frequently tolerate or let stand individuals of up to 18 species of columnar cacti when they clear the vegetation for cultivating maize (cultural status "M" in Table 3). This form of management is part of a general form of management *in situ* of useful perennial plants. It is also a common practice that people sow in these areas seeds of species of legume trees and plant vegetative propagules of the columnar cacti tolerated, in order to enhance their abundance in populations. Because the individuals of these tolerated species compete with the cultivated plants, people carefully select which species are the best for sparing. Their decision takes into account the usefulness of the species to spare. In the Tehuacán Valley, for instance, according to directed interviews, people manifested their preference to tolerate different species in the following order, according to their utility: *Leucaena esculenta, Prosopis laevigata* (Humb. and Bonp. Ex Willd.) M.C. Johnston, *Stenocereus stellatus, S. pruinosus, Pachycereus hollianus, P. marginatus, Myrtillocactus geometrizans, Pithecellobium dulce, Escontria chiotilla, Polaskia* spp., *Pachycereus weberi, Beaucarnea gracilis* Lem. and *Mitrocereus fulviceps* (Weber) Backeberg ex Bravo. They also take into account the characteristics of the useful products of the individuals within each species. In the case of columnar cacti, people prefer to spare mainly individuals with big fruits, sweet flavor, thin pericarp and few spines. However, the tolerance of other phenotypes is also common, especially when there are no other useful species or phenotypes competing. Sometimes, people prune the tolerated plants in order to improve conditions for growing maize.

Cultivation. A total of 12 species are cultivated (cultural status "C" in Table 3), mainly by planting vegetative parts in home gardens or in agricultural fields where they serve as living fences or as barriers to prevent soil erosion. In general, people cut vigorous branches from mature wild or cultivated individuals. Pieces of branches used for this purpose may be 20 to 150 cm long. They are left exposed to the sun for ten or fifteen days in order that the cut surface may dry, thus reducing fungal and bacterial infections. Then, the branches are planted in holes 10 to 40 cm deep with cattle or goat dung added as fertilizer before planting. They are usually planted just before the rainy season. They are eventually irrigated and ash is commonly deposited, as fertilizer, on the soil covering the main stems.

Individuals of columnar cacti cultivated in home gardens may also be derived from seedlings which grew from seeds dispersed via bird, bat or human feces. Because people generally do not recognize variants of columnar cactus species based on vegetative characteristics, decisions on eliminating or sparing individu-

als are taken after four to ten years, depending of the species managed, when the individuals first produce fruits.

Indigenous nomenclature and classification of columnar cacti.— Nahua classification. The Nahua people from the Municipality of Coxcatlán classify the cacti in six great categories (Figure 4). The first is "***nopalli***" which includes all the plants of the genus *Opuntia*; the second is "***nopal-xochitl***" ("nopal with flowers") and includes species of epiphytes with flat stems and beautiful flowers, such as species of the genus *Nopalxochia*; the third is "***huitznahuac***" ("surrounded of spines") or "***comitl***"

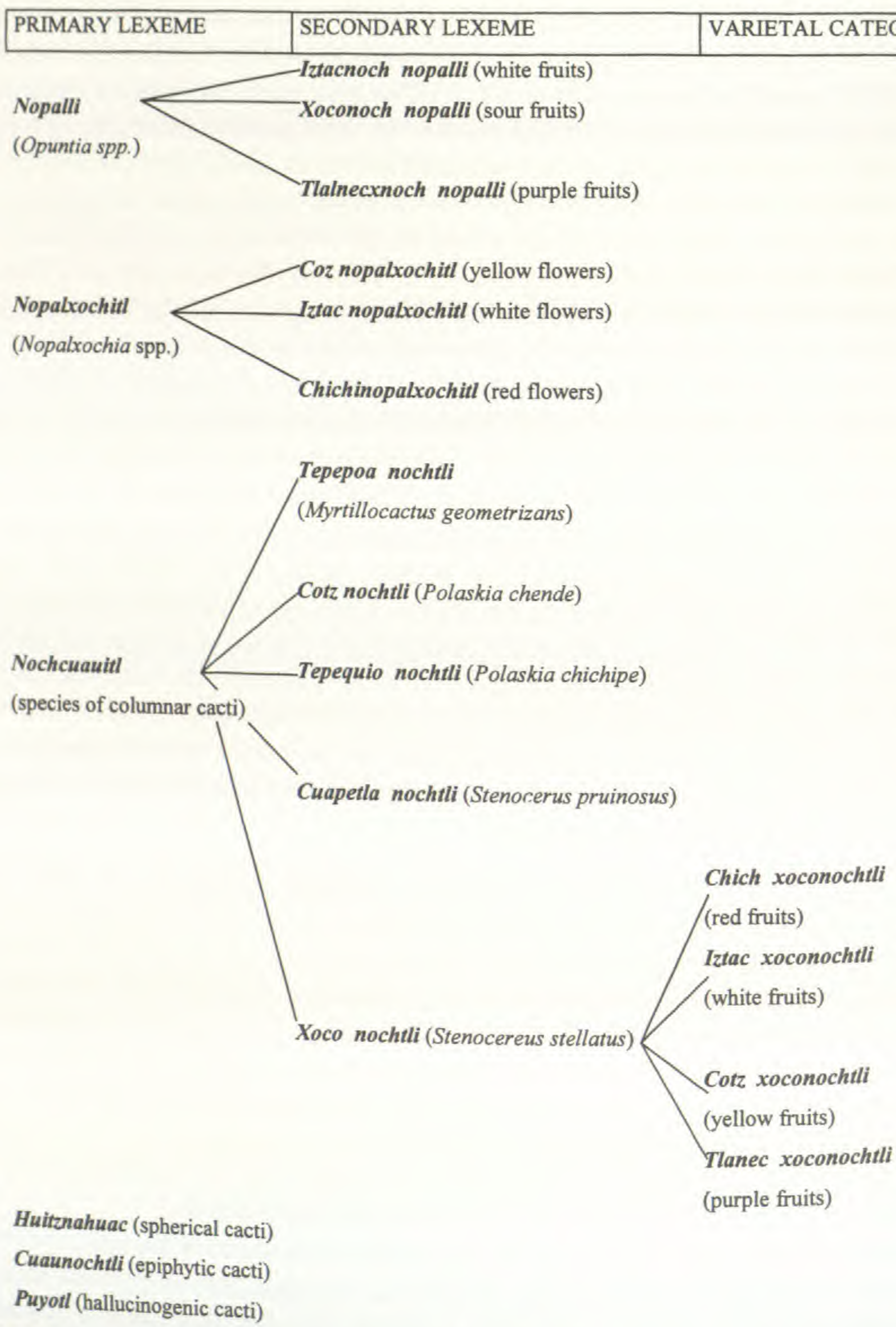

FIGURE 4.– Náhuatl system of classification of cacti.

(which refers to the form of traditional Indian pottery) which includes spherical cacti such as *Mammillaria, Ferocactus, Echinocactus*, and others; the fourth is "***cuaunochtli***" ("prickly pear on tree") which includes several species of epiphytic cacti such as *Hylocereus*; the fifth includes species of *Lophophora* which are called "***puyotl***" (the root of the transformed word "peyote") because of their hallucinogenic properties; the sixth includes the columnar cacti and is designated by the word "***noch-cuauitl***" which means "tree producing prickly pears". It is composed by the term "***nochtli***", a word that designates the fruits of all the species of cacti and "***cuauitl***" which means tree.

The name of each of these six categories is used by the Nahua as a folk generic and an epithet, generally referring to some characteristic of a specific part of the plant, provides a folk specific. In the case of the category "***nopal-xochitl***", the flowers are the parts which are considered for naming the folk specifics. For example, the word "***cos-nopal-xochitl***" includes as a prefix the term ***costic***, meaning yellow, signifying the kind of nopalxochitl with yellow flowers, indicating the cultural and cognitive significance of the flowers for the Nahua people in relation to these plants. In the case of the "***nopalli***" (*Opuntia*) and columnar cacti, fruits are the most important part used in classification. For example, terms "***iztac-noch-nopalli***", "***coz-noch-nopalli***", "***xoco-noch-nopalli***" and "***tlanecx-noch-nopalli***" designate nopalli with white, yellow, sour and purple prickly pears respectively.

In the case of columnar cacti, the Nahua of Coxcatlán use the name "***noch-cuauitl***" or more often only "***nochtli***" as a folk generic. This reveals the cultural importance of these fruits to the Nahua. For example, *Myrtillocactus geometrizans* is called "***tepe-poa-nochtli***", ("pitahaya from aggressive hills"); *Polaskia chende* is called "***cotzo-nochtli***" ("yellow pitahaya"); *P. chichipe* is called "***tepe-quio-nochtli***" ("pitahaya of scapes -***quiotl*** is the term used for agave scapes- from the hills"); *Stenocereus pruinosus* is called "***cuapetla-nochtli***" ("pitahaya of big tree"); and *S. stellatus* is called "***xoco-nochtli***" ("sour pitahaya").

The first level of classification of columnar cacti by the Nahua is based on color of the pulp. In the case of "***xoco-nochtli***" (*S. stellatus*), for instance (see Casas *et al.*, 1997b), people name four variants: "***chichi-xoco-nochtli***" ("red and pink xoconochtli"), "***iztac-xoco-nochtli***" ("white xoconochtli"), "***coz-xoco-noxtli***" ("yellow or orange xoconochtli"), "***tlanec-xoco-nochtli***" ("purple xoconochtli"). They subsequently distinguish between sweet and sour flavors, using the words "***necuti***" and "***xocotl***" respectively, but these epithets never form part of the names of the plant. Similarly, they use "***uitztli***" and "***amo uitztli***" for spiny and non spiny fruits.

Chocho-Popoloca classification. Among the Chocho-Popoloca people of the Municipality of Zapotitlán de las Salinas, the classification of cacti follows a hierarchical pattern very similar to that of the Nahua (Figure 5). The term "***túchi***" ("prickly pear") is used as folk generics for grouping species of *Opuntia* and columnar cacti with big edible fruits. This term is distinguished from "***lúchi***" that includes spherical cacti. The secondary lexeme "***kánda***" groups species of the genus *Opuntia*, while each species of columnar cactus present in the area is designated by a particular name. For instance, *Stenocereus pruinosus* is designated by the name "***túchi-chína***", *Myrtillocactus geometrizans* by "***túchi-lásha***", *Polaskia chichipe* by "***túchi-cásha***" and *S. stellatus* "***túchi-kíshi***. In species of columnar cacti, as well as in *Opuntia* spp.,

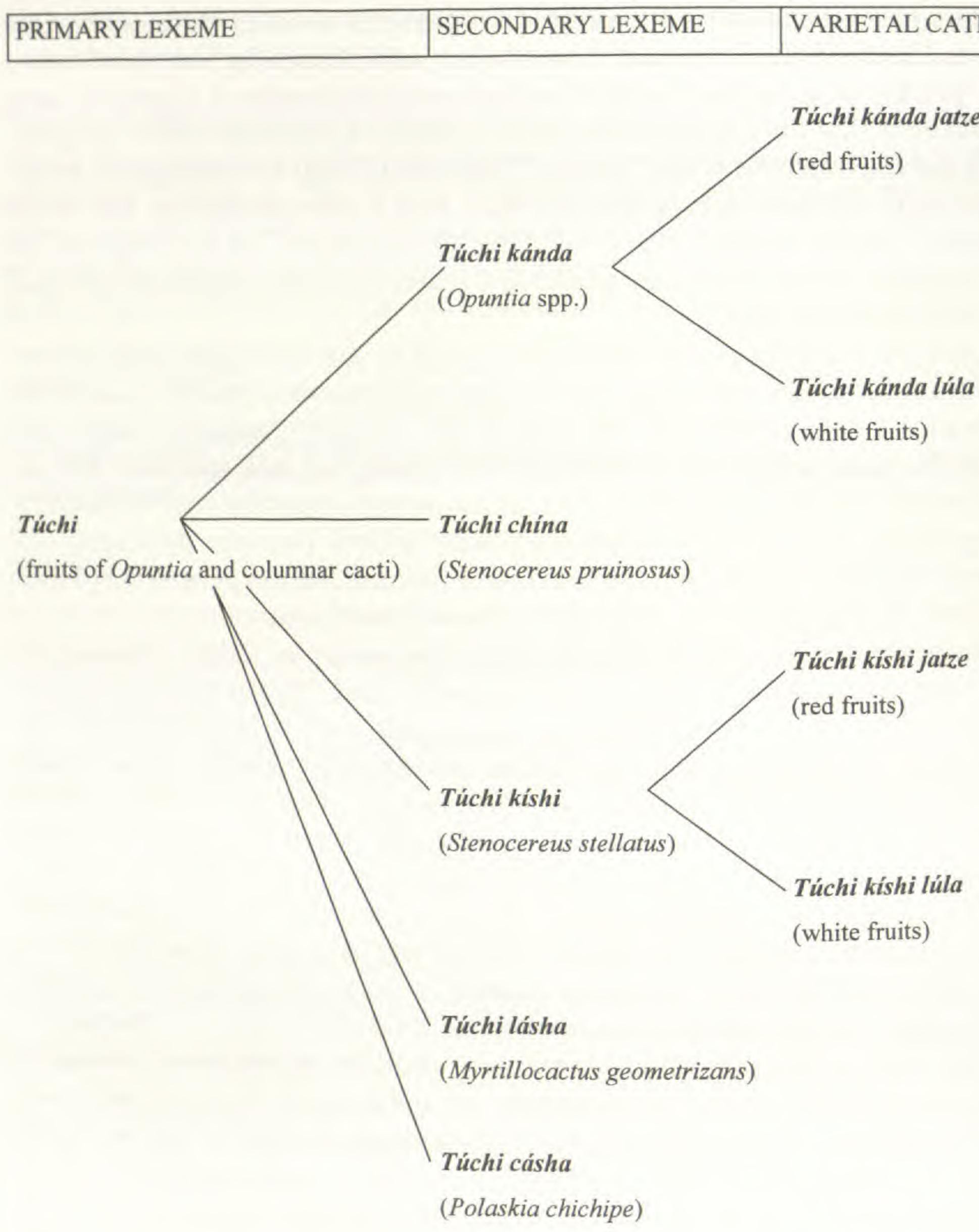

FIGURE 5.– Chocho-Popoloca system of classification of cacti.

further categories may be designated by color. In *Stenocereus stellatus*, for example "***túchi-kíshi-lula***" and "***túchi-kíshi-jatze***" are names used for designating variants of white and red pulp. Variants of other colors are absent in the area (Casas *et al.* 1997b). Similarly, the names "***túchi-kíshi-íisátu***", "***túchi-kíshi-íshetu***" and "***túchi-kíshi-íisan***" are used to designate variants of sour, sweet and insipid flavor, respectively. Variants of spiny fruits are designated by the name "***túchi-kíshi-nyúñu***", while the variants with few spines are designated by "***túchi-kíshi-canyúñu***" (see also Casas *et al.*, 1997b).

Mixtec classification. The Mixtec people of the Municipality of San Pedro y San Pablo Tequixtepec classify cacti in three great groups. In one of them the term

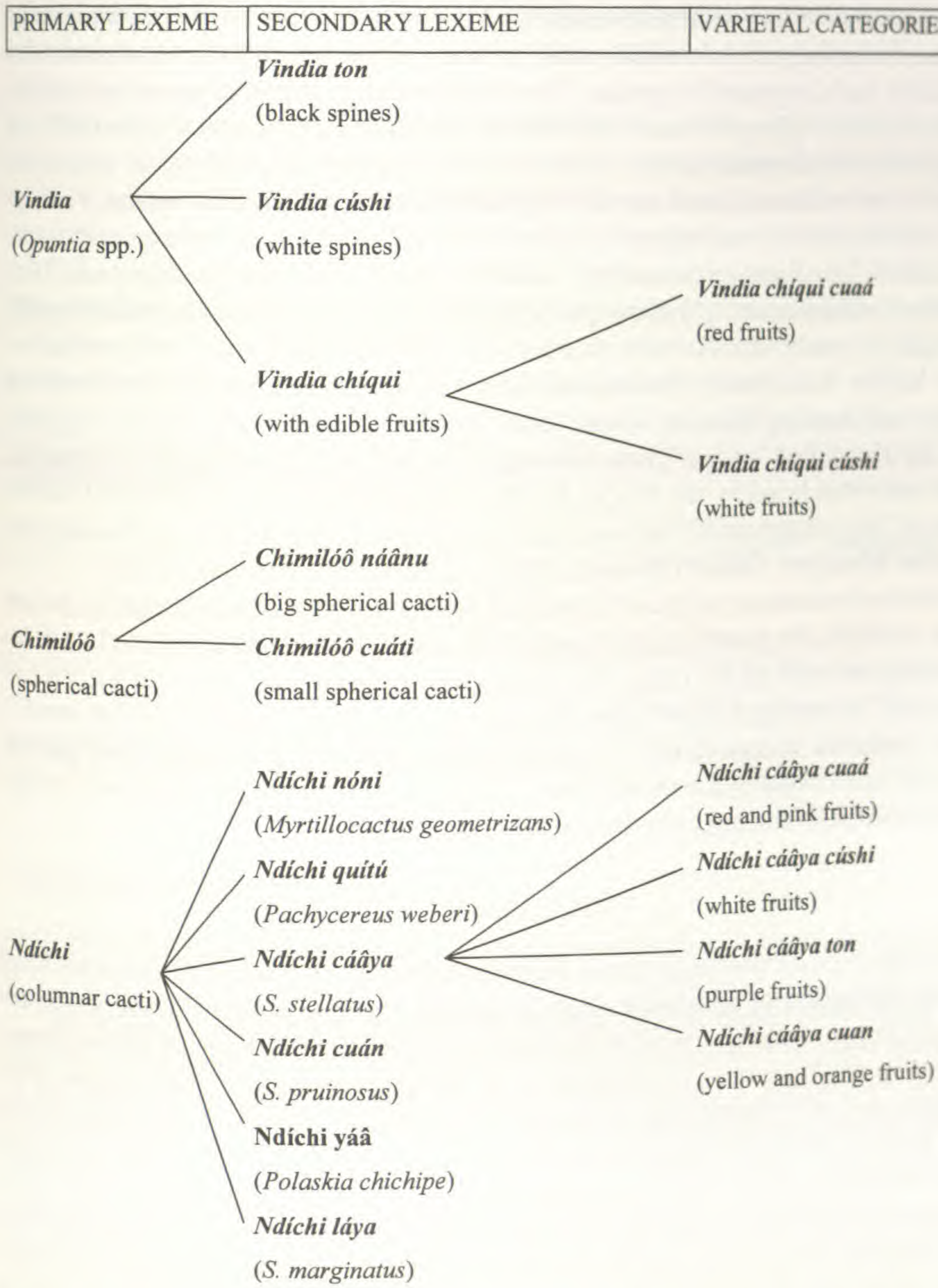

FIGURE 6.– Mixtec system of classification of cacti.

"***vindia***" is used as folk generics for naming *Opuntia* species (Figure 6). Specific terms may refer to characteristics of cladodes, for example "***vindia-ton***" ("black nopal") and "***vindia-cúshi***" ("white nopal") are terms referring to the presence of black and white colored spines respectively. Specific terms may also refer to characteristics of fruits which are called "***chíqui***". "***Vindia-chíqui-cuaá***" ("red prickly pear nopal"), "***vindia-chíqui-cúshi***" ("white prickly pear nopal") are examples of this situation. Spherical cacti are classified using the folk generics "***chimilóô***". People in the Mixtec region only distinguish two species of spherical cacti,

"***chimilóô-náânu***" ("big spherical cactus") in which *Ferocactus* and *Echinocactus* species are included, and "***chimilóô-cuáti***" ("small spherical cacti") which includes *Mammillaria* and *Coryphantha* species. The third main group is formed by columnar cacti classified using the term "***ndíchi***" as folk generics, which is also used for naming fruits of columnar cacti.

Species of columnar cacti are distinguished using particular terms. For example, "***ndíchi-nóni***" ("maize fruit") is used for naming *Myrtillocactus geometrizans*; "***ndíchi-quitú***" for *Pachycereus weberi*; "***ndíchi-cáâya***" ("sandy prickly pear") for *S. stellatus*; "***ndíchi-cuan***" ("yellow prickly pear") for *S. pruinosus*; "***ndíchi-yáâ***" ("white prickly pear") for *Polaskia chichipe* and "***ndíchi-laya***" for *P. marginatus*.

The Mixtec thus clearly distinguish between fruits of *Opuntia* and fruits of columnar cacti naming them as "***chíqui***" and "***ndíchi***", respectively. Fruits of spherical cacti are also called "***chíqui***", but, although they are also occasionally consumed, these are not considered by the Mixtec for the classification. Use of different names for fruits of *Opuntia* spp. and columnar cacti has also been found among the Zapotec of San Juan Mixtepec, Oaxaca (Eugene Hunn, personal communication).

Variants of columnar cacti are classified based on fruit characteristics. In the case of *S. stellatus*, for instance (see Casas *et al.*, 1997b), the first level of classification is based on color of the pulp. The Mixtec distinguish two main categories of "xoconochtli" according to their color: the red "xoconochtli" ("***ndíchi-cáâya-cuaá***") and the "colored xoconochtli" ("***ndíchi-cáâya-color***") in which they group xoconochtli with fruits of the three other colors (including white) that they recognize. They consider the red color as a wild characteristic.

DISCUSSION

Although both archaeological and historical sources indicate a continuous long history of utilization of columnar cacti by peoples of the south Pacific slope region, no evidence could be found in such sources about cultivation of these plants. In relation to the historical documents, it is difficult to accept that people who wrote them did not observe the presence of columnar cacti in the Indian home gardens as they can be seen at present. One possible explanation for this omission in the documents could be that Spaniards did not consider fruits of columnar cacti to be important resources, and for this reason they did not describe them as they did not describe many other plants. In this respect, it could be illustrative to mention that in the case of *Opuntia*, there are several references on cultivation of those species dedicated to the production of the "grana" (cochineal), a very important product for the Spaniards, but there are no references to those species dedicated to the production of prickly pear fruits. But another possible explanation for such an omission is that cultivation of columnar cacti started more recently, as suggested by Pimienta-Barrios and Nobel (1994) in the case of *Stenocereus queretaroensis*.

Additional archaeological and historical evidence is needed for answering this question, but botanical studies might also provide helpful information. These studies would allow us to examine evolutionary changes of columnar cacti under domestication by comparative analysis of morphological and genetic variation among wild and manipulated plant populations, as well as the analysis of reproductive biology and other biological aspects commonly affected by human

manipulation. This information might contribute to evaluating the extent and trends of changes under domestication and to better understanding about the antiquity of human manipulation.

The ethnobotanical information obtained indicates that at present people make decisions about how to manipulate columnar cacti species or variants according to the quality of their products, and their role in human subsistence (Figure 7). Thus, the species and variants cultivated or managed *in situ* are generally those with the most useful fruit characteristics. However, as we found in the case of *Stenocereus stellatus* (Casas *et al.*, 1997b), cultivation is particularly intensive in areas where the commercialization of fruits or their consumption by households makes necessary the production of more and or better fruits.

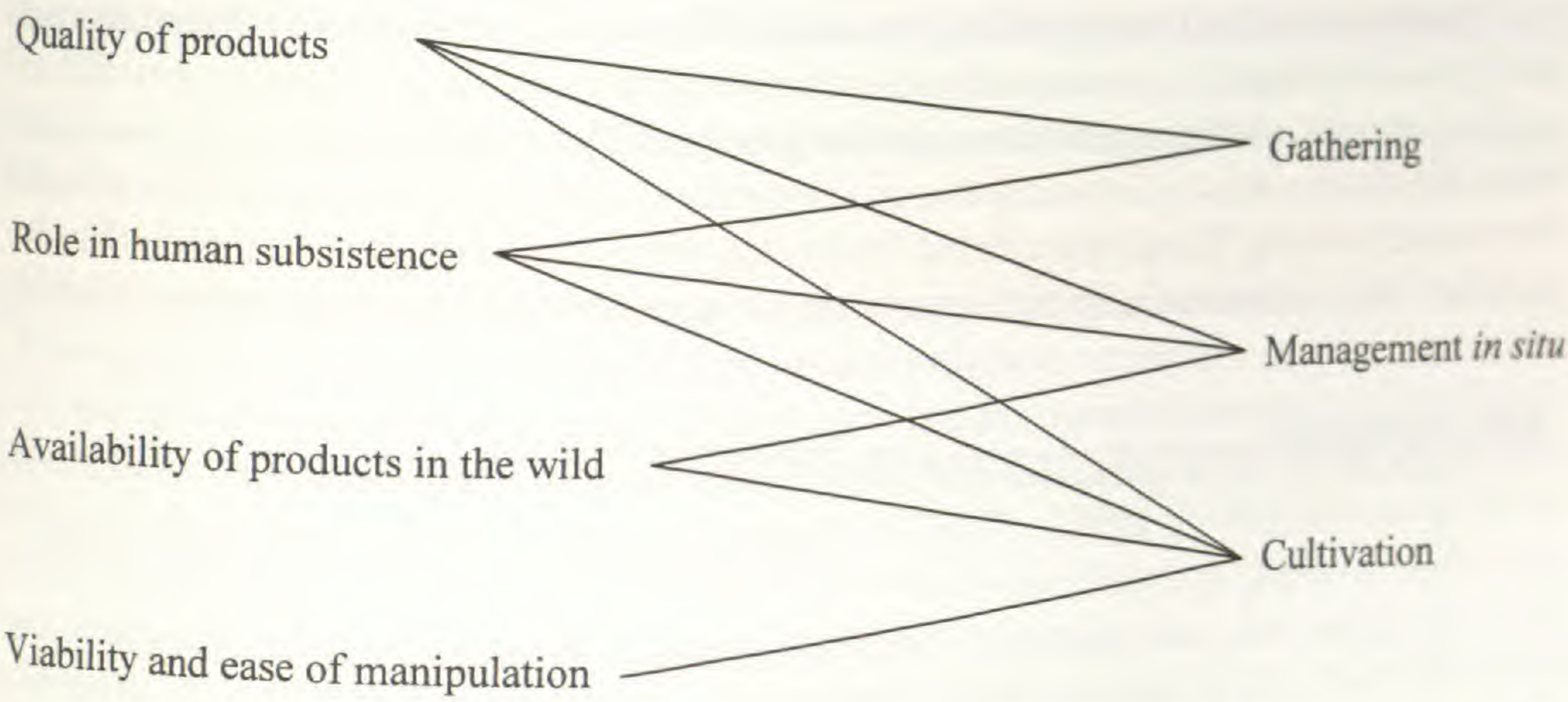

FIGURE 7.– Factors influencing types of interactions between people and columnar cacti.

Availability of plant resources is another crucial factor influencing the way they are manipulated, and this seems to be a general pattern of plant management in the area. Thus, we found that *Leucaena esculenta* and *S. stellatus* are intensively cultivated generally in places where wild populations are scarce, but not where they are abundant in the wild (Casas and Caballero, 1996; Casas *et al.*, 1997b). Also, Messer (1978) refers to a Zapotec informant who affirmed that "...we have the chipil (*Crotalaria pumila*) seeds to plant for the time when there are none in the fields so we will have greens to eat". A similar situation was observed by Casas, Viveros and Caballero (1994) among the Mixtec of Guerrero who, during the dry season, cultivate *Crotalaria pumila* and *Anoda cristata* and enhance *Amaranthus hybridus* L., in order to increase their availability.

The viability and ease of manipulation is also important. Thus, although species such as *Neobuxbaumia tetetzo, N. mezcalaensis, Mitrocereus fulviceps* and *Pachycereus weberi*, among others (Table 3), produce fruits of a very good quality, they are not cultivated *ex situ* because their slow growth makes unattractive the effort of sowing seeds and taking care of seedlings whose products most probably are not going to be seen by the sower. Slow growth may not be relevant for making decisions on managing wild populations of such species *in situ* since people simply tolerate their presence during the clearing of vegetation. However, the ef-

fect of artificial selection favoring particular phenotypes of these species *in situ* might be hardly notorious given the difficulties people have increasing numbers of desirable phenotypes by intentional direct propagation. Furthermore, when seeds of desirable phenotypes are sown, their generally outcrossing reproduction system (Casas et al., 1999b; Valiente-Banuet, *et al.* 1996, 1997a; 1997b) would make uncertain that the phenotypes selected were those expressed in the progeny sown, due to the additive genetic variance of desirable traits. On the contrary, the fixation of desirable characters in species with vegetative propagation such as *S. stellatus*, *S. pruinosus* or *S. queretaroensis* (Table 3) is relatively easy. In these species, the reproductive system is generally also outcrossing (Casas *et al.*, 1999b, Pimienta-Barrios and Nobel, 1994), but artificial selection on progeny from sexual reproduction is possible because they grow relatively fast.

Traditional classification of species and infraspecific variants of columnar cacti are generally based on characteristics of fruits, particularly size, color, and flavor of the pulp, as well as spininess and thickness of the peel. Fruits are at the same time the main useful parts and the characteristics mentioned are used by people for characterizing the quality of the fruits. Combinations of states of such characteristics may produce a broad spectrum of species and variants recognized by

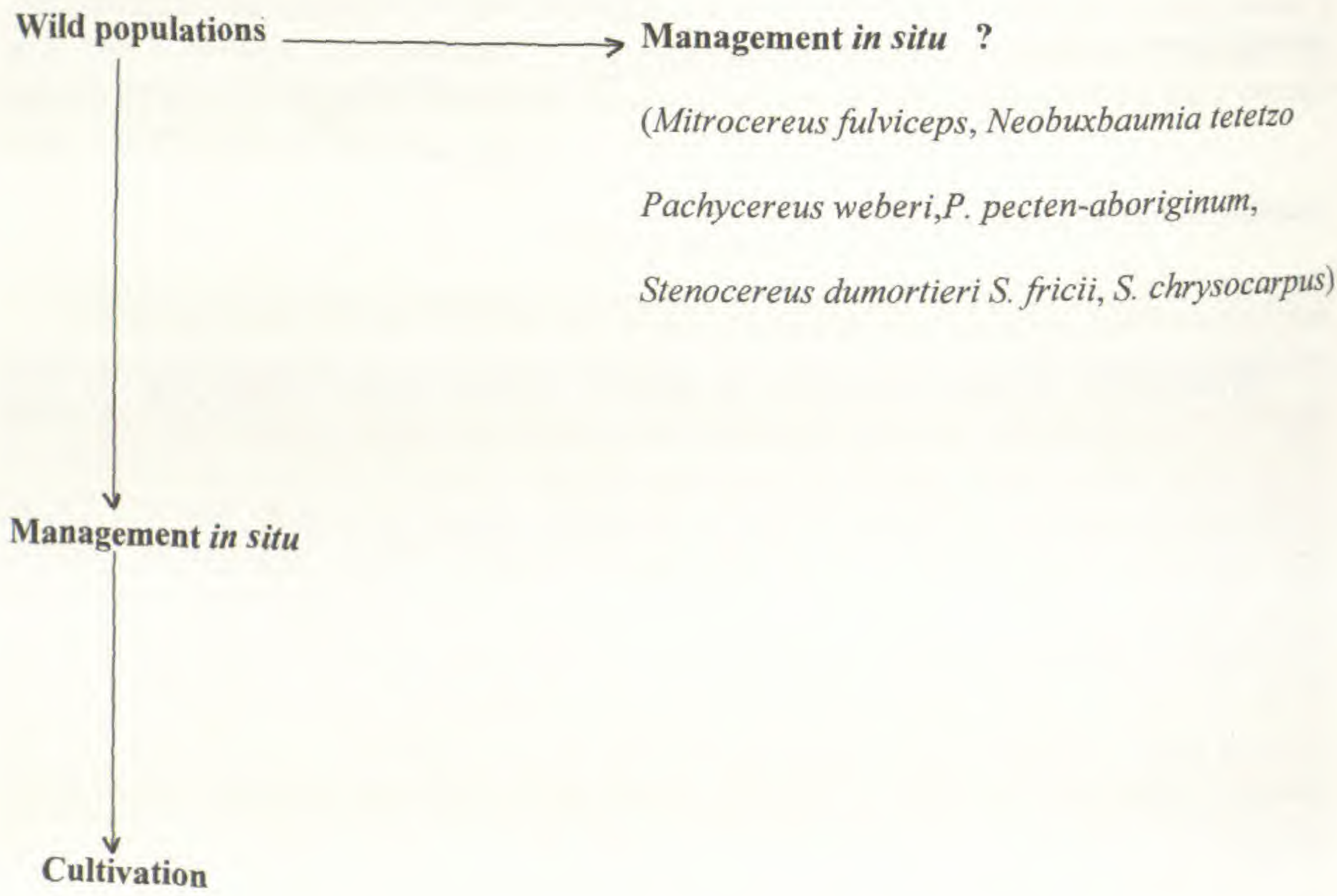

FIGURE 8.– Possible routes of domestication of columnar cacti.

people, which constitute the raw matter for artificial selection at plant community or species level. Artificial selection is apparently carried out by identifying and subsequently increasing by vegetative propagation the frequency of individuals with desirable phenotypes from wild, managed *in situ* or cultivated populations. Vegetative propagation is carried out by carrying branches of the desirable plants, wild or cultivated, to home gardens. But artificial selection apparently also occurs when plants of desired forms are preferentially spared or protected when land is cleared and non-desired plants are eliminated. A similar form of selection appears to occur when seedlings are spared by people in cultivated populations until their fruits can be evaluated, after which plants are either retained or discarded.

This information suggests that artificial selection is a potential or actual process that may act on species that are cultivated. Artificial selection has caused significant divergence between wild and manipulated populations in species such as *Stenocereus stellatus* and *S. queretaroensis* as has been documented by Casas (1997), Casas *et al.* (1999a, 1999b) and Pimienta-Barrios and Nobel (1994, 1998), and might also be significant in species such as *Myrtillocactus geometrizans, M. schenki, Escontria chiotilla, Pachycereus hollianus, P. marginatus, Polaskia chichipe, P. chende, Stenocereus fricci, S. griseus* and *S. pruinosus*, among others, which are intensely cultivated and managed *in situ* and have important morphological variation in characters that are targets of selection by people. However, the demonstration and evaluation of the extent to which these species have been domesticated is yet to be done. The case study of *Stenocereus stellatus* (Casas *et al.* 1997b, 1999a, 1999b) allows us to see that domestication under management *in situ* is an ongoing process. This case suggests that both *in situ* and *ex situ* artificial selection may be acting simultaneously in some species (Figure 8). This pattern of *in situ* and *ex situ* domestication acting in conjunction could be similar in species of relatively fast vegetative growth and clonal propagation. But a pattern of domestication *in situ* acting alone could allow us to analyze possible processes of domestication of some species of giant columnar cacti such as *Pacycereus weberi, Stenocereus dumortieri, Neobuxbaumia tetetzo* and *N. mezcalaensis*, among others.

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IN SITU CONSERVATION OF RICE LANDRACES AMONG THE BADUY OF WEST JAVA

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ABSTRACT.– A large number of landraces of rice have disappeared from irrigated fields in lowland Java since the adoption of high yielding varieties (HYVs) promoted by the Indonesian government. However, such genetic erosion has not taken place amongst the upland Baduy population. This is because maintenance of a traditional system of swidden (forest fallow) farming is considered to be both a religious obligation and a form of cultural identity. Baduy dry rice landraces are used mainly for performing rituals and in the feasts accompanying them. They cannot be sold, though in order to fulfil daily food requirements, various crops (fruit, vegetables, palm sugar) are traded for hulled lowland rice. The objective of this article is to document the way in which cultural practices serve to maintain diversity in traditional rice landraces.

Keywords: in situ conservation; rice varieties; swiddening; West Java

RÉSUMÉ.– Avec l'introduction des variétés a haut rendement encouragée par le gouvernment indonésien, un grand nombre de variétés de riz ont disparu des rizières irriguées des basses terres de Java. Cette érosion génétique n'a pas affecté les Baduy qui vivent dans les hautes terres de l'île. Cela s'explique par le fait que maintenir le système traditionnel d'agriculture sur brûlis est considéré a la fois comme une obligation religieuse et comme une forme d'identité culturelle. Les variétés baduy cultivées en rizière sèche sont conservées pour un usage essentiellement cérémoniel et rituel. Ces variétés ne peuvent être vendues, et d'autres produits (fruits, légumes, ou sucre de palme) sont commercialisés pour couvrir les nécéssités de base, en particulier l'achat de riz blanc provenant des basses terres. Cet article documente les pratiques culturelles qui ont permis de maintenir la diversité des variétés de riz traditionellement cultivées par les Baduy.

Mots clés: conservation in situ; culture sur brûlis; Java occidental

RESUMEN.– Un gran número de especies ancestrales de cultivos de arroz ha desaparecido de los campos irrigados en las tierras cálidas de Java, desde la adopción de variedades de alta productividad promovidas por el gobierno Indonesio. Sinembargo, tal erosión genética no ha tenido lugar entre la población

Baduy de climas frios. Esto se debe al mantenimiento de sistemas tradicionales en los que se quema el rastrojo o la maleza (monte de barbecho) y en los que la labranza es considerada tanto un deber religioso como una forma de identidad cultural. Las ancestrales especies de cultivos de arroz seco de Baduy, son usadas principalmente para representar ceremonias y en las fiestas que las acompañan. Estas no pueden venderse; para el sustento diario se almacenan varios cultivos (frutas, verduras, azucar de palma), los cuales son intercambiados por arroz trillado de clima cálido. El objetivo de este trabajo de investigación es documentar la forma en la cual las prácticas culturales sirven para mantener la diversidad en variedades tradicionales de cultivos de arroz.

Palabras clave: Conservación en el lugar de origen o in situ; tipos ancestrales de arroz, quema de rastrojo; Java Occidental.

INTRODUCTION

Over many centuries peasant farmers in Java have developed an irrigated system of rice cultivation (***sawah***) which involved the maintenance and creation of many distinctive varieties (Gelpke [1874] 1986, Geertz 1963, Terra 1958). Different varieties were planted in different plots to maintain the homogeneity of the germplasm, and under such a regime varieties were actively selected which reflected the special needs of various local environments: water availability and tolerance, soil type and nutrients, exposure to sunlight, and so on. Moreover, every stage of the rice cycle involved ritual focusing on veneration of the rice goddess and, therefore, with ensuring crop productivity (Mustapa [1913] 1985, pp. 83-84; Gelpke [1874] 1986, Soeganda 1982: 150-166). The rice products were mainly used to fulfil subsistence needs, although there is a long historical tradition of rice export to other parts of the Indonesian archipelago. Thus, phenotypic diversity of rice was firmly rooted in locality and in the religious regulation of the farming cycle.

The increasing use of Green Revolution technology in Indonesia since the late nineteen sixties, and in particular the introduction of High Yielding Varieties (HYVs) of rice, has led to extensive genetic erosion of traditional varieties here and in other parts of southeast Asia (Brush 1991: 158-9), as well as significant ecological, social, economic and cultural changes in farming practices (e.g. Nørlund, Cederroth and Gerdin 1986, Palmer 1976). In some places the planting of native varieties has been actually forbidden (e.g. Lansing 1991: 113); though the goal of high productivity has, above all else, been responsible for the exclusion of local varieties. However, among the Baduy, an enclave population practicing swidden or forest-fallow cultivation in the highlands of West Java, many old dry (upland, or hill) varieties survive through the requirements of traditional religious practice, and through the active rejection of the accouterments of the Green Revolution. This is especially evident in rituals connected with planting and harvesting practices, and with storage. Indeed, the seed of some varieties may be stored for between 50 and 90 years without apparent deterioration. What is additionally remarkable is that the effective conservation of phenotypic diversity is possible in an economic context where most rice consumed as food is obtained through the market from

lowland wet rice producers, and consists mainly of new HYV varieties which elsewhere are displacing local varieties. Lowland rice is exchanged for aren-sugar (*Arenga pinnata*) and other products. Thus, daily consumption relies on new varieties, while old varieties are produced and maintained through the religious obligation to sustain a traditional swidden system.

In this paper we wish to demonstrate how Baduy cultural practices maintain phenotypic diversity in rice, a connection which is still poorly understood for many domesticates (Brush 1992: 162). However, we do not automatically assume that phenotypic diversity is necessarily a good measure of genetic diversity, and acknowledge that varietal diversity calculated from local nomenclature may exaggerate the extent of genetic diversity actually present. We argue that members of the Baduy community have been successful in maintaining local rice varieties because their practices and underlying values are well adapted to the local ecological and socioeconomic upland environment and because, paradoxically, they have developed appropriate strategies enabling them to use the market to subsidise a traditional way of life. The data presented in this paper were obtained during field research conducted in the Baduy area by Iskandar in 1985, and between October 1995 and July 1996.

In situ conservation, the conservation of genetic resources in their pre-existing habitat, whether in natural or anthropogenic ecosystems, rather than under laboratory *ex situ* conditions, has attracted much attention in recent years. This is also the case - more specifically - for *folk* in situ conservation, that is effective conservation realised through farmer knowledge and experience which can be characterised as 'indigenous', 'local', or 'traditional', rather than that channelled through outside experts (Altieri and Merrick 1987, Brush 1991). Recent ethnobotanical research, for example, has shown that traditional farming methods often retain cultivars which under intensive and, especially, agro-industrial conditions have disappeared. Such cultivars have been selected on the basis of their suitability for local conditions (Brush 1986: 153), and for this reason confer many local advantages: ecological, economic and cultural. Moreover, farmers using traditional techniques have been shown to value diversity in its own right (Boster 1984, Shigeta 1996). We use the word *landrace* here (following Shigeta 1996: 235; see also Brush 1991: 154-5), to distinguish Baduy categories for sub-divisions of ancestral crop species from 'varieties' in the conventional Western taxonomic sense. Thus, in this context a landrace is a local category for grouping cultivated rice plants according to common characteristics reflected in specific vernacular names. Landraces represent locally distinguished types of germplasm developed by farmers, in contrast to 'varieties', which are usually the products of institutional breeding.

BADUY RICE CULTIVATION

The Baduy are a distinctive population of (in 1994-95) about 6440 individuals living in an upland area of some 5100 ha in Kanekes desa, sub-district of Leuwidamar, district of Lebak, residency of Banten, West Java (Figure1). They can be divided into two groups: about 502 'Inner Baduy' (Baduy Dalam, Urang Tangtu, Urang Girang, Kaum Daleum) and 5938 'Outer Baduy' (Baduy Luar, Urang

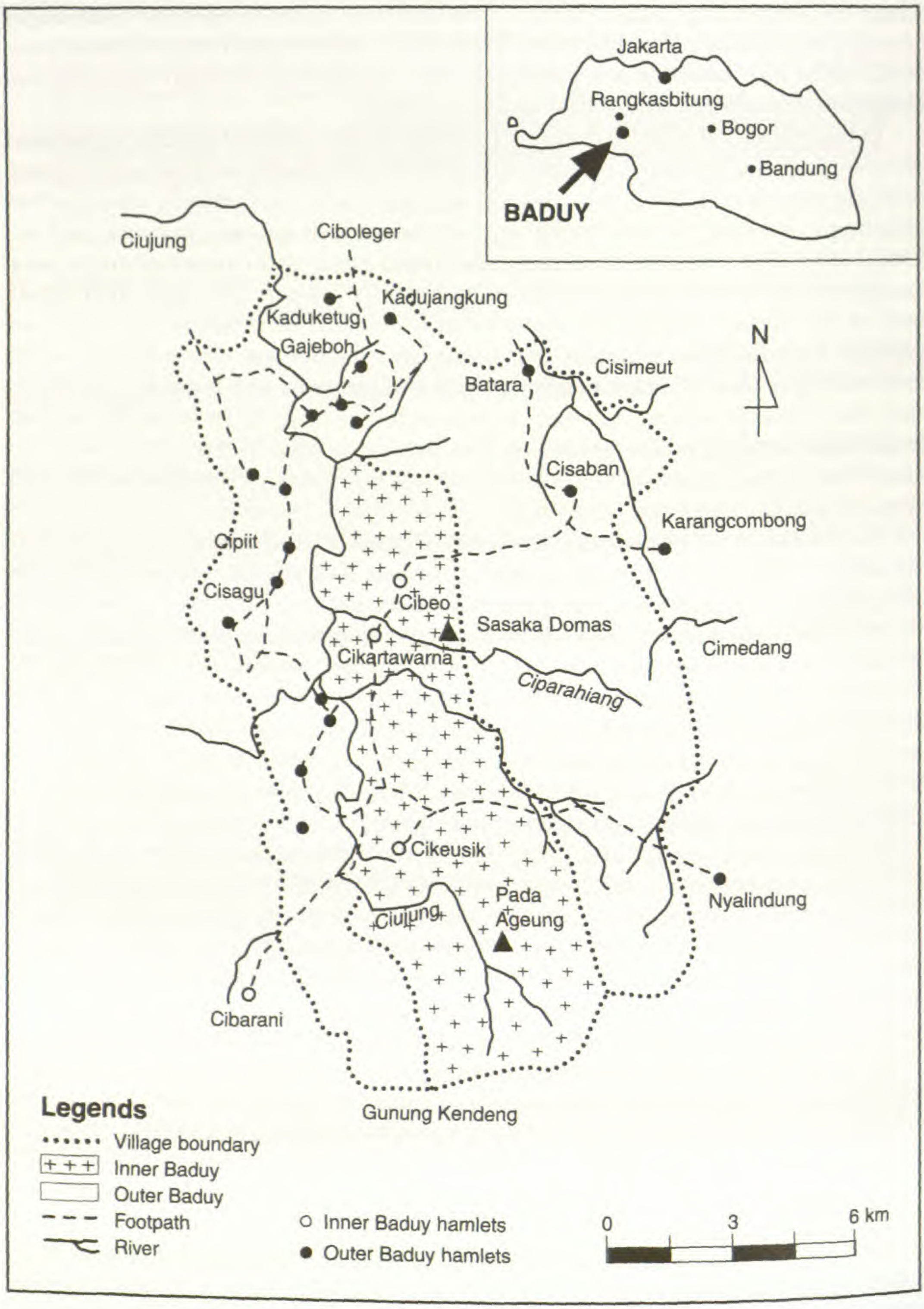


FIGURE 1.– The Baduy area of West Java

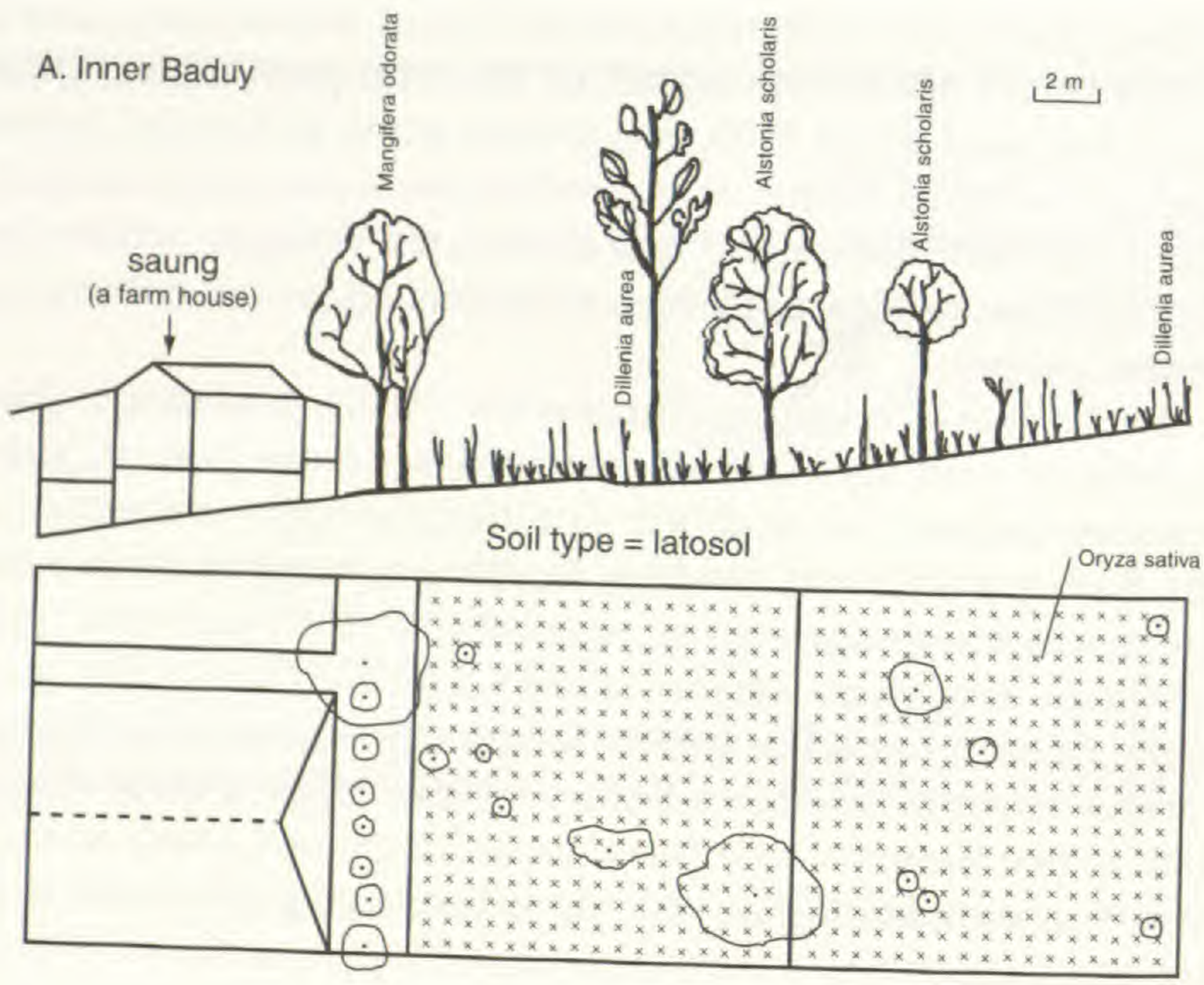
Panamping). Inner Baduy live in the hamlets of Cibeo, Cikartawarna, and Cikeusik, and in 1994 constituted about one eighth of the total population. Outer Baduy have a total population of about 5900, and inhabit some 44 hamlets located to the north, west and east of Inner Baduy. Surrounding these concentric areas is a buffer zone which contains both Baduy and non-Baduy, the Dangka, which has a number of crucial properties, not least of which is the ecological and cultural protection of the Baduy area proper.

Though the Baduy are ethnic Sundanese (West Javanese), their social organisation, religion and agricultural system differ from that of surrounding muslims, focussing instead on - and being unified through - ancestral customary law (***pikukuh***). Baduy traditional swidden farming is in many ways a remnant of a more widespread form of agriculture practised by the Sundanese, particularly in pre-islamic times. Swidden cultivation is so central to Baduy life and identity that anyone who does not practice it is no longer considered to be Baduy.

Of the various crops planted in a Baduy swidden field (*huma*) (Figure 2), the most important is rice (***pare*** = *Oryza sativa* japonica group1; padi, in Indonesian). Swidden rice is thus ***pare huma*** (unhusked) or ***beas huma*** (pounded and husked; beras, in Indonesian). Rice was commonly called Nyi Sri or Kersa Nyai ('the wish of Nyai') by ancient Sundanese, while rice cultivation was punctuated from beginning to end with various rituals (Mustapa 1985 (1913): 89; Soeganda 1982: 157; Locher-Scholten 1987: 83). Similar beliefs and practises are still found in Baduy. Swidden rice is considered sacred, a status expressed through veneration of its creator, the rice goddess, Nyi Sri Pohaci or Pohaci Sanghiyang Asri (Soeganda 1982: 170-72). Swidden rice and Pohaci Sanghyang Asri are, thus, aspects of a single reality, and both command respect (Danasasmita and Djatisunda 1986:78). It is for this reason that the cultivation of swidden rice is regarded as an obligation to the ancestors, and why it is prohibited to sell, gift or exchange rice landraces to non-Baduy.

Since swidden rice is sacred, and cannot be exchanged with non-Baduy, it is instead consumed mainly during the actual process of cultivating rice and on ritual occasions. In contrast, rice for ordinary consumption (which, in turn, may not be used in ritual) is acquired by trading non rice crops, such as banana (*Musa paradisiaca*), locus bean or petai (*Parkia speciosa*), durian (*Durio zibethinus*), rinu (*Piper rindu*), and palm sugar (*Arenga pinnata*), the last of which is produced by Outer Baduy only. These are harvested from swiddens (***huma***), protected anthropogenic forest surrounding hamlets (***dukuh lembur***), fallowed secondary forest (***reuma***), and protected forest (***leuweung kolot***). In addition, cash is acquired, particularly by Outer Baduy, by selling handicrafts and labour to neighbouring non-Baduy areas. Swidden cultivation of rice has for a long time been combined with the growing of fruit trees (Terra 1958: 160-161).

The six main stages of the swidden cycle, the work of which is articulated through ritual in ways which are known more widely from island southeast Asia (see e.g. Jensen 1974; Sutlive 1978; Visser 1989), and which are accompanied by the consumption of swidden rice include: (a) cutting underbrush (***nyacar***); (b) felling and pruning (***nuar*** and ***nutuh***); (c) burning (***ngahuru***), reburning debris (***ngaduruk***), and weeding under piles of debris (***nyasap***); (d) planting rice (***ngaseuk pare***); (e) first and second weeding (***ngored***); and (f) harvesting rice (***dibuat*** or ***panen pare***).



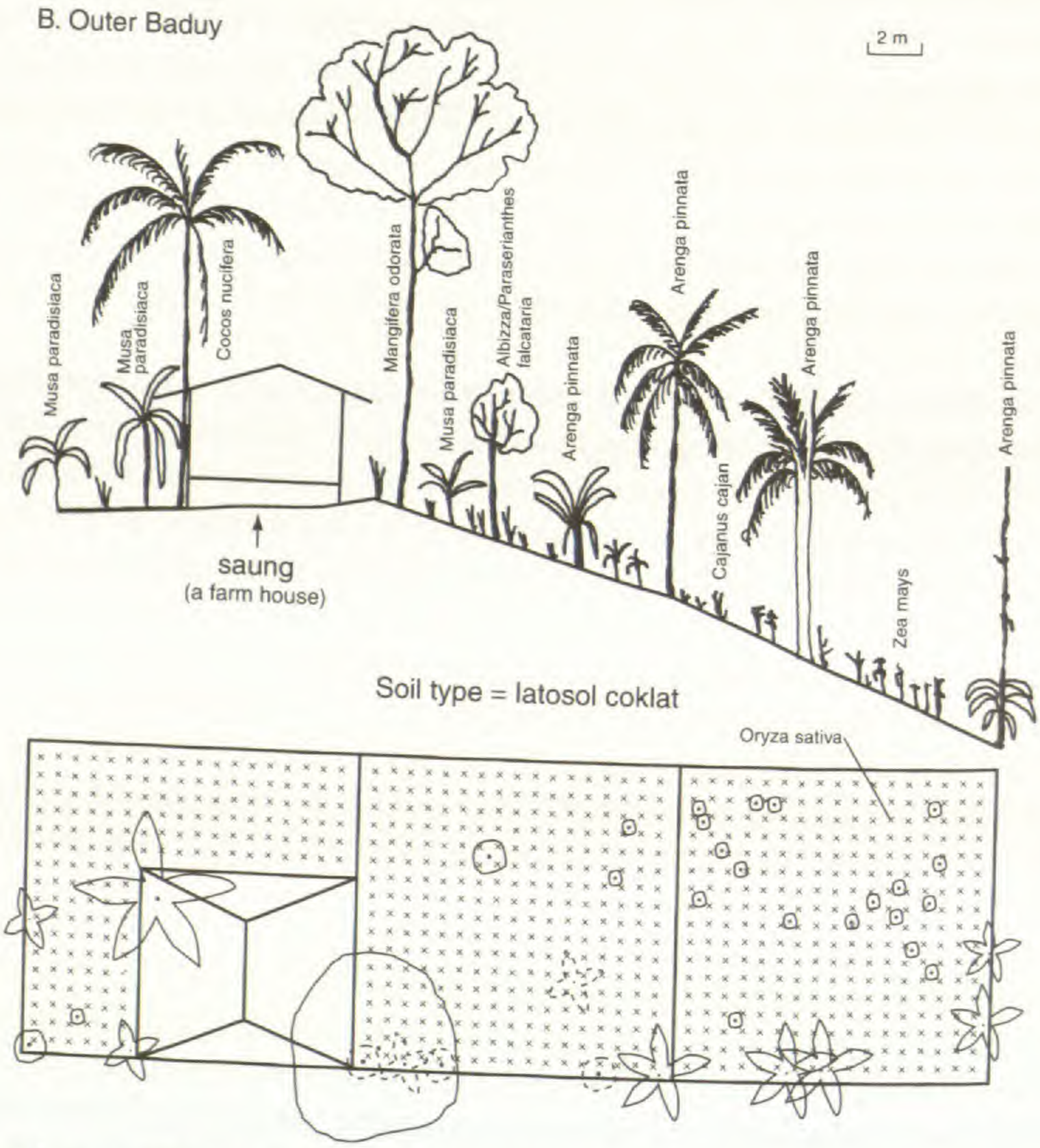


FIGURE 2.– Vegetation structure of a typical swidden plot (*huma*)

In addition, swidden rice is needed to perform various rituals in the hamlets whether these be conducted in each household (such as the ***nganyaran*** ritual, held after storing rice), or whether conducted communally, such as planting rice in sacred swidden plots, ***huma serang***.

Swidden cultivation among Inner and Outer Baduy follows basically the same pattern. Six kinds of swidden are recognised, depending on ownership:

(1) ***huma serang***, sacred swiddens belonging to the community, located in a special place to the south of each Inner Baduy hamlet, and never overlapping with other swidden plots. These are managed by ***girang seurat*** religious officials, but some tasks (such as cutting back bush and planting rice) are undertaken by the whole community;

(2) ***huma puun***, swiddens belonging to and managed by the families of religious leaders (***puun***) located to the south of each Inner Baduy hamlet;

(3) ***huma girang seurat***, swiddens belonging to and managed by families of the religious officials who assist the ***puun*** (***girang seurat***), located in a special place attached to the ***huma serang***;

(4) ***huma tangtu***, swiddens belonging to each Inner Baduy household, located outside the area of ***huma*** types 1-3, mostly to the north of each hamlet. Obtained through ancestral felling of mature forest, these swiddens (and particularly the perennial cultigens which they contain) are owned permanently and inherited. ***Huma tangtu*** in fallow may be loaned to other families.

(5) ***huma jaro dangka*** or ***huma tuladan***, swiddens belonging to and managed by assistants of ***puun*** religious leaders (***jaro dangka***) living in the ***dangka*** area. These are considered less sacred than ***huma serang***, and are used as a model swidden in Outer Baduy. Some activities, particularly planting rice, involve cooperation between Outer Baduy and performance of collective ritual; and

(6) ***huma panamping***, swiddens belonging to Outer Baduy households, obtained on loan and through inheritance or purchase from other Outer Baduy, or through purchase, rent, sharecropping or exchange for labour from neighbouring non-Baduy.

The most important factor determining the first month of the Baduy calendar is the harvesting time of the ***huma serang***. ***Huma tangtu*** and ***huma panamping*** are collectively termed ***huma masyarakat*** (community swiddens) as they are not directly controlled by religious leaders. Thus, work on the ***huma masyarakat*** is always preceded by work on the ***huma serang***. To perform the rituals at the beginning of the farming year new rice from the ***huma serang*** must be used.

BADUY KNOWLEDGE AND MANAGEMENT OF RICE DIVERSITY

Baduy have developed a complex knowledge relating to the creation and maintenance of rice diversity. This involves folk identification, selection, sowing, protection, harvesting, and storage.

On the basis of a field survey conducted by Iskandar, 89 different named landraces have been identified from Inner and Outer Baduy combined (Table 1), all medium to tall (130-150 cm) traditional dry cultivars1. Although some landraces predominate and others are grown by only a few households, knowledge of all the different landraces is widely shared and evenly distributed through the entire

TABLE 1.– Baduy rice landraces, recorded by Iskander between 1995-97

Folk Name	Glutinous(G) or Non Glutinous(NG)	Hairy(H) or Non Hairy Seed(NH)	Seed Colour: White(W), Red (R) and Black(B)	Rate of maturation: early(EM), normal(NM)	Notes
1. pare alean	NG	H	W	NM	
2. pare ambu ganti	NG	H	W	NM	ambu = mother; ganti = change
3. pare anjeni	NG	H	W	NM	
4. pare areuy	NG	NH	W	NM	areuy = liana
5. pare baduyut	NG	H	W	NM	
6. pare balogor	NG	NH	W	NM	
7. pare bangban	NG	NH	R	NM	bangban = k.o. tree (*Donax* sp.?)
8. pare banter	NG	H	W	NM	hairs are black
9. pare baur	NG	H	W	NM	
10. pare batu	NG	NH	W	NM	batu = stone
11. pare bayur	NG	NH	W	NM	
12. pare bentik	NG	NH	W	NM	bentik = curled
13. pare beunteur	NG	NH	W	NM	k.o. freshwater fish (*Puntius* ?sp)
14. pare beureum tiwu	NG	H	R	NM	beureu = red sugar cane (var. of Saccharum *officinarum*); hairs are black
15. pare biluk	NG	H	W	EM	
16. pare bologor	NG	NH	W	NM	
17. pare bongkok	NG	NH	R	NM	
18. pare bunar	NG	NH	R	NM	
19. pare bubuay	NG	H	W	NM	
20. pare buntut manjangan	NG	H	W	NM	buntut manjangan = deer
21. pare buntut nyiruan	NG	H	W/R	NM	buntut nyiruan = tail of a big bee
22. pare cao	NG	NH	W	NM	
23. pare cere telong	NG	NH	R	NM	
24. pare cikur	NG	NH	W	NM	cikur = k.o. ginger (*Kaempferia* sp?)
25. pare cinggir	NG	NH	W	NM	
26. pare cokrom	NG	NH	W	NM	
27. pare gintung	NG	NH	R	NM	gintung = k.o. tree (*Beschafia* sp?)
28. pare guling	NG	NH	W	NM	
29. pare hawara bunar	NG	NH	W	EM	hawara = early maturing (rice)
30. pare hawara koas	NG	H	W	EM	koas = *Canavalia* sp
31. pare janah	NG	NH	W	NM	planted in huma serang
32. pare jawara	NG	H	W	NM	planted in huma serang
33. pare jeruk	NG	NH	W	NM	jeruk = orange (*Citrus* sp.)
34. pare karudin	NG	H	W	NM	
35. pare kapundung	NG	NH	R	NM	

Folk Name	Glutinous(G) or Non Glutinous(NG)	Hairy(H) or Non Hairy Seed(NH)	Seed Colour: White(W), Red (R) and Black(B)	Rate of maturation: early(EM), normal(NM)	Notes
36. pare kembang ading	NG	NH	W	NM	kembang = flower ?
37. pare kembang kalapa	NG	NH	W	NM	kembang kalapa = flr of *Cocos nucifera*
38. pare ketan areuy	G	NH	R	NM	ketan = glutinous; areuy = liana
39. pare ketan	G	H	W	NM	beledug
40. pare (ketan) bodas	G	H	W	NM	bodas = white; = pare (ketan) huis = grey hairs (syn.); planted in huma serang
41. pare ketan bulu kuda	G	H	W	NM	bulu kuda = horse hair
42. pare ketan gadog	G	NH	W	NM	
43. pare ketan hideung	G	NH	B	NM	hideung = black; = pare peuceuk = black (syn., partic. Inner Baduy; planted in huma serang
44. pare ketan kasumba	G	NH	R	NM	early maturing; blackish red grain; kasumba = *Bixa orellana*
45. pare ketan keuyeup	G	NH	R	NM	keuyeup = crab
46. pare ketan kidang	G	H	W	NM	kidang = the constellation of Orion's belt
47. pare ketan jalupang	G	H	W	EM	early maturing
48. pare ketan langgasari	G	NH	W	NM	langgasari = name of epic sung narrative; sacred; = pare indung?
49. pare ketan meloy	G	H	W	NM	
50. pare ketan nangka	G	H	W	NM	nangka = jackfruit; *Artocarpus* heterophyllus
51. pare ketan putri	G	NH	R	EM	putri = princess or daughter; planted in huma serang
52. pare ketan ruyung	G	NH	R	NM	
53. pare ketan siang	G	NH	R	NM	siang = day, bright; syn. = pare siang, pare beureum (partic. Inner Baduy); sacred, planted in huma serang
54. pare kiara	NG	H	W	NM	kiara = k.o. tree (*Ficus*)
55. pare kokak	NG	NH	W	NM	
56. pare kolelet	NG	H	W	NM	

Folk Name	Glutinous(G) or Non Glutinous(NG)	Hairy(H) or Non Hairy Seed(NH)	Seed Colour: White(W), Red (R) and Black(B)	Rate of maturation: early(EM), normal(NM)	Notes
57. pare koneng	NG	NH	W	NM	koneng = yellow, tumeric (*Curcuma domestica*); sacred
58. pare konyal	NG	NH	R	NM	konyal=fr. of *Antidesma* sp.
59. pare leungsir	NG	NH	W	NM	
60. pare limar	NG	NH	R	NM	
61. pare lopang	NG	NH	R	NM	
62. pare malati	NG	H	W	NM	malati = jasmine flr. (*Jasminum* sp.)
63. pare marukan	NG	NH	R	NM	
64. pare menteng	NG	NH	W	NM	menteng = fr. of *Baccaurea*
65. pare menyan	NG	H	W	NM	menyan = incense derived from benzoin gum, *Styrox* spp.; hairs are black
66. pare nagayanti	NG	H	W	NM	
67. pare nangsi	NG	NH	W	NM	nangsi = k.o. tree (*Villebrunia* sp.)
68. pare ninggul	NG	H	W	NM	hairs are black
69. pare pendok	NG	NH	W	NM	leger = non-hairy (leger) (rice)
70. pare peuteuy	NG	NH	W	NM	peuteuy = *Parkia* sp.
71. pare racik	NG	H	W	NM	hairs are black
72. pare reumay	NG	NH	W	NM	
73. pare rumbay	NG	NH	W	NM	
74. pare sabeulah	NG	NH	W	NM	sabeulah = half
75. pare salak	NG	H	W	NM	salak = fr. of a k.o. palm (*Salacca zalacca*)
76. pare sampay	NG	H	R	NM	
77. pare sempur	NG	H	W	NM	sempur = *Dillenia* sp.
78. pare sereh	NG	H	W	EM	sereh = lemon grass (*Cymbopogon citratus*); early maturing
79. pare seungkeu	NG	H	W	NM	
80. pare seuti	NG	H	W	NM	
81. pare sikep kuning	NG	H	W	NM	kuning = yellow
82. pare singgul	NG	H	W	NM	
83. pare sintung	NG	NH	W	NM	flr. stalk of *Cocos nucifera*
84. pare tanggay	NG	NH	W	NM	
85. pare tanjung	NG	NH	W	NM	tanjung = flr. of *Mimusops*
86. pare tapos	NG	NH	W	NM	
87. pare tundun	NG	H	W	NM	tundun = fr. of rambutan (*Nephelium* spp.)
88. pare tunggul	NG	H	W	NM	tunggul = tree stump
89. pare wanti	NG	H	W	NM	

Key: ( ) = optional; flr. = flower; fr. = fruit

TABLE 2.– Diagnostic characteristics used in Baduy rice classification.

Main Criteria	Vernacular/	English	Notes
1. Glutinousness of cooked rice; waxy endosperm	pare ketan	Sticky rice	Cooked rice is sticky Regarded as superior for culinary purposes
	pare biasa	Non Sticky rice	Cooked rice non sticky
2. Hairiness of unhusked rice	pare bulu	Hairy	Unhulled rice has hair of various lengths and colours
	pare leger	Non hairy	Unhulled rice does not have hair
3. Colour of hulled rice	beas beureum	Red hulled rice	Hulled rice has red colour
	beas bodas	White hulled rice	Hulled rice has white colour
	beas hideung	Black hulled rice	Hulled rice has black colour
4. Shape, size and colour of grain	pare sabeulah	Half-size grain rice	Small rice grain
	pare ketan kasumba		Violet coloured grain rice
5. Distinctive panicle	pare ketan hideung	Blackish panicle	Rice has distinctive blackish panicle
6. Maturity	pare hawara	Early maturing	Rice can be harvested in less than 6 months

population. These are classified by Baduy on the basis of stickiness of the cooked rice, hairiness of the unhusked rice, colour of the hulled rice, distinctiveness of the panicle, length of time taken to mature, and shape, size, and colour of the grains (Table 2).

These distinctions are reflected in the general terminology applied to different types. Thus, glutinous landraces are ***pare ketan*** and non glutinous ***pare biasa*** (= 'ordinary'), hairy seed types are ***pare bulu*** and non-hairy ***pare leger***; those landraces maturing early (that is in less than 6 months) are ***pare hawara***, and those maturing later ***pare leuir***, and those with a dark stalk are ***jarami hideung***, in contrast to those with ordinary stalks. Each of these binary distinctions is important for the Baduy in grouping landraces according to key characteristics. It is difficult, however, to rank them in a way which would generate a unitary taxonomy of levels and contrasting types.

Of the 89 names listed in table 1, 73 are semantic and morphosyntactic binomials, while 16 are trinomials or optional trinomials. In every case, the trinomials contain as their middle segment the term ***ketan*** (glutinous), indicating through contrast the existence of a semi-covert residual grouping comprising the remaining 73 binomials. This grouping is co-terminous with the category ***pare biasa*** ('ordinary rice', non-glutinous) in regular speech. However, despite the lexical encoding of glutinousness, the most salient characteristic for Baduy farmers appears to be hairiness. Colour is second to hairiness as a diagnostic characteristic, though refers specifically to the husked grains. Other classifications, according to rate of maturity for example, would appear to be secondary to, independent of,

and cut across, this basic morphological distinction. Such an arrangement might best be represented analytically as a multi-dimensional paradigm in which differences are ordered through simultaneous intersection (e.g. Kay 1966) rather than as a standard taxonomy of levels and contrast.

Thus, Baduy rice landraces are distinguished and labelled according to ecological, morphological and culinary factors. Let us consider some of these in further detail. For ease of subsequent reference individual named landraces are prefixed by the identification number provided in table 1 and do not appear in boldface (e.g. 7-pare bangban).

1. Ecological factors include maturation period. Early-ripening types are known as ***pare hawara*** (and include 30-pare hawara koas and 29-pare hawara bunar). They are mainly used to replace rice in particular plots which has failed to grow, in order to maximise use of space and productivity. These landraces are planted approximately one month after the main planting, although they can be harvested at the same time as other landraces.
2. Some rice landraces are classified on the basis of grain phenotype, including hairiness, size, and colour. Modern varieties are generally non-hairy, with short straw, early ripening, photoperiod insensitive, responsive to the application of nitrogen, requiring more water and good drainage, are more productive and less attractive from a culinary point of view. 40 (45 %) of the 89 Baduy landraces recorded are recognised for their hairiness or for being awned3 (***pare bulu***); the rest (55 %) are recognised as awnless (***pare leger***). Prior to the Green Revolution, both the awned and awnless varieties were common throughout the Javanese lowland, usually named ***pare bulu*** and ***pare gundil*** respectively. Taxonomically, like the Baduy landraces, they were also types of *javanica* (see note 1). As far as the Baduy are concerned, though, the distinction between hairy and non-hairy, or awned and awnless, encodes no particular aesthetic preference. However, awned rice varieties do confer more protection against grain-eating pests, such as birds, rats and wild pigs (Burkill 1935: 1598), as a result of the physical properties of the hairs .
3. The colour, length and form of grain hair can also be used to classify rice varieties. Thus, 74-pare sabeulah is half the size (***sabeulah***, meaning half); 44-pare ketan kasumba is violet, ***kasumba***; 65-pare menyan is a black type, ***menyan*** meaning incense; 21-pare buntut nyiruan has short hair like the tail of a large bee, ***buntut nyiruan***. The colour of ***beas*** or husked rice is also used as a means of distinguishing different landraces e.g. 43-pare ketan hideung, ***hideung*** meaning black, and 51-pare ketan putri, or a blackish-red colour. Of the remainder, about 70 landraces are white (***beas bodas***), and 15 'red' (***beas beureum***). This proportion reflects a culinary preference for white rice.
4. Straw and panicle colour is also used to identify rice landraces e.g. 43-pare ketan hideung, with blackish straw and panicle.
5. Finally, landraces are distinguished on the basis of whether the grain has a waxy endosperm or not, i.e. glutinousness (c.f. Sakamoto 1996). Glutinous landraces are generally considered superior for culinary purposes, the cooked rice having a pleasant smell and being sticky. They are predominantly used for making traditional cakes and are consumed in rituals and ceremonies. About 15 (19%) of the 89 Baduy landraces are glutinous (***pare ketan***).

Table 3 groups the 89 landraces recorded according to combinations of four characteristics: hairiness, glutinousness, rate of maturity and colour. 13 of the 24 combinations have no representatives. 63 percent is made up of two combinations only: H.NG.NM.W and NH.NG.NM.W. This reflects the equal preference for white hairy and white non-hairy landraces. Sacred rice landraces are drawn from seven combinations, and include representatives of each character listed. What is surprising about the overall pattern is the absence of early maturing landraces amongst each of the most popular combinations.

Selection.– Rice is largely a self-pollinating plant in which some degree of outcrossing may take place between adjacent areas planted with different varieties, or between planted varieties and wild or weedy rice. Potential outcrossing is about 0.1-1 per percent. Landraces may be genetically homogeneous, but more usually combine several more-or-less homozygous lines. Therefore, to obtain pure seed

TABLE 3.– 88 Baduy landraces grouped by combination of four main diagnostic characters.

	Character combination present				No. landraces	Percentage	Sacred landrace (including those planted in *huma serang*)
1.	H	G	NM	W	6	7	1
2.	H	G	NM	R	0	0	
3.	H	G	NM	B	0	0	
4.	H	NG	NM	W	26	29	1
5.	H	NG	NM	R	1	1	
6.	H	NG	NM	B	0	0	
7.	NH	G	NM	W	2	2	1
8.	NH	G	NM	R	4	4	1
9.	NH	G	NM	B	1	1	1
10.	NH	NG	NM	W	30	34	2
11.	NH	NG	NM	R	12	13	
12.	NH	NG	NM	B	0	0	
13.	H	G	EM	W	2	2	
14.	H	G	EM	R	0	0	
15.	H	G	EM	B	0	0	
16.	H	NG	EM	W	3	3	
17.	H	NG	EM	R	0	0	
18.	H	NG	EM	B	0	0	
19.	NH	G	EM	W	0	0	
20.	NH	G	EM	R	1	1	1
21.	NH	G	EM	W	0	0	
22.	NH	NG	EM	W	1	1	
23.	NH	NG	EM	R	0	0	
24.	NH	NG	EM	B	0	0	
Totals					89	100	8

Key. H = hairy, NH = non-hairy, G = glutinous, NG = non-glutinous, NM = normal rate of maturity, EM = early maturing, W = white, B = black, R = red.

for planting the following year, rice seed must be properly selected. Baduy selection (***dipasing***) is usually undertaken during harvesting (see also discussion of harvesting below). Homogeneous and good quality (***beuneur***) bundles of panicles from different varieties (***huasan***) are selected and marked using special bamboo string. This is usually based on phenotypic appearance satisfying the characteristics of the particular landrace and on the presence of healthy and productive traits. It is the work of women assisted by their husbands. Before being carried to the settlements, these bundles are hung on a bamboo pole (***lantayan***) covered with a thatch of sago palm leaves (*Metroxylon sagu*) placed near the swidden shelter (Figure 5). Although different bundles come from different landraces they are not confused because of their distinctive marking.

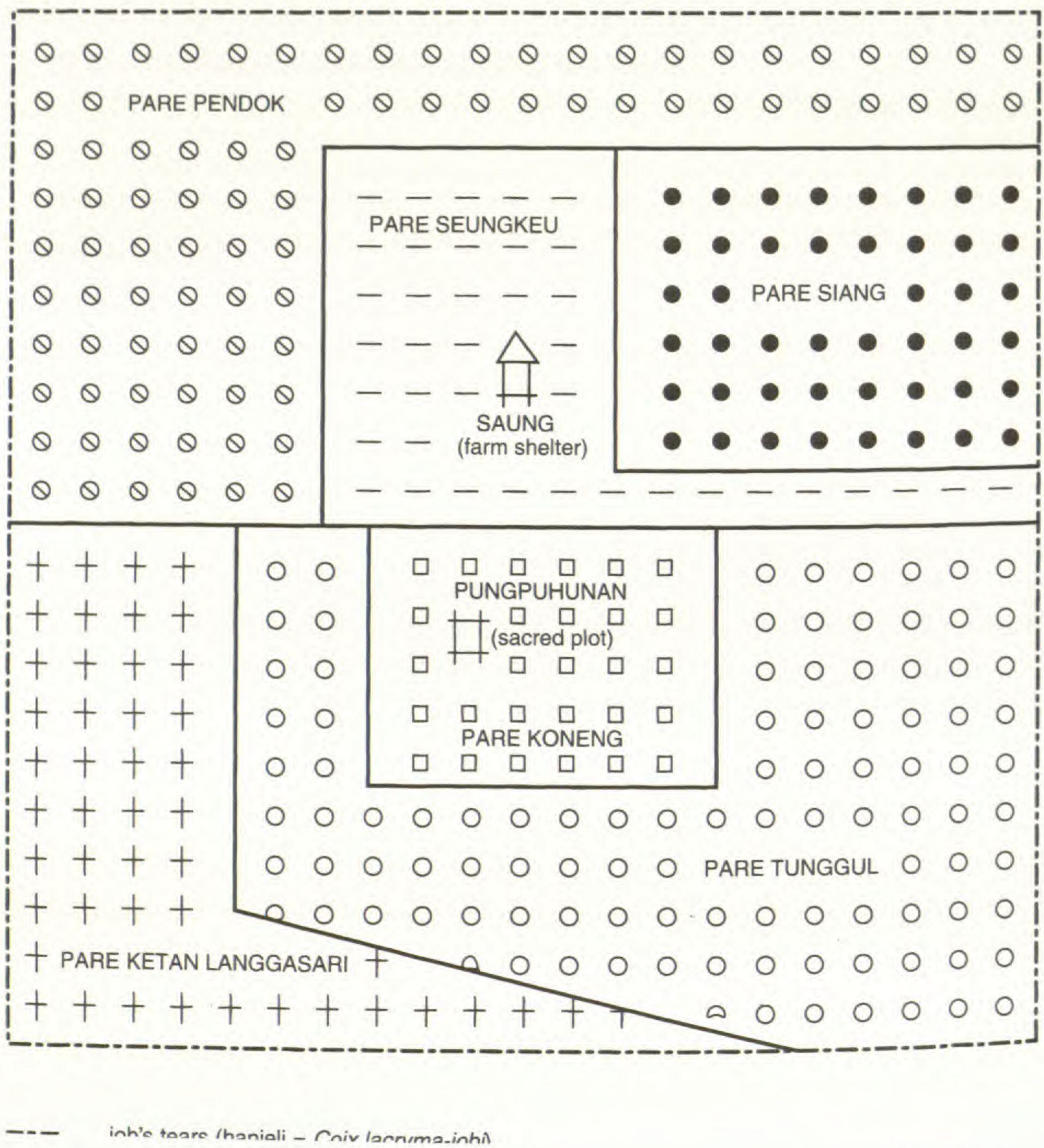


FIGURE 3.– Indicative planting pattern for different landraces in a Baduy swidden plot

After drying, about one week after harvesting, all rice bundles are carried to the settlements. In the hamlet rice is re-selected. Some marked seed rice bundles are separated and put into sacks and placed in the house, or (in the case of some Outer Baduy) a wooden trunk. Later, one or two days before planting, these bundles are threshed one-at-a-time by stamping in a large flat bamboo basket. For winnowing, a small flat basket is used. After separating out good quality seed, rice from bundles according to landrace is put into separate woven bamboo baskets or cloth sacks.

In selecting rice seed, preference is given to three landraces: 57-pare koneng, 53-pare ketan siang, and 48-pare ketan langgasari. These are all considered to be sacred, and are required to be planted by each household in separate parts of each swidden plot (Figure 3). They are not permitted to be in contact with each other, and may be separated from other - non sacred - landraces to prevent contagion. However, in addition, other landraces, including 31-pare-janah, 40-pare ketan bodas and 43-pare ketan hideung (=peuceuk), may be planted in the ***huma serang***, and for this reason are also considered sacred.

If the swidden plot of any individual household is not large enough (that is an estimated 0.5 ha) to plant at least five landraces (namely, the three sacred landraces and two others), there is no obligation to plant sacred rice. Moreover, if there is no ***pungpuhunan*** (the sacred place in the centre of a swidden field), the necessary swidden cycle rituals cannot be performed and the household must join the rituals of relatives who do have a ***pungpuhunan***. The same follows for the celebration of the communal rituals of ***kawalu*** and ***ngalaksa***, which take place after the harvesting. Similar alternative procedures exist for other rituals, such as those which occur before second weeding, before harvesting, and at the first tasting of new rice. On these occasions they join close relatives who have been asked to join in the ritual of planting rice. Thus, any household which has not planted sacred rice in the previous farming cycle but intends to plant such rice in the following year, must borrow from relatives. Indeed, this is the mechanism employed should an individual wish to plant any other landrace not planted previously. As soon as possible after the harvest, borrowed rice should be returned either by returning the same number of bundles of the same landraces or in the form of different landraces, depending on what has been agreed. In this way rice germplasm circulates and diffuses between Baduy households along kinship and affinal lines, so maintaining landrace diversity. Alternatively, the loan can be returned in terms of pounded rice rather than unpounded rice bundles, but of equivalent quantity.

Sowing.– Sowing in the ***huma serang, huma puun,*** and ***huma masyarakat*** commences in July-August, August-September, and September-October4 respectively, after the burning of vegetation. In the morning prior to sowing the male head of a household prepares the ***pungpuhunan***. This measures about one square metre, and is bordered by *Amomum* stems with a construction of poles, bamboo and *Arenga* leaves. At the same time, close kin with swidden plots nearby assist. A key moment in the ritual is when a couple of seeds of sacred rice, called the 'rice mother', are sown in the middle of the ***pungpuhunan***. Seven holes inside the ***pungpuhunan*** are then sown with sacred rice seeds of 57-pare koneng, while 7 holes outside the ***pungpuhunan*** are sown with seeds of 53-pare ketan siang. A couple of sacred seeds

(***sakuren***) of 48-pare langgasari, also called ***pare indung***, are additionally sown in the middle of the ***pungpuhunan***. This symbolises the 'head' and 'neck' of Nyi Pohaci.The seven holes outside the ***pungpuhunan*** represent the 'arms' of Nyi Pohaci. 48-pare langgasari from the ***pungpuhunan*** is the first landrace to be harvested, the whole stalk being pulled out intact and stored separately from the rest of the grain in the rice barn. A more detailed account of this process is provided in Iskandar (1998: 348).

At least 5 landraces are planted in the ***huma serang***, 53-pare ketan siang, 57-pare koneng, 48-pare ketan langgasari, 31-pare janah, and 43-pare ketan hideung, divided into several sub-plots marked with *Arenga pinnata* leaf ribs (***lidi kawung***). Sacred rice seeds are placed in separate parts of the swidden: 57-pare koneng, 53-pare ketan siang, and 48-pare ketan langgasari being sown at the centre, east, and west, respectively. These different landraces are not permitted to be in contact with each other. In order to ensure this, the boundaries between them are planted with other non-sacred landraces (Figure 3). Baduy believe that this prohibition has an important practical function: to maintain the distinctiveness of the different landraces by ensuring that each sacred type can be harvested (***dibuat*** or ***dipanen***) and separated (***dipasing***) easily and its purity more easily guaranteed. In practise, some mixing is likely. A similar reasoning is connected to the prohibition on sacred rice not coming into contact with the farm house. In wet rice cultivation, where HYVs predominate and where sickles have replaced finger-knives, the harvesting and selecting of seed of non-HYVs becomes difficult, and after one year can no longer be used for planting in the next season, as the seed is no longer homogeneous. If such seed is planted, rice will grow as a mixture of different heights and produce a low yield. As a result, in non-Baduy lowland areas seeds are usually bought rather than being homegrown. But such seed can be used only for one farming season, and in the following year new seed must be bought again. Farmer independence is therefore restricted with more dependence on market-led inputs and energy subsidies from outside, over which Baduy have no control (Iskandar 1998: 473-474).

We have no data to suggest that two or more Baduy rice landraces might ever be sown in the same hole, while only a few landraces have disappeared because they have been planted in contact with others and during harvest could not be easily separated. These are generally those which have similarities in grain colour and shape. For example, if there is crop failure in a swidden, or the crop grows badly, 44-ketan kasumba, 30-hawara koas, 47-ketan jalupang, and 78-pare sereh will commonly be planted as a replacement (***pikeun ngayum***), mixed with other landraces. These are recognised as maturing more quickly (***pare hawara***), and can be harvested in less than 5 months. However, apart from 44-ketan kasumba, which has a very distinctive bluish-red (violet) seed colour (***kasumba***), these landraces have seeds of similar colour and shape.

Tables 4 and 5 compare rice landraces planted by 16 Outer Baduy households in 1985 and 1995. In 1985 the total number of landraces planted in the sampled households was 42, the range for number of landraces planted between 5 and 18, and the mean number per household 9.06, and each landrace was planted by a mean of 3.45 households. By 1995, the total number of different landraces for the

TABLE 4.– Rice landraces planted by 16 households in Outer Baduy in 1985

Rice Landraces	Respondents																No. of respondents planting landrace
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1. pare ambu ganti								x			x						2
2. pare anjeni					x												1
3. pare areuy				x		x		x									3
4. pare bangban						x				x							2
5. pare bayur								x							x		2
6. pare bentik		x	x				x	x		x		x		x	x		8
7. pare bongkok								x									1
8. pare bubuay	x							x								x	3
9. pare bunar	x																1
10. pare buntut menjangan						x											1
11. pare cao				x		x	x								x		4
12. pare cikur												x					1
13. pare cinggir								x									1
14. pare hawara koas						x											1
15. pare ketan kasumba				x						x							2
16. pare ketan bulu kuda						x											1
17. pare ketan hideung/ peuceuk		x								x		x					3
18. pare ketan jalupang		x															1
19. pare ketan langgasari*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
20. pare ketan putri				x													1
21. pare ketan kidang				x													1
22. pare koneng*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
23. pare konyal				x													1
24. pare limar				x			x					x			x		4
25. pare lopang				x													1
26. pare malati				x		x	x					x			x		5
27. pare mananggul					x				x								2
28. pare marukan		x									x						2
29. pare menteng				x	x	x	x					x			x	x	7
30. pare pendok leger	x	x		x			x	x			x	x					7
31. pare racik			x				x		x			x		x			5
32. pare rumbay					x												1
33. pare sabeulah									x								1
34. pare sampay				x													1
35. pare sereh		x		x							x	x		x	x		6
36. pare seungkeu						x	x	x				x	x				5
37. pare seuti													x				1
38. pare siang*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
39. pare singgul			x										x				2
40. pare tanggay				x													1
41. pare tanjung				x													1
42. pare tunggul					x	x			x					x			4
Total in each household	6	9	6	18	8	13	11	12	7	7	7	13	6	7	10	5	

TABLE 5.– Rice landraces planted by 16 households in Outer Baduy in 1995

Rice Landraces	Respondents																No. of respondents planting landrace
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1. pare areuy						x											1
2. pare bangban																x	1
3. pare bentik					x		x			x	x	x				x	6
4. pare beunteur	x									x							2
5. pare bologor											x	x					2
6. pare bunar									x								1
7. pare cao	x		x		x	x	x					x		x			7
8. pare cokrom								x		x		x					3
9. pare hawara kaos														x			1
10. pare ketan hideung							x										1
11. pare ketan jalupang										x		x					2
12. pare ketan langgasari	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
13. pare kapundung			x						x	x							3
14. pare kohak												x					1
15. pare koneng	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
16. pare konyal	x														x		2
17. pare limar							x					x		x		x	4
18. pare malati												x					1
19. pare marukan	x									x							2
20. pare menteng			x	x					x								3
21. pare ninggul				x													1
22. pare pendok		x											x				2
23. pare reumay																x	1
24. pare rumbay	x			x	x	x			x								5
25. pare sabeulah									x								1
26. pare sereh				x												x	2
27. pare seungkeu	x	x		x			x					x	x				6
28. pare siang	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
29. pare sikep			x														1
30. pare sintung															x		1
31. pare tundun											x						1
32. pare tunggul		x								x			x				3
33. pare wanti	x		x														2
Total in each household	10	6	8	8	6	6	8	4	8	10	6	12	6	6	5	8	

same households had decreased to 33, the range for the total number of landraces planted was between 5 and 12, the mean number per household had declined to 7.31, and each landrace was planted by a mean of 3.54. The decline in the number of landraces over this ten year period can be attributed to land shortage, as a strong correlation can be shown between size of swidden plot and number of landraces planted. Thus, given that 1 rice bundle is sufficient for planting 0.1 ha, and that usually one bundle of each landrace will be planted, a swidden plot of 0.5 ha will contain 5 landraces, one of 0.6 ha 6 landraces, one of 0.8 ha 8 landraces, and so on.

TABLE 6.– Rice landraces planted by 11 households in Inner Baduy in 1995

Rice Landraces	Respondents											No. of respondents planting landrace
	1	2	3	4	5	6	7	8	9	10	11	
1. pare baduyut											x	1
2. pare bangban										x		1
3. pare banter										x		1
4. pare bentik										x		1
5. pare beunteur			x								x	2
6. pare biluk		x								x		2
7. pare cokrom	x											1
8. pare hawara										x		1
9. pare janah	x											1
10. pare jeruk			x	x								2
11. pare kapundung					x					x		2
12. pare ketan areuy			x							x		2
13. pare ketan huis/bodas			x		x				x	x		4
14. pare ketan keuyeup			x									1
15. pare ketan langgasari	x	x	x	x	x	x	x	x	x	x	x	11
16. pare ketan nangka			x									1
17. pare ketan peuceuk/ hideung			x						x	x		3
18. pare kiara		x			x							2
19. pare kolelet					x						x	2
20. pare kohak											x	1
21. pare koneng	x	x	x	x	x	x	x	x	x	x	x	11
22. pare konyal				x		x	x	x		x		5
23. pare leungsir					x					x		2
24. pare limar	x		x	x			x					4
25. pare menteng							x			x		2
26. pare menyan		x			x	x					x	4
27. pare nagayanti										x		1
28. pare pendok	x											1
29. pare racik										x	x	2
30. pare sabeulah											x	1
31. pare salak					x							1
32. pare sereh		x									x	2
33. pare seungkeu	x				x			x		x		4
34. pare siang	x	x	x	x	x	x	x	x	x	x	x	11
35. pare singgul		x										1
36. pare sintung			x									1
37. pare tanggay								x				2
38. pare tapos		x										1
Total in each household:	8	10	12	6	11	5	6	6	5	18	11	

The landraces disappearing from the swiddens of the sampled households between 1985 and 1995 include 2-pare ambu ganti, 3-pare anjeni, 11-pare bayur, 17-pare bongkok, 19-pare bubuay, 20-pare buntut menjangan, 24-pare cikur, 25-pare cinggir, 44-pare ketan kasumba, 41-pare ketan bulu kuda, 51-pare ketan putri,

46-pare ketan kidang, 61-pare lopang, pare mananggul, 71-pare racik, 76-pare sampay, 82-pare singgul, 84-pare tanggay and 85-pare tanjung. However, although there is a net decline in the number of landraces for these households for the period 1985-95, the plots surveyed in 1995 also contained 11 landraces not observed for the same households in 1985 (13-pare benteur, 16-pare bologor, 26-pare cokrom, 35-pare kapundung, 55-pare kohak, pare 68-ninggul, 72-pare reumay, 81-pare sikep, 83-pare sintung, 87-pare tundun and 89-pare wanti). This suggests that landraces are continuing to circulate between households.

Table 6, by comparison with the Outer Baduy data summarised in tables 4 and 5, concerns landraces planted by 11 Inner Baduy households in 1995. Although we do not have corresponding information for 1985, it can be seen that the number of landraces is 38, the range for the number of landraces planted between 5 and 18 and the mean number per household 9.54, while each landrace was planted by a mean of 2.58 households. These Inner Baduy data not only indicate that Inner Baduy households are more likely to conserve landraces, but that this is correlated in part at least to a larger average swidden size. It should also noted that in all cases there is a strong correlation between frequency of landrace planted, the extent to which it is conserved and the requirement that it be planted in a ***pungpuhunan*** or ***huma serang*** (12-pare bentik, 22-pare cao, 48-pare ketan langgasari, 57-pare koneng, 64-pare menteng, 69-pare pendok leger, 78-pare sereh, 79-pare seungkeu, 53-pare ketan siang, 60-pare limar, 40-pare ketan bodas, 65-pare menyan).

FIGURE 4.– Harvesting rice using a finger knife

Crop maintenance and protection.– After sowing, the next important task necessary to ensure a successful rice harvest is weeding and control of pests. Weeding is usually done twice. The first weeding is undertaken about two weeks after sowing and approximately finished about 40 days after planting. A few weeks later the swidden is already regrown with weeds, and a second weeding must be undertaken. At the same time, rice is fed with traditional herbal pesticides between five and nine times, industrial pesticides being strongly prohibited for cultural reasons. These former are made of ***cangkudu*** (*Morinda citrifolia*) fruits mixed with ***laja*** (*Languas galanga*), green coconut milk (*Cocos nucifera*), orange peel (*Citrus grandis*), fermented palm sugar juice (*Arenga pinnata*), and kitchen ash, spread by hand over the swidden. In addition, leaves of ***kanyere*** (*Bridelia monoica*), ***bungur*** (*Lagerstromia* sp), and ***walang*** (Zingiberaceae sp.), are burned twice a day in the farm shelter, and at various places in the swidden. These contain chemical poisons which together with the smoke from the burning are believed to deter insect pests, such as ***kungkang*** (the coreid bug, *Leptocorisa acuta*).

Harvesting.– Five months after sowing, or in the month of Kasa (January-February), Karo (February-March) and Katiga (March-April), rice in the ***huma serang***, ***huma puun***, and ***huma masyarakat***, respectively, matures and is ready to be harvested. Three days before harvesting a special ritual named ***mipit*** is performed. This involves an offering to the rice soul to ensure that it does not desert the plant during reaping. Rice is then harvested (Fig. 4) by men, women, and children working in groups consisting of husband, wife, sons, daughters, and close relatives.

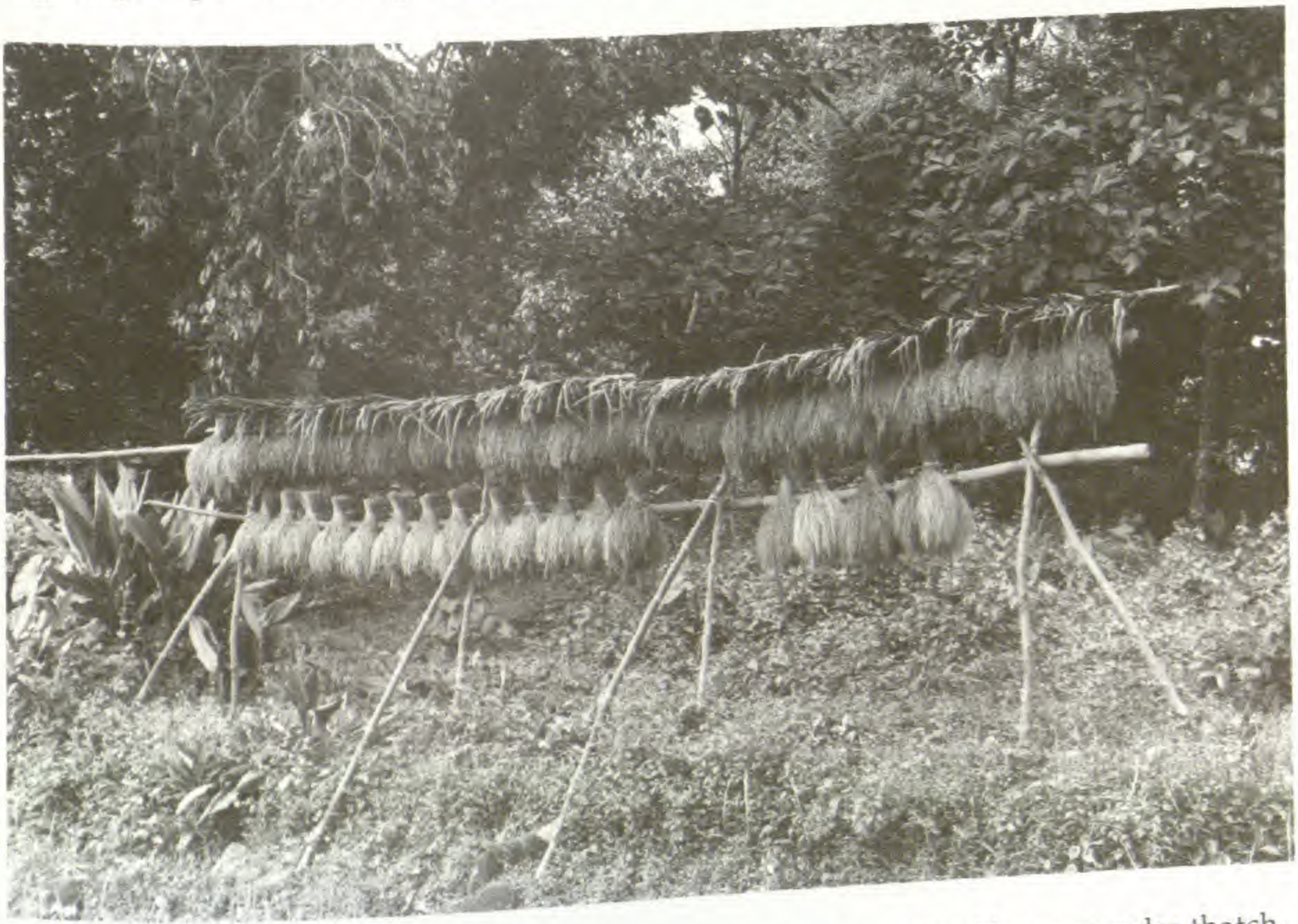


FIGURE 5.– Harvested rice bundles of various landraces, protected by sago palm thatch, awaiting transport to the settlement for storage

Harvesting rice is mostly achieved through labour-exchange between kin and friends. Each participating household must later be repaid, only sometimes in the form of rice.

Reaping is undertaken using a finger knife (***etem***, or ani-ani in Javanese). Rice panicles are cut individually using the right hand and after cutting about five panicles, these are held in the left hand and each fistful put on the ground. About four fistfuls are tied together with bamboo string, to form a bundle (***sapocong***). These procedures are difficult to perform using HYV varieties because the panicles are too short, the seeds easily drop off, and because the panicles are not easily bundled. Indeed, it has long been suggested that one of the main reasons for the extent of traditional rice diversity lies in the use of the finger knife; an implement which cuts panicles individually being more likely to register any variation from the norm for the harvester (Grist 1953: 59-60; c.f. Grist 1986:167-8). Moreover, in the Baduy case, each landrace is harvested separately, in its own block.

After about a week all rice has been completely harvested. The rice bundles are carried by the men on their shoulders using a wooden or bamboo pole, or carried by the women in the small of the back or at the hip with the help of a cloth sling. The bundles are then hung on a bamboo pole, supported by other bamboos to the height of about two metres, which is placed near the farm shelter (see earlier discussion of selecting seed). Each ***jajalon*** (one meter piece of sago palm thatch) consists of two rows on which 20 ***beungkeut*** or ***pocong*** (rice bundles) are hung (Fig. 5).

Storing.– After the harvest, the final stage of swidden farming is to carry rice to the settlement and place it in a rice barn. Rice is usually carried by household members, exchange-labour, or wage labour. According to Geise (1952)5, before the ***kawalu*** ceremony, five rice bundles are brought from the ***huma serang*** to a farm shelter (***saung***) and the panicles hung upside down. The bamboo string tying each rice bundle is replaced by bark cloth (***tali teureup***). This rice is not hung on the bamboo pole together with ordinary rice, but is brought directly to the shelter. Five rice bundles of 5 different landraces are dried: 31-pare janah, 53-pare ketan siang, 53-pare ketan putri, 44-pare ketan huis, and 52-pare ketan peuceuk (43-pare ketan hideung). After drying, these bundles are stacked in the required way and covered by ***mara asri*** leaves (*Macaranga sp*). The rice is brought to the hamlet to be pounded, carried by hand, as it is prohibited to carry it on the shoulder. The bundles are put in the house of the ***girang seurat***, covered by a sacred cloth and perfumed. On the following day, in the early morning, the bundles are brought to a pounding shelter (***saung lisung***) by a group comprising 5 women: 31-pare janah is brought by the ***puun***'s wife, followed by ***ambu seurat*** carrying 53-pare ketan siang, while 51-pare ketan putri and 40-pare ketan bodas are carried by ***ambu parekan*** and the wife of a former ***puun***. These ritual arrangements contribute towards maintaining the perceptual distinctiveness of the landraces concerned.

As mentioned in connection with seed selection, rice is selected in the hamlet. Six rice seed bundles of good quality from different landraces are separated for planting the following year. These are usually stored in a special place in the rice barn or house, separated from the rest of the rice. In addition, 30 rice bundles are

FIGURE 6.– Internal framework(a) and (b) external view of a Baduy rice barn

selected for use in various rituals, such as ***ngadiukeun pare***, the ritual associated with putting rice in a barn. This requires several bundles of **pare indung**, 'rice mother', ***pasangan indung***, 'rice couple' and ***panganteur***, 'companion', ***nganyaran***. The other rituals for which these bundles are used include that for tasting new rice (one or two rice bundles), the Dangka ***ngalaksa*** (one or two rice bundles), and the Inner Baduy ***kawalu*** (one or two rice bundles). ***Ngalaksa*** means 'making ***laksa***'; ***laksa*** being a noodle made from flour of ***huma serang*** rice (in Inner Baduy) or of ***huma jaro dangka*** rice (in Outer Baduy). The rice used must have been taken from 7 rice stalks of the ***pungpuhunan*** rice. The ***pungpuhunan*** - as we have seen- is the most sacred place in the swidden plot, regarded by Baduy as the essence of the earth, and this essence is believed to be absorbed by rice grown within it.

Rice seed and rice bundles for use in rituals are placed in the house, while the rest are stored in a rice barn (***leuit***, Fig. 6). Before rice is stored in the barn, the ritual of ***nganyaran***, 'the first tasting of rice' is performed. A special meal of steamed glutinous rice (***kejo ketan***), steamed swidden rice (***kejo huma***) and freshwater fish is provided and the new rice tasted. At this time, each household sends a meal of new rice to close relatives and friends, and in return will receive new rice meals from others. From this point onwards new rice may be permitted to be consumed by each household.

Another ritual performed at this stage involves placing the 'rice mother' (***pare indung***) in the barn: ***ngadiukeun pare indung***, 'to place mother rice'. This is performed on the same day as planting rice. The performance begins with the upper part of the rice panicles harvested from the ***pungpuhunan*** and ***mupuan*** or ***mipit*** being cut to flatten the upper part of the panicles. This rice is divided into three bundles (***ranggeong***): 'the rice couple', 'male and female' (***bikang jeung salaki***), and one bundle of 'companion' (***saranggeong panganteur***). The 'rice couple' is tied with various plants, such as leaves of ***kukuyaan*** (*Kibara coricea*), ***kakandelan*** (*Hoya difesifolia*), ***ilat mintul*** (*Scleria purpurascens*), ***tumbueusi*** (*Phyllantus niruri*), ***mara asri*** (*Macaranga triloba*), ***areuy geureung*** (*Stephania javonica*), ***pacing*** (*Costus speciosus*) and ***teureup*** (*Ficus elasticus*). Some of these plants are placed on the woven bamboo wall of the rice barn, being species considered to be those loved by Nyi Pohaci and to have symbolic functions. The ritual is aimed at welcoming the rice goddess back home (to the rice barn).

The rice is wrapped in white cotton cloth (***boeh***) and carried by a woman (***bikang***) to the rice barn. In the barn the rice is put (***dielep***) in the middle by a man, and other rice bundles placed round it. Over three days and three nights, ***gharu*** incense (*Gonystylus macrophyllus*), ***pisitan*** peel (*Lansium domesticum*), and the root of ***jambaka*** (*Dianella nemurosa*) is burned inside the barn. ***Jaringao*** (*Acorus calamus*), ***cikur*** (*Kaemferia galanga*), ***panglay*** (*Zingiber cassumunar*) and water are spread inside and outside the rice barn. Moreover, throughout the year, every time rice is taken from the barn (***nguyang***) for pounding, betel leaves, lime, gambier, *Areca* nut, and ***panglay*** are chewed and spread on the rice barn to 'awaken' the rice (***ngahudangkeun pare***). Finally, after all the rice has been stored, and between two and five times a week, rituals are performed to respect Nyi Pohaci, which involve the further burning of *Gonystylus*, *Lansium* peel, ***nangka beurit*** (*Artocarpus integra*) peel, and *Dianella* root.

Most of the plant medicines used in swiddening and in the rice barns are typified by strong aromas, and some have long been recognised as traditional insecticides in some Asian countries. For example, the fruit peel of *Lansium domesticum*, when burned, gives an aromatic smell and in the past was used by the Javanese to drive away mosquitos (Burkill 1935: 1316). Similarly, *Acorus calamus* was used in China and India to control fleas and lice (ibid: 37). On the evidence of Baduy who have moved to government resettlement schemes, chemical fertiliser application and pesticides reduce the storability of seed rice. Since Baduy rice is not contaminated with chemical fertilisers and pesticides, we suggest that this is the reason why rice can be stored in the rice barns for between 10 and 90 years, and transmitted across several generations through inheritance.6 Most couples who have been married several decades have usually between 2 and 5 big rice barns encircling the settlement, each containing between 800 and 1200 rice bundles. This rice is inherited by the children on the death of a parent, when it is divided equally irrespective of sex, after reducing it by two thirds (one third for the cost of the death ritual, and one third for the surviving spouse).

CONCLUSION

Javanese lowland irrigated rice farming has changed from a subsistence to a semi-commercial or commercial system following the introduction of a Green Revolution programme in the early 1970s. This programme has tended mainly to emphasise an increase in productivity at the expense of other key emergent properties of the agroecosystem necessary to achieve sustainability: stability and equitability (Conway and Barbier 1990: 37-48). Thus, although the productivity of wet rice cultivation has risen, Green Revolution technology has resulted in increased social differentiation, the undermining of the position of women in the rural labour force, pest infestation, water pollution arising from the application of nitrate fertilisers and pesticides, and the erosion of rice germplasm diversity (see Timmer 1973; Collier et al. 1973; Ihalauw and Utami 1975; Palmer 1976; Alexander and Alexander 1982; Husken and White 1989; Fox 1991; and Lansing 1991).

Unlike modern irrigated rice cultivation in Java, Baduy swidden farming is still strongly embedded in other aspects of traditional culture. Practising swidden farming is considered to be the main obligation of their religion. In other words, we can identify other important cultural objectives related to farming (such as stability, equitability, and continuity) in addition to productivity. Modern technologies to increase productivity, such as High Yielding Varieties (HYVs) of rice, chemical fertilisers, pesticides, tilling land, and irrigation techniques are not only not used but are culturally proscribed. Although rice productivity is low, loss of local rice varieties, environmental pollution, and social differentiation have been avoided. Baduy have a high crop diversity achieved through intercropping and multiple cropping in swidden plots, while their rice landraces are resistant to pest damage and are more efficient in using solar energy and soil minerals. In addition, their swidden system has an important role in maintaining the gene pool of various crops, including rice varieties *in situ*. Such local landraces are potentially available for use in the future to obtain new varieties more resistant to pests and

drought, and to confer other advantages such as culinary preference.

It can therefore be seen that the requirements of maintaining a separate cultural identity, the centrality of upland rice swiddening to this identity, and the success the Baduy have had in retaining their identity, has had some very specific consequences for the conservation of traditional rice varieties. Thus:

1. The maintenance of upland swidden cultivation techniques in itself has necessitated the retention of local rice varieties.
2. Specific religious requirements ensure that certain specific varieties are preserved.
3. There is a cultural value placed on diversity itself in the rice crop which is reflected in the number of landraces and in planting patterns.
4. Techniques of selection, planting, harvesting and storage ensure the preservation of the distinctiveness of individual varieties.
5. The acceptability of purchased rice for ordinary meals, the storage potential of the varieties grown and the use of effective storage practices, all ensure the preservation of some genetic material for up to 90 years before replanting.

It has long been recognised (e.g. Vavilov 1926) that centres of landrace diversity are important as pools of genetic resources for crop improvement, and that these are endangered by the ecological simplification which accompanies agricultural modernisation and rural social change (Hawkes 1983). Although cultural conservatism of the kind described here might arguably also result in genetic 'bottlenecking', the Baduy case is clearly an important addition to our knowledge of traditional (folk) in situ cultivation, and in a time of increasing environmental instability in the traditional wet rice heartland of Asia, a valuable genetic resource in the face of uncertainty.

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NOTES

1. Until recently, it was conventional to divide *sativa* rice into three taxonomic groups: *japonica*, (or *sinica*), *indica* and *javanica* (e.g. Barker, Herdt and Rose 1985: 14). According to Vergara and De Datta (1996: 109), javanicas should now be assigned to the *japonica* group on the basis of chemotaxonomy. *Indica* cultivars are mostly tropical, and are characteristically tall, leafy, high tillering, prone to lodging, respond poorly to fertilisation (particularly

to nitrogen), are photoperiod sensitive, hardy, disease resistant, tolerate unfavourable growing conditions and produce reasonable yields under conditions of low management. *Japonica* cultivars, by contrast, are mostly temperate, with short stiff straw, less tillering, are less leafy, resistant to lodging, photoperiod insensitive and early maturing. Within the japonicas, cultivars traditionally described as *javanica* are tropical, low tillering, not easily lodged, photoperiod insensitive, cool temperature tolerant, with a relatively long maturation period, wide leaves and tall sturdy stalks, long panicles, not easily shattering, of large and bold grain type, and of intermediate rice texture (Barker, Herdt and Rose 1985: 16; Fox 1991: 64).

2. By comparison, in southeast Asia, Conklin (1992, unpubl., see also 1980, 1988) reports 85-7 landraces for irrigated Ifugao agriculture in upland Luzon. Parekesit and Hadikusumah (1997) suggest that some 88 landraces were found in pre Green Revolution irrigated fields in West Java, and Kusnaka Adimihardja (pers. comm. to Iskandar) reports 126 landraces for wet and dry fields combined in the Kasepuhan area of West Java. For dry rice alone, Friedberg (1990: 198-200) has reported 30 landraces for the Bunaq (Timor), Revel (1990: 176-7) 36 for Palawan, Dove (1985: 159-165) a minimum of 44 planted by Kantu' (east Kalimantan) in 1975-6 swiddens, and Visser (1989: 40) 14 for Sahu on Halmahera. Thus, the number of reported Baduy varieties is comparable to the highest number reported for irrigated rice agriculture and is exceptionally high for dry rice cultivation.

3. The awn is technically a lance-shaped extension of the lemma, which with the palea forms the husk. The lemma, palea, upper and lower glume together constitute the spikelet, several of which make up the panicle, the exact number varying from cultivar to cultivar. In wild rices the awn assists in dispersing the ripe grain at seeding, a function lost in non-shattering cultivated rices (Burkill 1935: 1598).

4. Rainfall in July is 158 mm compared with 170 mm in October, while the average number of rain days for these two months is 7 in both cases. The difference in precipitation over this period of sowing is therefore minimal. However, the average altitude of Inner Baduy ***huma serang*** is higher than Outer Baduy ***huma masyarakat***, surrounded by dense forest and receiving less sunlight. The slight difference in temperature which this occasions leads to Inner Baduy ***huma serang*** rice maturing more slowly and therefore having to be planted earlier than rice in ***huma masyarakat***.

5. The Inner Baduy ***kawalu*** ceremony is difficult to observe directly as non-Baduy are not presently permitted to attend. However, descriptions obtained by Iskandar from Outer Baduy informants, and direct observation of similar ceremonies, conform generally to descriptions given by Geise.

6. Confirmation of claims for length of storage time was obtained by Iskander, who interviewed informants aged between 65 and 75 years reporting having inherited identified rice bundles from their parents. Bundles stored for more than a generation are deliberately retained as a buffer against chronic shortfalls (***bahaya kelaparan***), but as they are not known to us to have been used as seed rice during the period covered by this study, we are unable to test the claim that the germplasm is viable.

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MAIZE DIVERSITY AND CULTURAL CHANGE IN A MAYA AGROECOLOGICAL LANDSCAPE

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ABSTRACT.– Much research has been conducted investigating impacts of introduced crop varieties on local crop plants. It has been demonstrated in many settings that the diversity of local landraces declines once so called "improved" varieties are introduced. My research in southern Belize among the Mopan Maya found that certain maize landraces are planted by a dwindling number of people. However, this decline is unrelated to introduced varieties. Instead, my research has found that traditional varieties decline once their cultural significance is weakened by social change. This paper examines how cultural change among the Mopan Maya has affected the maize diversity in southern Belize. This paper also discusses the symbolic meaning of maize among the Mopan, and their role in maize evolution.

Keywords: maize varieties, cultural change, missionaries.

RESUMEN.– Muchas investigaciones se han hechos estudiando los impactos de la variedad de cultivos introducidos en plantas locales. En muchos lugares se ha demostrado que la diversidad de plantas indígenas locales decae media vez las variedades "mejoradas" son introducidas. Mis pesquisas llevadas a cabo en el sur de Belice, entre los Mayas Mopán, encontraron que ciertas variedades indígenas de maíz están siendo sembradas por menos gente ahora. Sin embargo, esta disminución no tiene ninguna relación con las variedades introducidas. Mis investigaciones han encontrado que las variedades tradicionales decaen media vez su significado cultural se debilita debido a cambios sociales. Este ensayo examina como los cambios culturales entre los Mayas Mopán han afectado la diversidad de maíz en el sur de Belice. Asísmismo, este ensayo discute el significado simbólico de maíz entre los Mayas Mopán y su rol en la evolución del maíz.

Palabras claves: variedades de maíz, cambios culturales, misioneros.

RÉSUMÉ.– Plus de la recherche avait conduit sur des impacts de les variétés de la réolte introduit sur les récoltes locales. Il y avait démontré dans plusiers des décors que la diversité des variétés locales a décliné autrefois ainsi appelée les variétés ameliorée sont introduit. Ma recherche dans le sud de Belize parmi les Mayas Mopan a trouvé que certaine variétés locales du maïs sont planté par un nombre des gens en diminution. Cependent, cet déclin n'a aucun rapport avec les variétés introduits. Au lieu de cela, j'ai trouvé que las variétés traditionnelles décline dès que leur importance culturelle a faibli par le chandement social. Cet papier examine comment le changement culturel parmi les Mayas Mopan a été un effet sur la diversité du maïs dans le sud de Belize. Puis, il inclut aussi le sens symbolique du maïs parmi le Mopan et leur rôle dans l'évolution du maïs.

Les mots clés: les variétés du maïs, le changement culturel, les missionaires.

INTRODUCTION

I present this case study of the relationship among Maya farmers' knowledge of local maize (*Zea mays* L.) varieties, the symbolic meaning of these varieties, and management of these landraces under conditions of cultural and economic change in southern Belize. Several themes regarding maize and the Mopan Maya are addressed: first, the swidden milpa system of the Mopan Maya in which maize is the focal crop is examined. Next, the symbolic value of maize in Mopan Maya culture is discussed. The author then discusses the role Mopan farmers play in maize evolution. And lastly, the author examines maize diversity in the Mopan cultural region and discusses the factors that are undermining this diversity.

Much has been written concerning the abandonment of local crop landraces -- primarily after so-called improved varieties became available. Many authors point to programs like the green revolution as being responsible for the loss of diversity among most of the world's major cereal crops (Fowler and Mooney 1990; Oldfield and Alcorn 1987; Pearce 1980). Although programs that seek to replace local varieties with greater yielding or more pest-resistant varieties have no doubt led to the loss of genetic diversity in some agricultural landscapes (Harlan 1975; Frankel and Hawkes 1975), my research in southern Belize found little correlation between improved varieties being introduced and old varieties being abandoned there. Instead, this and other research demonstrates how cultural and economic changes alter the perception and use of maize varieties in an indigenous landscape where maize historically has been and remains the focal crop (Soleri and Cleveland 1993; Soleri and Smith 1995; Zimmerer 1996).

This paper is the result of periodic fieldwork conducted between 1994 and 1998. Interviews were conducted with 89 Mopan farmers pertaining to the number of maize varieties planted in the past and present, changes in their agroecological practices, and the symbolic meaning of maize varieties. Most interviews were conducted with farmers in San Antonio and San José; however, Mopan in Santa Cruz, Nalumka, and Santa Elena were also included (Fig. 1). Both informal and formal interviews were conducted with Mopan farmers concerning past and present agricultural practices. I and two Mopan villagers with survey experience administered 89 formal interviews. Topics investigated through formal interviews included the number of maize varieties grown by Mopan farmers, the perception and meaning of maize to individuals, and how traditional agroecological practices and beliefs changed within the lifetime of the informant. Informal interviews covered similar topics, however, these were conducted in situations where a formal meeting was not possible (e.g. meeting someone in a village shop or along a roadside). In San Antonio and San José, a spatial systematic sample was used to select farmers for formal interviews. Twelve ethnobotanical market surveys were conducted in Punta Gorda, the district capital, to investigate crop selection among the Mopan Maya. These surveys were conducted over a three-year period in order to record changes in the varieties of maize being sold.

A great deal of research has been conducted concerning traditional agriculture and crop diversity -- especially maize. Much of this research has been concerned with the erosion of crop diversity in domestication hearths. Some prominent recent examples of this research include Zimmerer's studies of cultural change and crop diversity

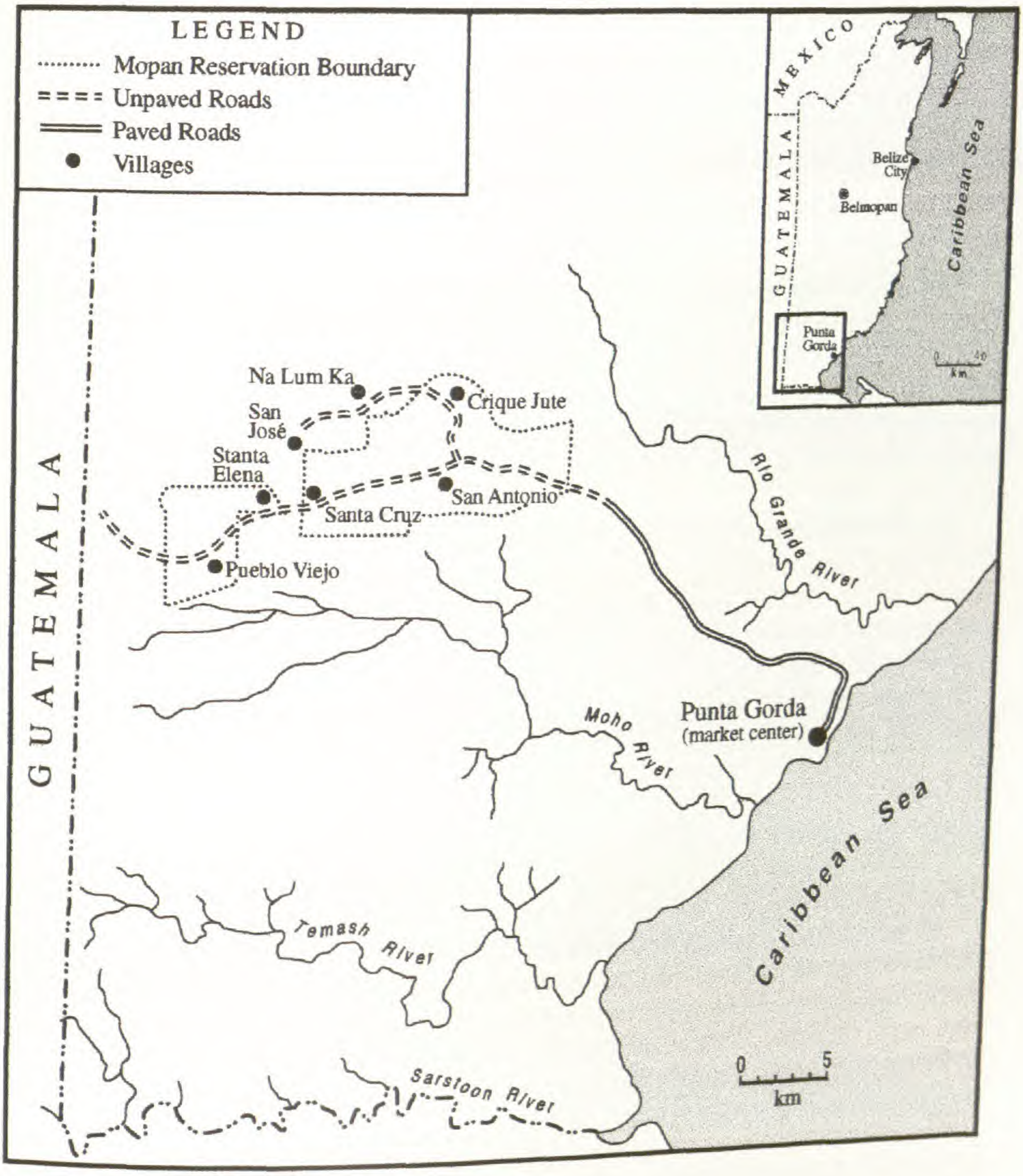

FIGURE 1.–Mopan villages in southern Belize

in Peru (1988, 1990, 1991; and Douches 1991), Bellon's research concerned with maize diversity under conditions of technological change in Mexico (1991, 1995; and Brush 1994), Brush's extensive survey of traditional farming systems and crop landraces in both Mexico and South America (1986, 1989, 1992; et al. 1992), as well as other studies by Clawson (1985), Altieri and Merrick (1987), Merrick (1990), Louette (et al. 1997), and Wilken's (1987) broad description of traditional farming practices in Mexico and Guatemala. Some less recent, yet still prominent, research concerned with crop diversity and traditional agriculture includes Anderson's studies of maize diversity in Mexico and Guatemala (Anderson 1946, 1947), Johannessen's work on the domestication process in Guatemala (Johannessen et al. 1970; and Johannessen1982), and Wellhausen's survey of maize diversity in Mexico (Wellhausen et. al 1952).

An important theme of these works, particularly the more recent literature cited, is the role farmer's play in maintaining crop diversity and how this diversity is affected by cultural and economic change. This chapter will follow a similar vein by discussing how cultural and economic change has affected maize diversity among the Mopan Maya.

CULTURAL SETTING

This study was conducted in the Mopan Maya cultural region in the Toledo District in southern Belize (Figure 1). The Mopan Maya present an interesting group through which to study agricultural changes because their overall culture has dramatically changed over the past 50 years (Wilk and Chapin 1990). Examples of change include the Mopan economy, growing educational opportunities for young people, especially women, and development projects focused on village women (Steinberg 1998).

The Mopan economy moved from subsistence-based to market-oriented after 1940 when the government constructed a road from San Antonio, the largest Mopan community, to Punta Gorda, the primary market town (Figure 1). This road created an outlet for Mopan agricultural products, thereby generating cash incomes in an economy that was previously subsistence-based. Rising income and contact with greater Belizean society resulted in growing economic and social aspirations, especially among young adults. These rising expectations set in motion what Gregory (1987) called the "young man's revolt," in which the younger male generation refused to participate in the previously mandatory civil-religious hierarchy, or cargo system. As a result, the traditional political, economic, and religious hierarchies were turned upside down as prestige and honor were no longer associated with age and experience, but instead with cash and material wealth.

More recently, a young women's revolt has taken place. More Mopan women are receiving high school educations than at any time in the past. Women who attend high school have opportunities beyond the control of their families. In the past, many married around the age of 14 (Gregory 1987; Wilk and Chapin 1990); however, with greater emphasis placed on education, marriage is being postponed and involving less parental interference.

Traditional gender roles where a woman's economic security is totally dependent on her husband's earning potential is also changing with the help of outside development agencies. Most villages formed women's cooperatives in the past five years that earn income by running corn mills and/or selling handicrafts to tourists. Before corn mills were established in villages, women spent up to three hours a day grinding corn by hand for tortillas, the mainstay of the Mopan diet. Some devote the extra time to handicrafts, generating their own income. Some women reported using their money to buy metal cooking pots, which are considered luxuries and a great source of pride for the family. Village women have more free time and money, empowering them within Mopan society.

Other areas of change over the past 50 years include: 1) political change, where politics moved from being local, Catholic Church oriented to more national, secular oriented; and 2) religious change, where since the 1970s large numbers of people left the Catholic Church and joined Protestant evangelical churches.

THE MOPAN MILPA SYSTEM

The Mopan practice slash-and-burn agriculture that is characteristic throughout Mesoamerica as well as most of the tropics. As in other areas of the tropics, vegetation is felled, left to dry, and then burned, with the ash acting as a fertilizer for crop plants. Two maize crops are planted each year by the Mopan. The first in May (***sotzilnil***) and the second in November (***matahambre***). The May crop always involves burning, while in the second planting the vegetation is usually cut and left to rot. However, some farmers will burn their milpas in November if weeds and grasses are becoming too prolific.

May planting is a time of anxiety among the Mopan because if farmers plant too early in the short, dry season, the crop will wither and be wasted. In recent years, farmers have complained that the rainy season is arriving later and later; therefore, many Mopan farmers have begun to adjust their planting time to late May or early June. However, risk always looms large in Mopan agricultural life. Religious ceremonies are an important part of Mopan culture during the burning and planting season prior to the arrival of the rains in May and June. Prayer services are held in most communities and farmers burn copal in their fields and make offerings in order to assure the timely arrival of rain.

Mopan milpas range between two and five hectares. Milpas are almost always created from young second growth vegetation rather than primary forest. Today, primary forests are so distant from Mopan settlements that it has become impractical to maintain a milpa so far away. For example, the largest Mopan town, San Antonio, is about three to four hours walking time from the nearest large tracts of primary forest. Usually, the forest is allowed to regenerate for no more than five years before the Mopan clear the same plot again. All farmers in this study claim a five year fallow period is the longest they would allow their field to regenerate before clearing, with 28 of the 89 farmers indicating that fields are cleared and burned every year.

CULTURAL IMPORTANCE AND MEANING OF MAIZE

Despite all of the cultural changes the Mopan Maya have undergone in the past 50 years, the milpa and maize remain defining features of their culture. Almost every able-bodied adult male, as well as many widowed or single adult females, grow maize. Even those who are considered rich by Mopan standards, and who could buy it from their neighbors, still maintain a milpa with maize, even if the milpa is small and economically insignificant. For instance, a retired Mopan nurse who trained and worked in the United States, who lives in a cement two-story modern home, and who dresses in Western-style clothing, continues to clear, burn, and plant a field with maize. She does not do this for the income, but instead because the Mopan continue to have very strong ties to the milpa and maize. Maintaining a milpa and growing maize is synonymous with being Mopan Maya. Maize is part of the Mopan cultural core.

Maize has similar importance throughout Mesoamerica, particularly in the pan-Maya highland and lowland areas. This applies not only to today, but also for thousands of years in the past. It is the staple crop that gave rise to the magnificent

temples as well as provides income for today's rural peasants (Galinat 1995). As a result of its long-term importance to the Maya, hundreds of varieties of maize are grown in dozens of environments. The diffusion into different physical settings has resulted in varieties ranging from those that are adapted to short growing seasons at high altitudes to drought resistant varieties that thrive in desert conditions. There is no other single crop that is more important in a historical or modern sense to the indigenous cultures of Mesoamerica.

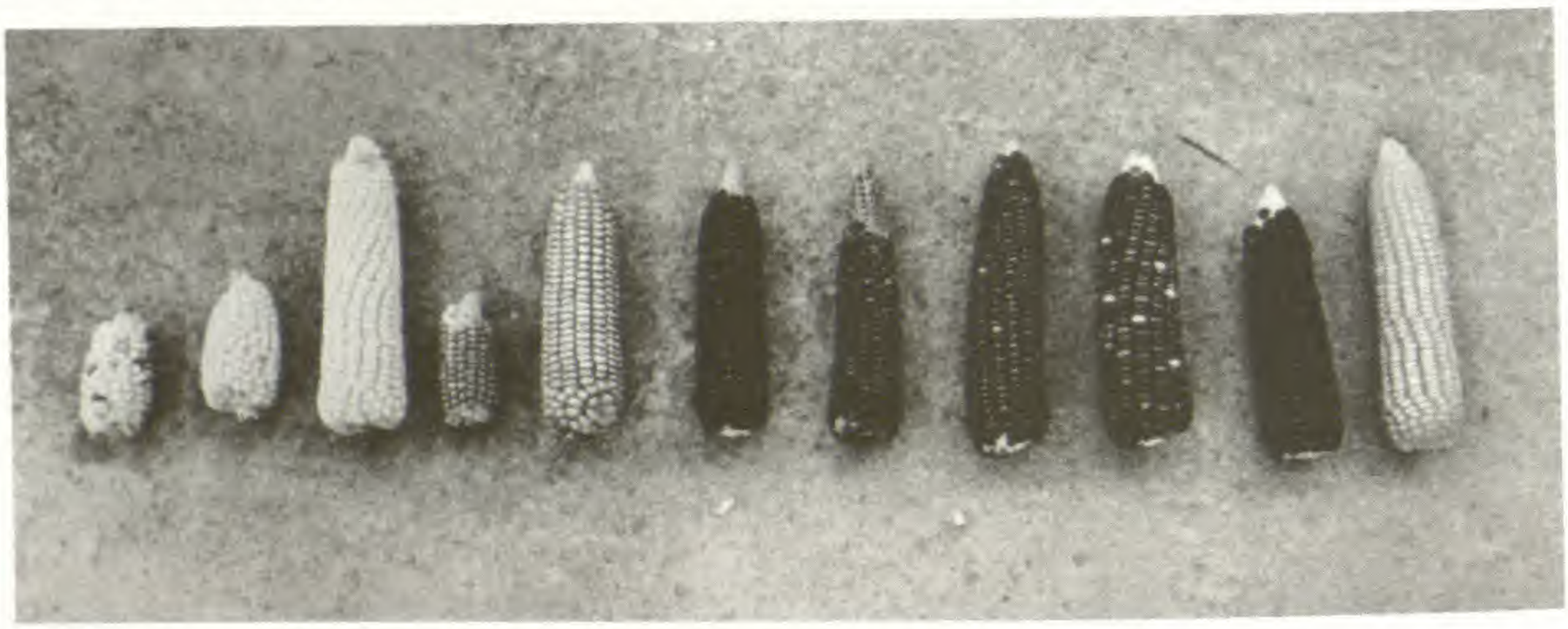

FIGURE 2.–Maize varieties that are planted by the Mopan. One through three, left to right, are the white variety (***sic nil***), four and five are the red variety (***chuck nil***), six through ten are the black variety (***bush nil***), and eleven is the yellow variety (***kún nil***).

Among the Mopan, particularly older villagers, maize continues to have mythological legends attached to it (Steinberg 1996). The Mopan grow four local maize (***ixim***) varieties (Steinberg 99, 100, 101, 102, WIS), and one hybrid variety of maize. These include the black variety (***bush nil*** in Mopan), the red variety (***chuck nil***), the yellow variety (***kún nil***), and a white variety (***sic nil***) (Figure 2). The white variety is harvested as "green" corn that is used in tamales, or harvested when mature and used for animal feed or for tortillas. All varieties (white, yellow, red, and black) take about 4 months to mature, but when harvested green, the white variety is harvested after 2 months, making it the fastest maturing variety.

The symbolic value of maize is linked with its color. Of the four varieties grown by the Mopan, black and red maize have the most spiritual/cultural significance attached to them. Because of their symbolic importance, these two varieties are not sold. They are grown for household consumption, especially at celebrations.

The Mopan claim the colors of maize represent the different temperatures at which it was created. This belief is described in the following folktale:

The Maya saw the *wewe* ant (leaf-cutter ant) carrying the maize kernels along a path one day. The Maya were hungry and wanted to collect the maize, but it took too long to collect it from each ant. So the Maya followed the ant to the source of the corn, which was a huge rock with a very thin crack. The crack was too thin for the Mopan to reach in and get the maize. The Maya knew they would need help to crack open the rock and get the maize. So they asked the woodpecker to crack open the stone. The woodpecker tried, but he could not do it alone. So the

Maya asked the Gods to hit the rock with lightning at the same time the woodpecker was pecking at the rock. The Maya told the woodpecker to be careful and to fly away just before the lightning struck the rock. The woodpecker was too slow; when the lightning struck, it also hit the woodpecker in his head turning his comb bright red (probably a Lineated woodpecker). When the lightning hit the rock the rock burst open, burning some of the seeds according to how close they were to the spot where the lightning struck the rock. This heat produced the individual colors. The black variety was created under the most intense heat, followed by the red variety, then the yellow, and the white variety under the least hot conditions.

The association of maize color with different temperatures has also been noted in Maya cultural areas in Guatemala (Johannessen 1982).

Another folktale links the black color to sexual promiscuity. According to informants:

> A women was taking lunch to her husband who was working in their milpa when she met a stranger along the path. The stranger was a handsome man. She stopped and talked with him. He then talked her into having sex with him in the forest. When the husband found out, he was very upset and chased the wife out of the house and killed her. As punishment for their actions, god burned the maize crop, producing the black color in response to the Mopan straying from the path of accepted social mores.

To the Mopan, the red maize also carries a great deal of symbolic value. In addition to the folklore mentioned above, the Mopan claim the red color represents Christ's blood that was shed on the cross. As the blood dripped to the ground, it stained the maize plants growing around him. When white maize is planted too close to red maize, they cross-breed and the Mopan claim the maize is splattered with Christ's blood.

Medicinal powers are also attributed to maize. Maize kernels are brewed with hot water to make maize teas or soups to strengthen individuals who are weak or lethargic. Several informants claimed that tortillas made from black maize provide extra strength, allowing a person to work for a long time without becoming hungry after eating the tortillas.

Besides its supposed medicinal powers, maize porridge or (*lukenoox*) is served during religious ceremonies. All-night prayer vigils to honor a particular religious figure prior to or during Maya Catholic feast days are common in Mopan villages. A maize porridge is served to the individuals who are participating in the vigil. This is said to help participants maintain their stamina through the all-night prayer services as well as become spiritually more pure by eating the most sacred of all Mopan crop plants (maize). This maize porridge is also served to individuals who participate in the Mopan deer dance, a masked-dance performance that was once performed in all Mopan villages, but in recent times has become quite rare (Steinberg 1997). During this celebration, young men in the village attempt to climb a greased pole in an effort to retrieve a satchel of money placed on top of the pole. The participants are fed maize porridge in order to provide them with the energy and power needed to reach the top of the pole.

Maize is also made into ***chicha***, a fermented maize "brew." Chicha is made from maize kernels that are infested with weevils. The weevils are believed to play a role in its alcoholic potency. Chicha is still a common feature in Mopan villages, even with the availability of rum and beer. Unfortunately, it feeds the alcoholic appetite of the most economically marginalized in the villages– usually the old or destitute (which are often one in the same).

The white variety is preferred for tamales and tortillas, the staple food of the Mopan which is eaten at every meal. The white variety is described as being the easiest to work with when it is ground into a paste, followed by the black and red varieties. The yellow variety is described as being extremely tough and difficult to work with by several women in the San Antonio corn mill. The Mopan claim the yellow variety is grown almost solely for animal feed because of its hard texture.

The Mopan value maize above all other crops they grow, referring to it with respect and never wasting it. This respect can be witnessed during ceremonies commemorating certain agricultural events, like planting and harvesting. Personal and material sacrifices are offered to the spirit of the maize plant to help ensure a good crop. These sacrifices include abstaining from sexual intercourse before planting or holding a feast to honor the spirit of maize. Regarding the use of maize, maize is never supposed to be treated in a careless, wasteful manner. Maize is fed to animals in a way that is considered to be respectful to the maize plant. While it is on the ground, individuals are never supposed to trample on it.

No other plant grown by the Mopan has such cultural importance assigned to it. Other crops, such as rice or beans, are merely described as cash crops. These plants are not crops with great cultural importance and are not assigned significant symbolic status.

THE MOPAN ROLE IN MAIZE EVOLUTION

Mopan farmers have an impact on maize evolution as they select for specific desired traits. These traits include kernel size, ear size, color, and resistance to pests. Robust kernels from large ears are selected and set aside for the next season's planting. Seed kernels are never selected from stunted ears, or from the ends of the ears. A similar method is employed when selecting for color. Large kernels from healthy ears with uniform color are selected for seed. In one informant's home was a small, but growing, pile of future seed corn of the red variety. Each kernel was a brilliant ruby color, with no trace of any other variety's imprint. Seed kernels were selected as the corn was shucked and prepared for either sale or home use. Selection for pest resistance is similar. Ears and individual kernels that lack any weevil or other pest damage while on the stalk and in storage are set aside to be used in the future.

Little effort is made to isolate individual varieties in separate fields. The shortage of arable land due to population growth has limited the number of fields available to a single farmer. As a result of this growing pressure on land resources, many farmers do not have the luxury of using multiple fields in several different microenvironments. The Mopan have not maintained the folk pedological system described in many studies in other ethnoecological settings (see Wilken 1987). In my survey, only five of the 89 informants claimed that certain varieties of maize

are adapted to, and have better yields in, specialized soil environments. And of those three, they gave vague descriptions of how each variety of maize is adapted to specific micro-environmental conditions. Instead, most Mopan claim none of the varieties are specialized, and that any can be planted where others have been planted. The Mopan do recognize that different varieties must be grown in separate sections of a field if the characteristics of that variety are to be maintained. Because of the close proximity of the different varieties, many ears bear mixed or speckled kernels.

MAIZE DIVERSITY IN THE MOPAN CULTURAL LANDSCAPE

Over the three year period of field work, the Mopan planted four local maize varieties and one hybrid variety. However, the number of individuals planting the red and black varieties today are so small these two landraces are on the brink of extinction in the study villages– especially the red variety. Of 89 farmers surveyed, only four still plant red maize, while 17 plant the black variety.

Informants claim that more individuals planted the red and black varieties in the past. Although they may never have been as common as the white or yellow varieties, of 89 farmers interviewed, 55 claimed they do remember their fathers planting the red or black varieties. According to one informant, black and red maize were "much more common in the past, especially when the dances and (Maya Catholic) holidays were celebrated."

In contrast to what many researchers have found in other agroecological landscapes, the decline of these varieties is not due to the introduction of maize hybrids. Only three individuals in my survey planted commercial hybrids. Hybrids are available from missionary Mennonite farmers, and they do offer some advantages over local varieties in that they mature in a shorter period of time and they are rarely blown over by wind gusts because their stalks are shorter. However, they are not preferred by the Mopan because of their susceptibility to weevil infestation while in storage.

I found that local varieties are abandoned once their cultural significance is weakened by forces unrelated to hybrid introduction. One of the driving forces behind recent changes in traditional Mopan agroecology is the influence of Protestant evangelical missionaries. The evangelizing of rural villages in southern Belize began in earnest in the middle and late 1970s. As missionaries entered villages, traditional, synthesized Maya Catholic beliefs and practices began to be abandoned (Gregory 1987; Steinberg 1997).

Although maize may at first seem unrelated to religion, stories and rituals associated with it have been incorporated into the Maya Catholic faith. The ritual significance of maize was transferred from traditional Maya beliefs to the Catholic faith. The Maya Catholic religion allowed these traditions to continue in post-contact Maya culture. However, this connection between the spiritual and natural world is being rapidly eroded. As more individuals convert to evangelical denominations, fewer plant red and black maize. A significant correlation exists at the five percent level between those who grow red and black maize and religious affiliation (Table 1). Eleven of the 17 farmers growing black maize were Catholic, while all four individuals who grew red maize were Catholic.

Table 1.– Maize Correlation Coefficients. Probabilities in parentheses

	AGE	RELIGION	PLANT IN PAST?	YELLOW MAIZE	WHITE MAIZE	BLACK MAIZE	RED MAIZE	FATHER PLANT THEM?
AGE	1.000 (0.000)							
RELIGION	0.0600 (0.5764)	1.0000 (0.0000)						
PLANT IN PAST?	0.2475* (0.0194)	0.2415* (0.0226)	1.0000 (0.0000)					
YELLOW MAIZE	0.0302 (0.7788)	-0.2470* (0.0196)	-0.0047 (0.9648)	1.0000 (0.0000)				
WHITE MAIZE	-0.2487* (0.0188)	-0.1259 (0.2397)	-0.0964 (0.3687)	-0.0495 (0.6449)	1.0000 (0.0000)			
BLACK MAIZE	0.2295* (0.3971)	0.2390* (0.0241)	0.3448* (0.0009)	0.0663 (0.5373)	-0.3085* (0.0033)	1.0000 (0.0000)		
RED MAIZE	0.0909 (0.3971)	0.2347* (0.0268)	0.0964 (0.3687)	-0.1765 (0.0980)	0.0471 (0.6614)	0.0326 (0.7620)	1.0000 (0.0000)	
FATHER PLANT THEM?	0.1770 (0.0971)	0.1235 (0.2487)	-0.0947 (0.3772)	-0.2518* (0.0173)	-0.0589 (0.5832)	-0.0297 (0.7820)	0.1706 (0.1100)	1.0000 (0.0000)

A young farmer explained why he did not participate in such traditional activities: he claimed his father's generation planted black maize, but he did not believe in the superstition associated with it. Instead, he planted white maize because he perceived it as having less religious significance, and because it could be sold more easily. He, and many of his generational counterparts, eagerly embrace the new religion that promises a new identity and a break with the perception of the "old ways" as superstitious. The old ways came from a time when the Maya Catholic belief system affected all parts of Maya life. The civic/religious cargo system was supported, each village celebrated its patron saint's feast day with public dances, and the communal land and labor systems were strong. Even among Mopan Catholics today (who still make-up the majority of Mopan), many traditions associated with the old ways are being abandoned because of the divisive nature of the missionary work. Entire communities and families have split along religious lines; thus the cultural solidarity which motivated individuals to continue many traditions is declining. Once the religious connection between the natural world and Maya Catholicism is weakened, traditional varieties are abandoned for those which are more culturally neutral.

Protestant missionaries forbid converts to participate in activities that have ties to the Maya Catholic culture. When one converts, he or she is expected to be "born again" not just spiritually, but also culturally. This means giving up rituals

that are connected with the Maya Catholic faith and culture. Crops, traditional dress, and cultural dances are all examples of ethnic traits that have been impacted by evangelical conversions (Steinberg 1997).

Not only are the red and black varieties becoming rare, they are also grown predominantly by older farmers. Again, a significant correlation exists at the five percent level between age and farmers planting black and red maize varieties (Table 1). Within the study population, 12 of the 17 farmers who were growing black maize were over 40 years old, while three of the four individuals who planted red corn were over 40. While another correlation exists at the five percent level between young farmers and planting efforts concentrated on white maize (Table 1). It appears that the younger farmers want little to do with symbols of the old ways.

Besides the impact of cultural change on maize diversity discussed above, commercialization of the Mopan milpa also has had an impact on how many varieties the Mopan plant and maintain. The Mopan have been producing agricultural products for the larger Belizean economy since the early 1940s; therefore, they are well integrated into a national economy. Although the milpa and maize have retained their significance in the Mopan culture *overall,* the milpa is also a commodity-oriented, market-driven land use system for virtually all Mopan. The Mopan have few economic opportunities beyond what is produced in the milpa; therefore, maximum returns are demanded. The Mopan depend on an economically active milpa system to produce cash income, not a milpa that produces ritualistic crops with little cash value.

The result of this commercialization of the milpa is illustrated in the diversity of maize grown by the Mopan. Few Mopan farmers grow crops that are valued for religious, ceremonial, or cultural reasons. Instead, most Mopan grow crops that can produce cash. By far the most popular varieties of maize are the white and yellow races. These varieties have less symbolic value and more cash value. In 12 surveys of the agricultural market in Punta Gorda, this study found no farmers who sold the black or red maize varieties. As a result, the Mopan dedicate most of the milpa space to the production of first white, and then second the yellow variety. The Mopan cannot sell the black or red varieties; therefore, few people grow them. The market-driven milpa does not value ceremonial and traditional crops (i.e., agricultural diversity); instead, it values commodities that produce economic returns.

Because the red and black varieties are planted by so few farmers, several informants claimed that the seeds of these varieties are no longer available. Several informants acted surprised that they were still planted at all. Seed is exchanged among family and friends. Once these sources stop growing a particular variety, it is very difficult for the Mopan to then find enough seeds to plant. Some informants claimed the red and black varieties are no longer planted by any Mopan. Given the fact that the red and black varieties are used only in home consumption and grown by so few farmers, it is easy to understand why farmers who do not plant these varieties themselves believe that they are no longer planted by anyone.

CONCLUSIONS

Although maize maintains an important position in the Mopan agroecological landscape, its meaning, significance, and maintenance have not been impermeable to outside forces driving cultural change among the Mopan. Most Mopan plant only one or two varieties of maize. This is particularly true among the younger generation. The result is a less diverse, more homogeneous agricultural landscape.

This research demonstrates that decisions made by traditional farmers regarding crop maintenance and selection are more complex than some researchers have suggested. The availability of hybrids does not invariably lead to the abandonment of local landraces. In the Mopan cultural region of southern Belize, certain landraces are maintained for symbolic, ritualistic purposes. Once the rituals are abandoned and their symbolism weakened, these varieties are planted by fewer individuals. Similarly, when farmers move away from a subsistence economy and become involved in a market-driven economy, varieties that have little or no cash value fall out of the crop complex grown by farmers.

The outside Western world is certainly impacting maize diversity in southern Belize, but, in much broader and more complex ways than is posited by placing the blame for the abandonment of local landraces on the introduction of green revolution varieties.

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This impressive treatise assembles a dazzling array of facts, patterns and ideas about the living South American members of the camel family. Most of this tome is devoted to the two domesticated species, llama and alpaca, which form important elements of Andean culture history and traditional life. Their wild relatives, the vicuña and guanaco, are extant, though uncommon and understandably receive less attention.

The thirteen substantive chapters of this monograph cover taxonomy and phylogeny, biological aspects (habitat, morphology, anatomy, reproduction, nutrition, diseases, genetic selection); paleontology; archaeology (in Peru); domestication process; history (in Peru), chronicler perspectives on these animals; llamas in the republican period after 1825; archaeology and history outside Peru; use patterns past and present; Andean pastoralism, present distribution of camelids; and as somewhat an aside, an essay into the history of Old World camels introduced to Peru. Indices organized by name, place, and archaeological site help the reader locate specific information. The bibliography of more than 1600 items is an indispensable retrieval tool to those seeking printed references of these animals. Besides five distribution maps, there is a section of photographs of pre and post Conquest representations of llamas and alpacas.

Careful winnowing of the archaeological literature and close reading of the historical sources form the strongest parts of Bonavia's book. A Professor at Cayetano Heredia University in Lima and past Guggenheim fellow, Bonavia has a doctorate in archaeology. Prehistoric reconstruction of the domestication and prehistory of llamas and alpacas will remain inferential until some way can be found to identify camelid bones by these species. These animals had a much wider spread and ecological amplitude than their present distribution indicates. Llamas had disappeared from many areas including the Peruvian coast by the mid-colonial period. Since he author does a splendid literature search, gaps in this book's coverage point to holes in knowledge about camelids. Studies on contemporary camelid keeping community by community would tell us much about variations in local use patterns. A comprehensive study of the marketing of camelid products would fill the blank spots on how those items, especially fleece, get into sales channels. If phenotypic diversity of both llamas and alpacas were systematically investigated, some interesting variations would surely unfold.

The most extensive collation yet assembled on this topic, this book is an essential source on these animals and should be in all major libraries and personal collections on ethnozoology. Where opinions diverge, Bonavia carefully examines the evidence, sorts out scholarly attributions of ideas, and not infrequently corrects misinterpretations and wrong citations. To use only an example, Bonaviea carefully weighs the evidence for a past use of the llama as a mount. Although the llama was generally not used in that way, Bonavia goes through the historical descriptions and ceramic materials to qualify his assertions about them.

The sum of its organizational lapses, typos and missed references are minor compared to its virtue as a useful, balanced scholarly synthesis. For the next de-

cade at least, this book will be the essential source for scholars seeking a range of information about New World camelids. The Institut Français d'Études Andines (IFEA) and its editor Georges Pratlong must be commended for having added this hefty tome to a monographic series that includes many superb studies of Andean land and life.

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