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JOURNAL OF ETHNOBIOLOGY

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COVER ILLUSTRATION: Oko But demonstrates how to blow water through the internodes of ***bulo apai*** (*Dinochloa* sp.) (Gollin, this issue Figure 2).

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ETHNOBIOTICA

For this issue of the journal, I have invited Jan Timbrook, president of the society, to address you, the membership.

Naomi

A Message fron the President of the Society of Ethnobiology

Gaining knowledge for its own sake and reporting results only to our ethnobiological colleagues is no longer enough. Today, we must reach out in diverse ways, not just to our peers and students, but to the general public as well. We must take responsibility for presenting our findings to wider audiences and encouraging them to value the research we do. As indigenous peoples, native habitats, and archaeological and cultural sites are increasingly threatened on a global scale, we ethnobiologists stand in a uniquely powerful position to help stem the tide of cultural and biological destruction. By taking an active role in the broader community to promote understanding and foster appreciation of the ways in which humans interact with the environment, we can enhance the prospects for survival of the places, the peoples, and the cultural traditions in which vital knowledge resides.

People who keep traditional knowledge alive have always been active participants in the Society of Ethnobiology, as collaborators in research and as presenters at our annual conferences. Their involvement has been growing over the years, but has never been so great or well-integrated as in the 2004 Society of Ethnobiology meeting at University of California, Davis. The diversity of oral presentations, posters, panel discussions and demonstrations, supplemented by field trips to see how California Indian basketweavers manage plant populations and a presentation by Maidu Dancers and Traditionalists, who pay honor to the natural world through their work—all of these combined to give us new insights into human stewardship of the environment. Thanks to Kat Anderson and all the people at Davis for making this year's conference a rewarding experience of unparalleled richness.

Now I must ask you to help spread the word by telling your friends and colleagues about the Society of Ethnobiology. It's surprising that many people who are involved in one or another aspect of ethnobiology are unaware of our organization, even though it was first in the field, established in 1978. Our members comprise a lively, diverse assemblage of researchers, educators, agency representatives, First Nations people and others who share a common interest in relationships between humans and other living organisms. Though based in North America, the Society is international in scope, with members active all over the world. The *Journal of Ethnobiology* is about to start its twenty-fifth year. Discussions are underway toward digitizing as much of its content as possible, with an ultimate

goal of making the articles even more accessible through our website. To find out more about the society and the journal, visit our website, **ethnobiology.org**.

It might be easy to confuse our group with other professional societies. The Society of Economic Botany (SEB), whose journal has a long history of publishing studies about economically useful plants, is increasingly including ethnobiological articles. More recently established in the International Society of Ethnobiology (ISE), an independent group that shares many of the same interests as the original Society of Ethnobiology but whose mission is more overtly political, actively pursuing intellectual property rights issues in a worldwide context. There are several other organizations—even a Society for Ethnoentomology—and more such groups are formed each year. If more ethnobiological researchers participate in our society rather than develop new groups from scratch, they will not only benefit from the consolidation of organizational effort, but will enjoy even more opportunities for stimulating interchanges with others of like mind.

The Society of Ethnobiology provides a forum for communication among researchers who strive to understand the myriad interactions betweeen people, plants and animals. Fields relevant to ethnobiology include Anthropology to Zoology, and everything in between—animal husbandry, agriculture, archaeology, botany, chemistry, cuisine, ecology, education, ethnology, evolution, forestry, linguistics, medicine, mycology, nutrition, pharmacology, taxonomy, and much more. Who is not interested in at least one of those areas? Ethnobiology is the unifying discipline.

The other officers, trustees, and I hear from members and prospective members who would like to see their own specialty better represented. We want to encourage all of you to join and participate in the Society—present papers at our annual meeting and submit them for publication in the *Journal of Ethnobiology*. You can share your ideas and hear from colleagues who are working in related areas with perspectives that may be new to you. Just as exciting as the research presentations are informal discussions with people from all over the world and experiencing new places.

You'll have that opportunity at the 28th annual meeting of the Society of Ethnobiology on May 11–14, 2005. It will be hosted by the University of Alaska in Anchorage, where important zooarchaeological research is being done on human settlement of circumpolar regions. We'll also examine ecological knowledge, human relationships with wildlife, resource management, and conservation of biological and cultural diversity—from indigenous as well as Western academic perspectives—and hear about current findings in all fields of ethnobiology.

These issues have great relevance in our world today. What we derive from our interactions with other ethnobiologists—native and non-native, in all our different fields—is not only information but inspiration. I hope we'll be inspired to take action, to spread greater understanding of the value of traditional knowledge, to help set a beneficial course for the future.

Please join us!

Jan Timbrook

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SUBTLE AND PROFOUND SENSORY ATTRIBUTES OF MEDICINAL PLANTS AMONG THE KENYAH LEPPO` KE OF EAST KALIMANTAN, BORNEO

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ABSTRACT.—The Kenyah Leppo` Ke of Borneo rely heavily on plants grown and gathered for healing a wide range of ailments. This study explores sensory selection criteria of medicinal plants in regard to cultural understandings of efficacy. Over 92% of the medicinal plants have one or more salient sensory properties such as bitterness and astringency. Some Leppo` Ke sensory attributes have no simple English gloss; *"**nglidah,**"* which characterizes disparate species (e.g., a moth larva, *Cymbopogon citratus, Litsea cubeba*), is discussed. This sensory category shares a number of chemotaxonomic and pharmacologic characteristics. Subordinate categories of the Kenyah sensory domain accentuate the subtleties and sophistication of perception, interpretation, and application that guide their therapeutic systems. The chemistry of less obvious sensory attributes and implications of this research for ethnobotany concludes this paper.

Key words: Borneo, chemosensory evaluation, ethnobotany, ethnopharmacology, ethnomedicine.

RESUMEN.—Los Kenyah Leppo` Ke de Borneo dependen básicamente del cultivo y recolección de plantas para curar un amplio rango de enfermedades. Este estudio explora los criterios sensoriales de selección de plantas medicinales y su relación con el entendimiento cultural sobre su eficacia. Se ha encontrado que más del 92% de la flora medicinal tiene una o más propiedades sensoriales sobresalientes como el amargor y la astringencia. Algunas categorías sensoriales usadas por los Leppo` Ke, no tienen traducciones simples o convencionales al inglés. En el trabajo se analiza la cualidad "nglidah," que caracteriza a una dispar serie de especies: desde una larva de polilla, hasta *Cymbopogon citratus,* y *Litsea cubeba.* Esta categoría sensorial comparte tanto atributos químico-taxonómicos como farmacológicos. Las categorías subordinadas del dominio de los sentidos de los Kenyah, enfatizan la precisión y sofisticación de la percepción, interpretación y aplicación que guían los sistemas terapéuticos nativos. El documento concluye discutiendo la química de los atributos sensoriales menos obvios y las implicaciones de esta investigación para la etnobotánica.

RÉSUMÉ.—Les Kenyah Leppo` Ke de Bornéo utilisent les plantes tant cultivées que récoltées afin de guérir un vaste ensemble de maladies. Cette étude examine la compréhension culturelle de l'efficacité des plantes médicinales en faisant appel à une série de critères sensoriels de sélection liés à ces plantes. Plus de 92% des plantes médicinales possèdent une ou plusieurs propriétés sensorielles importantes telles que l'amertume et l'astringence. Parmi les attributs sensoriels des Leppo` Ke, certains ne peuvent être traduits en anglais en des termes simples.

Ainsi, le «**nglidah**», qui caractérise plusieurs espèces disparates (par exemple, des larves de papillon de nuit, *Cymbopogon citratus, Litsea cubeba*), est discuté dans cet article. Cette catégorie sensorielle possède plusieurs caractéristiques pharmacologiques et chémotaxonomiques. La présence de catégories subordonnées liées au domaine sensoriel des Kenyah augmente les subtilités et la sophistication non seulement de la perception, mais également de l'interprétation et de l'application qui servent de guide dans leurs systèmes thérapeutiques. La chimie des attributs moins frappants sur le plan sensoriel ainsi que les conséquences de cette recherche pour l'ethnobotanique complètent cet article.

INTRODUCTION: WAKE UP AND SENSE THE MEDICINE

A growing number of ethnobotanists and ethnopharmacologists have shown that sensory perception plays a major role in how humans identify and utilize medicinal plants (e.g., Berlin and Berlin 1996; Brett 1994; Brett and Heinrich 1998; Casagrande 2001; Heinrich 1994, 1998; Heinrich and Barrera 1992; Johns 1990; Leonti et al. 2002; Shepard 1999, 2002). They have demonstrated that chemosensory input is cognitively structured, named, and assigned a therapeutic use value. These investigations have improved our understanding of the cultural and chemical basis for the use of medicinal plants by indigenous and native peoples, and, for this author are inspirational.

Whereas visual evaluation of the floral environment is the most obvious cue by which people determine a plant's utility for medicine, this paper centers on chemosensory selection criteria for medicinal plants. After several ethnobotanical field investigations around Indonesia over the course of more than a decade, it became clear to me that native plant practitioners place a high value on certain sensory features of plants in selecting, organizing, and employing their botanical pharmacopoeia. I realized that if chemical cues such as bitterness, astringency, and irritant properties are salient in the immensely popular and increasingly prepackaged system of Javanese *jamu* found throughout the archipelago (see Gollin 1993), this must also be true in the more localized medical systems still reliant on the collection of fresh material. This assumption was supported by investigations I conducted in Sumatra (Gollin 1991) and Maluku (Etkin et al. 1996) and in my initial research in Kalimantan (Gollin 1997a, 1997b). When walking through the woods with plant consultants in Kalimantan, I noticed that people frequently snapped off leaves and put them to tongue or nose. They also used a machete to nick a tree to take a swipe of the latex or to examine the inner bark or xylem. Often, inspecting the plant's odor, taste, and morphology is done for the specific purpose of identifying a plant or determining a plant's medicinal or other value. But at times it appears to be almost a behavioral tic, a habitual assessment of one's surroundings. In and around the village and in fields where the plants are more familiar, people do not conduct this diagnostic. However, as is true across Indonesia, people in Kalimantan discuss and order plants according to essential properties such as bitterness, astringency, and pungency. Considering the wealth of literature on Indo-Malaysian medicinal folkways, it is odd that only a few authors have touched upon the sensory aspects of medicinal plant use; those that

have done so have treated the subject lightly (e.g., Ave and Sunito 1990; Kimball 1979; van Esterik 1988).

Perceptual Salience of Bitterness and Astringency among Both Native Plant Practitioners and Ethnobotanical Researchers.—Bitter and astringent principles are especially salient to plant users and are heavily featured in pharmacopoeia worldwide. This is not surprising, because there is a link between chemoperception and biological activity (Gollin 2001).

The understanding that bitter principles are therapeutic is widespread in native healing systems and foodways (Etkin et al. 1990; Etkin and Ross 1982; Johns 1990, 1994). One pattern found in diverse settings is the application of bitter principles for treatment of internal (primarily fever, gastrointestinal, and respiratory complaints) and external infections (skin ailments). Bitter plants are employed against gastrointestinal complaints among the Tzeltal and Maya of Chiapas (Berlin and Berlin 1996; Brett 1994), the Mixe of Oaxaca (Heinrich and Barrera 1992), the Matisigenka of Peruvian Amazon (Shepard 1999), the Alune of Maluku (Etkin et al. 1996), and the Popoluca of Mexico (Leonti et al. 2002). Bitter principles are valued as antipyretics in diverse locales from South America (Johns 1990) to Thailand (Brun and Schumacher 1987). In every locale in which I have conducted research around Indonesia, I have been told by plant users that bitterness cures fever, particularly malaria. For instance, for the Alune of Maluku, bitterness is said to strengthen the blood and is favored for treatment of febrile conditions (Etkin et al. 1996).

The therapeutic attributes of astringency are especially similar across cultures. The physiological effect of astringency—due to the presence of polyphenolic compounds, or tannins (Cotton 1996)—is so distinctive that it is easy to see why the therapeutic intentions stated by native practitioners for tannin-containing plants is similar in diverse medical systems. Tannins blur the distinction between a chemical sense and a tactile one. In other words, astringency is as much the sensation of drying and roughness in the mouth, and the drawing-in sensations felt in the cheeks and muscles of the face, or the feeling of tightening and drying of the skin from external applications, as it is a flavor (Lawless and Heymann 1999). Astringent plants are exploited widely by humans for stomach disorders, most prominently as treatment for diarrhea and dysentery (Berlin and Berlin 1996; Brett 1994; de Padua et al. 1999; Etkin et al. 1996; Heinrich and Barrera 1992; Leonti et al. 2002; Shepard 1999), styptics and vulneraries (de Padua et al. 1999; Perry and Metzger 1980), and control of dental caries (de Padua et al. 1999; Elvin-Lewis et al. 1980; Kakiuchi et al. 1986; Perry and Metzger 1980). For instance, among the Matsigenka, astringent plants are believed to draw the invisible worms that cause illness "together" so that they can be expelled from the body (Shepard 1999). These beliefs parallel perceptions about astringency in Indo-Malaysia. Among the Alune astringent plants are understood to expel "dirt" and "clean the stomach" and are therefore useful for diarrheal diseases, as well as cleaning and shrinking the uterus after childbirth (Etkin et al. 1996).

It is no longer novel to argue that people utilize bitter and astringent (and related pungent) properties in plants to banish disease according to familiar patterns. Moreover, there is by now an immense corpus of information based on

laboratory and clinical analysis that confirms efficacy from a scientific standpoint (e.g., Ross 1999). Although beyond the scope of this article, it is worth noting that pharmacologic analysis of plant remedies underscores their effectiveness against certain ailments.

Scientific experiments conducted on bitter and astringent plants have also demonstrated the degree to which a given taxon produces the effects desired and expected *within the user's own system of medical belief and practice.* Efficacy is itself a cultural construction (Etkin 1992; Ortiz de Montellano 1986). For instance, bitter plants sometimes contain powerful emetic and diaphoretic alkaloids, properties that often constitute the indigenous rationale for a plant's use. *Eurycoma longifolia* Jack is a highly regarded febrifuge and treatment for stomachache throughout Borneo and other regions of Indonesia (Perry and Metzger 1980). The bitter constituents of the roots are strong enough to induce vomiting in large doses and are expressly employed for their emetic effect in order to expel disease from the body (Sosef and Horsten 1999).

Expanding the Ethnopharmacological Palate.—Sense properties such as bitterness, astringency, pungency, sourness, and sweetness are consistently linked to the treatment of specific classes of disease. These "basic" or "primary" tastes found in folk classification systems depart slightly from those recognized in Western science. Western taste-researchers since Aristotle generally agree that there are four basic qualities: sweetness, bitterness, saltiness, sourness that combine to make all known flavors (Scott and Plata-Salaman 1991). Recently, a new taste primary—long recognized in Asian systems—was added to the traditional Western scientific quartet, *umami* (Japanese for foods with a savory, delicious, meaty essence) as elicited by monosodium glutamate (Lindemann 2000). The gustatory dimension is vital to insight into most Asian therapeutic systems (Laderman 1983; van Esterik 1988). For instance, in the royal medical tradition of Wat Pho, Thailand, taste theory (*rod*) postulated curative properties for each of ten plant flavors used as medicines and foods; e.g., astringency "heals wounds," sweetness "permeates the flesh," bitterness "supports the blood and the bile," heat "cures wind," fat "cures muscles and tendons," salt "permeates the skin," sour "bites the mucus," bland "cures mucus and is diuretic" (Brun and Schumacher 1987: 22–23). Hindi taste vocabulary is made up of six basic "tastes" (*rasa*): sweet, sour, salty, bitter, pungent, and astringent that form the basis of Ayurvedic medical theory (Pinard 1991).

Previous scholarship on the taste, smell, and feel of medicinal plants has primarily been conducted in South and Central America. The research presented here focuses on chemosensory selection and utilization of medicinal plants among the Kenyah Leppo` Ke people of East Kalimantan, Indonesian Borneo. Local interpreters recognize in the vast majority (92%) of species that make up the Leppo` Ke botanical pharmacopoeia one or more sensory properties. Often sensory features of plants are explicitly linked to remedying broad illness categories (e.g., bitter plants for fever conditions) or to specified therapeutic mechanisms (e.g., astringent plants for stanching blood flow). This ethnobotanical line of inquiry will go a step further than other investigations that have concentrated on a handful of more obvious organoleptic characteristics of medicinal plants by high-

lighting subtle sensory properties of therapeutic significance as identified by the Kenyah Leppo` Ke, with special attention to the complex culinary and therapeutic quality, ***nglidah***.

STUDY SITE

The Bahau River Valley is in the Pujungan subdistrict of East Kalimantan, central Borneo. The Bahau watershed is one of the largest expanses of continuous forest in Borneo (Wollenberg 2001). The villages visited for this study sit near or within the boundaries of the Kayan-Mentarang National Park, one of the largest protected blocks of rain forest in Southeast Asia (Jessup et al. 1992). The region is very mountainous and steep (few slopes are less than 40%) (Snel 1994) and holds a complex mosaic of vegetation types (MacDonald 1993) as well as a high proportion of species endemism (Jessup et al. 1992). Lowland forests (below 1,000 mASL) include varied species of dipterocarps (especially *Shorea* and *Dipterocarpus*), Euphorbiaceae, Moraceae, and Dillinaceae, among others. At around 400 mASL, mixed dipterocarp forest changes quite abruptly to mixed primary oak forest, and is dominated by *Lithocarpus, Castanopsis,* and *Quercus.* In the upper plateaus there are a number of edible and other useful plants such as *Salacca, Artocarpus, Calamus,* and *Garcinia* (Sorenson and Morris 1997). Forest trees are covered with a variety of epiphytes and lianas. The human population density is low, with less than one person per square kilometer throughout the region (Jessup et al. 1992).

Research was conducted primarily in the Upper Bahau village of Long Tebulo, but also in neighboring settlements of Long Pujungan (pop. 427), Long Alango (pop. 406), Long Kemuat (pop. 100), and Apau Ping (pop. 346). I chose Long Tebulo as the primary study site because the residents showed a deep knowledge of and interest in plants. Tebulo has no government health post, and Tebulo respondents were able to free list more medicinal plants than those from neighboring villages. Tebulo has a substantial number of elders, who are generally repositories of extensive ethnobotanical knowledge. Most importantly, Tebulo residents welcomed the opportunity to record the Kenyah medicinal flora and local use of plant medicines (Figure 1).

Long Tebulo is situated at a bend on the upper reaches of the Bahau River (lat. 2.5° N, long. 115.5° E). The village is approximately 375 m above sea level, while the entire village territory extends several hundred meters up to and beyond the surrounding mountain ridges. The term ***long*** means "confluence." The village is bisected by Sungai Tebulo, a small river which drains into the Bahau. The ***tana` ulen*** 'reserved/restricted land'—the customary village territory of Long Tebulo—is partly located within the boundaries of the Kayan-Mentarang National Park, which is across the river from the village. The closest neighboring villages are Long Alango (two hours upriver) and Long Uli (an hour downriver). Tebulo has a church, an elementary school, a meeting hall, and soccer field. In addition to a pastor and church officials, there are a few civil servants: two teachers, a village head and village secretary.

Long Tebulo had a population of 165 people at last count (Gollin 2001). The number of residents actually present in the village at any given time is variable.

FIGURE 1.—Author's research associate, Ba`un Uluk, and a focus group of men from Long Tebulo resting in the forest before collecting medicinal plants.

There is regular out-migration to Malaysia in search of temporary wage-labor employment, while students who attend junior (SMP) and senior (SMA) high schools in Pujungan and Tanjung Selor come and go according to the academic calendar. Kenyah Leppo` Ke represents the majority cultural group in Tebulo. There are also Kenyah Leppo` Ma`ut (14), Kenyah Bakung (5), Kayan (5), and Kenyah Leppo` Tau (1) residents. The Kenyah, one of the most numerous and heterogeneous groups of Dayak (an exonym used to describe the numerous indigenous tribes that inhabit the Borneo interior), are comprised of over forty different subgroups with different dialects and cultures (Anau 1998).

The landscape around Long Tebulo is highly anthropogenic. A walk from village to forest reveals a carefully designed resource schema, with a rich array of plants grown or managed for convenient access to foods, medicines, and building and craft supplies. Yard gardens hold many taxa. Trails radiating out of the village to the lowland wet rice (cf. *Oryza sativa* L.) fields and the upland swidden fields are lined with pineapples (*Ananas comosus* Merrill), fruit trees (e.g., *Lansium domesticum* Jack), manioc (*Manihot esculenta* Crantz), and plants such as bamboo and *Donax cannaeformis* Rolfe used for plaiting, foods, and medicines. Taro (*Colocasia esculenta* Schott) and water spinach (*Ipomoea aquatica* Forsk.) are planted in the canals that fill the terraced paddy fields. Secondary forest close to the village provides firewood, fruit, and the largest percentage of medicinal flora. Further from the village in primary forest areas, families tend trees to which they hold usufruct rights such as durian (*Durio* spp.) (Figure 2).

FIGURE 2.—Oko But demonstrates how to blow water through the internodes of ***bulo apai*** (*Dinochloa* sp.), a bamboo used as a source of potable water on forest sojourns, and as an eye wash for ocular irritation. ***Bulo apai*** is one of the few remedies in the Leppo` Ke pharmacopoeia with no explicit sensory property.

METHODS

Field research in Kalimantan was carried out in two field seasons for a total period of fourteen months (July–August 1994 and June 1997–June 1998). I initially visited the Upper Bahau in 1994 as a member of an ethnobotanical field team. During this preliminary fieldwork among the Kenyah, I became acquainted with the medicinal flora, diet, health concerns, ethnomedicinal practices, and healing specialists of four Upper Bahau River communities (Gollin 1997a, 1997b). I re-

turned to the area in 1997 to conduct doctoral research. I collected ethnographic data and botanical specimens with the assistance of one of the daughters of my Kenyah host family in Tebulo. We conducted interviews in Indonesian and the local language Kenyah Leppo` Ke and, to a minor extent, Kenyah Leppo` Ma`ut.

Project Participants.—In total, 149 people in 7 different communities (Long Alango, Apau Ping, Long Berini, Long Kemuat, Long Bia`, and Tanjung Selor) were formally interviewed for this study, many on a repeated basis. Participants were interviewed individually, during family and community gatherings, and in focus groups defined by age, gender, education, and expertise. I employed (nonrandom) judgment sampling and snowball sampling methods (Bernard 1994). Each time I conducted a set of interviews, particularly cognitive protocols, I used judgment sampling to create a sample representative of the population. This approach enabled me to elicit a diversity of views held by recognized botanical specialists and lay practitioners. Snowball sampling was used to identify villagers recognized as knowledgeable about medicinal plants and other healing therapies (e.g., ***tukang memoh*** 'massage technician/worker') and build a network of practitioners to work with on a regular basis.

Interview Protocols.—Structured, semistructured, and unstructured data collection conducted in peoples' homes and on plant collection field trips centered on three general categories: health and illness beliefs and practices; healing beliefs and practices; and chemosensory and symbolic aspects of therapeutic plants. Different interview techniques and careful field observation were used to collect, contextualize, and confirm data (Bernard 1994; Etkin 1993a; Pelto and Pelto 1990). A variety of research tools such as free listing, pile sorting, and consensus analysis were used to define cultural domains, elicit native taxonomies, determine consensus and variation in knowledge, and continually cross-check impressions and statements with local respondents (Bernard 1994; Handwerker and Borgatti 1998; Romney and D'Andrade 1964; Trotter and Logan 1986; Weller and Romney 1988; Werner and Fenton 1973).

Elicitation of Sensory Properties of Plants and their Medicinal Values.—I elicited sensory information in a context of use, gathering a list over many months before using structured protocols to ask respondents about medicinal and extramedicinal qualities of flavors, textures, and odors (cf. Brett 1994). Taste and smell are richly complex experiences (Rozin 1982) and hence not readily subjected to "standard" measures. Attempts to determine "basic taste terms" employing methodology developed for the color domain (Berlin and Kay 1969) have been problematic (Bartoshuk 1978; Kuipers 1991).

Sentence completion methods were used to elicit and expand data on chemosensory properties of plants. Sensory qualities of ethnobotanical taxa mentioned by respondents repeatedly in interviews, during plant collection trips and cooking, dyeing, or healing sessions were used to construct a list of eighteen of the most salient sensory qualities of plants. Respondents then linked sensory quality with the therapeutic value of a plant by verbally filling in the following Leppo` Ke sentence for each property: "***Buk ka*** (e.g., ***pa` it, pa:t***) ***de, teneng taban***

inu a o?" meaning, "If something (a plant) is ——— (e.g., 'bitter,' 'astringent'), it is good for ——— (disease or medicine)?"

Observation.—Observation of plant selection, preparation and application was essential to separating what people say they do from what they actually do, and for generating more appropriate research questions (Bernard 1994; Martin 1995). For example, in context of use I was able to observe and query practitioners about the role of plants *without* distinctive sense properties that were likely to be biologically inert: are such plants adjuvants (i.e., do they amplify the activity of the main ingredient); are they vehicles (solvents, binders or carriers) for other biologically active medicinal components; do they render unpalatable preparations more palatable or serve a symbolic end? My personal experiences with local remedies for stomachache, fever, wounds, and skin infections and an eye infection aided my understanding of reported therapeutic effects and sensory aspects of the *materia medica.* I kept a weekly log of meals and recipes. I participated in household and community activities such as gathering food plants and fuel wood, fishing, farming, cooking, church raising, and celebrations which deepened my understanding of the role of plants in peoples' daily lives and complemented formal data collection.

Collection, Preparation, and Identification of Botanical Specimens.—My research associate, Ba`un Uluk, and I collected voucher specimens and ethnobotanical data during walks with villagers. Trail walks varying in length from about three to twelve kilometers followed the pathways from the village to wet rice fields (first series of interviews), hilltop rice fields (second series), and finally near and remote forest areas (third series). Almost every adult in Tebulo participated in individual or focus group trips, as did a few plant specialists in the villages of Long Pujungan, Long Alango, and Apau Ping. We were able to cover approximately seventy-five percent of the ***tana`*** ***ulen*** familiar to Tebulo villagers. We also collected plants in primary forest area about one hour upriver of Tebulo, an undisturbed site not generally exploited by Tebulo residents. Plant walks would start on a common pathway and end up in a villager's family field or favorite spot for hunting or gathering forest products. Covering the same terrain repeatedly with different participants aided my ability to see consensus and variation in knowledge and ascertain individual expertise. Visiting new areas suggested by a field collaborator allowed him/her to point out the ethnobotanical flora with which s/he was most familiar and extend my knowledge of surrounding habitats. Plant walks and collection trips yielded a number of plants not mentioned during in-house interviews.

Yard, village, field, and forest interviews followed the same line of inquiry as in-house formal and informal surveys. Aspects of the selection, preparation, application, and expected outcome of each medicinal plant encountered were discussed. Forest excursions were especially useful for discussing sensory properties of plants. Other economic flora that intersect with the botanical pharmacopoeia, such as hunting and fishing poisons, cosmetics, dyes, and food plants, were recorded. Field trips also addressed shifting cultivation techniques, forest succession, ethnoecology, and ethnotaxonomy (e.g., local classification of plants, animals, soils, forest types).

Because the number of therapeutic plants recorded was too large to gather, prepare, and transport, only a subset of study plants was collected for further study. I concentrated on lesser known wild species that could be found. I was fortunate to be in Kayan-Mentarang during mast fruiting season, when several important plant families—Sapotaceae, Fagaceae, Burseraceae—fruit simultaneously. This synchronized burst of reproductive energy takes place at irregular intervals of two to ten years and usually lasts a few weeks or months. I was able to collect fertile specimens for a majority of the study plants, the presence of both flower and fruit allowing easier identification. All voucher specimens were made according to standard botanical collecting procedures as suggested by Alexiades and Sheldon (1996) and Martin (1995).

The majority of plant determinations were made by taxonomists at the Herbarium Bogoriense (BO) in Indonesia and the Leiden Rijksherbarium (L) in the Netherlands. A few taxa were identified by specialists at the Bishop Museum (BISH) in Honolulu, Hawai'i (LXG 105–98, *Pandanus gibbsianus* Martelli), the University of Aarhus in Denmark (all ten Zingiberaceae collections), and specialists working with the Lyon Arboretum (HAW), in Hawai'i. The Herbarium Bogoriense reviewed collections for adherence to the CITES (Convention on International Trade of Endangered Species) agreement. A complete set of each of the collections was distributed to: Lalut Birai field station (WWF-Indonesia Programme's Kayan-Mentarang project), Herbarium Bogoriense, the Leiden Rijksherbarium, and the Lyon Arboretum. I donated collection no. LXG 105–98 (*Pandanus gibbsianus*) to the Bishop Museum in Honolulu, Hawai'i and all ten Zingiberaceae collections to the University of Aarhus in Denmark.

I identified a number of common species (particularly pantropic fruits and vegetables found in yard gardens and fields) using illustrated botanical references (de Guzman and Siemonsma 1999; de Padua et al. 1999; Hutton 1996a, 1996b, 1997). In addition to botanical collections, I collected four insect samples: an immature and a mature moth larva, and a male and female beetle associated with the medicinal larva identified by an entomologist at the Bishop Museum.

Analysis of Study Plants and Cognitive Data.—Investigation of the ethnobotany, pharmacology and chemical constituents of plant parts and extracts of study plants was facilitated by using the NAPRALERT (Natural Products ALERT) Data Base as suggested by Etkin (1993) and Martin (1995). Analysis of cognitive data (free lists, pile sorts, ranking) was facilitated by using *Anthropac* version 4.71 (see Handwerker and Borgatti 1998).

KEY HEALING METAPHORS OF THE KENYAH LEPPO` KE

Three prominent concepts—matching, expelling, and shrinking—are central to understanding Leppo` Ke beliefs and practices and the therapeutic utility of certain sense properties. Hot-cold or humoral concepts are most frequently discussed within the framework of expelling and shrinking.

Teneng *(Matching).*—The belief that the patient must choose the most appropriate or ***teneng*** ('fitting', 'matching', 'compatible') medical practitioner and practice to effect a cure finds parallels in diverse cultural groups (e.g., Etkin 1992; Hardon

1994; Laderman 1991; Nichter 1989). The directive, "If one (therapy) doesn't work, just try another" was frequently invoked in resolving health complaints. Villagers thus commonly draw upon methods and medicines from more than one healing paradigm at a time, employing Kenyah medicines, biomedical pharmaceuticals, Javanese and Chinese manufactured liniments, or Malay charms in the search for the most fitting therapy. The approach to any therapy, local or introduced, is not "Does it work?" but "Does it work for me?"

Tai kawang *(Exiting).—**Tai kawang*** involves coaxing disease out of the body and looking for visual signs of egress, it is a common therapeutic concept among native healing systems around the world (Etkin 1993b; Porter 1997). Many Leppo` Ke diseases result from a build-up of excess physical elements such as heat, cold, moisture, wind, or bodily fluids such as pus or blood, or poisons or foreign objects introduced into the body as a result of human or supernatural foul play. Sometimes these elements exit on their own, as wind may do in the form of flatulence or heat through sweating. More often than not, however, these conditions call for therapeutic intervention, such as using emetics, diuretics, or cathartics to draw out the agents of disease. Egress therapies underscore the chemical utility of plants. Plant irritants are a common feature of native healing systems for these purposes. For example, the urticaceous plant ***pei*** (*Dendrocnide stimulans* (L.f.) Chew), a kind of stinging nettle, is usually wholly avoided, but, villagers explained that it can be applied to open up a boil for draining.

Tai kupit *(Shrinking).*—Reduction of swelling of the skin or internal organs, joints, or bones is part of the process of healing. Tumescence occurs as a result of trespasses on somatic borders by wind, heat, and other causative agents. There are a number of techniques used for compressing, deflating, or shrinking afflicted areas of the body. For example, several bitter plants (e.g., *Tinospora crispa* (L.) Hook. f. & Thomson, *Eurycoma longifolia*) serve to drive fever out of the body *and* shrink the ***lu`ung kayung***, that is, the 'fever organ' or spleen. At the same time, spleen enlargement may be addressed externally by a number of means, but most typically by hot rock compresses using 'bitter' papaya leaves.

MAKING SCENTS OF *TABAN KENYAH* (KENYAH MEDICINE): THE LEPPO` KE MEDICINAL FLORA AND THEIR SENSE PROPERTIES

The Botanical Pharmacopoeia.—Study participants reported 216 locally distinguished medicinal folk species with 392 possible combinations or remedies made from local flora. Of the 192 taxonomically identified plants (116 voucher specimens collected plus 76 common garden species identified *in situ*), there are 182 angiosperms represented by 69 families and 10 pteridophytes represented by 7 families. Three medicinal fungi were identified in interviews, but none were available for collection. Over 92% of the Leppo` Ke botanical *materia medica* are identified as having one or more salient sensory properties, with only 16 out of the 192 taxonomically identified plants possessing no such quality. Often, plants that do not contain any of the sense properties summarized below have other distinctive physiological features in that they exude a colorful sap, are scabrous,

emollient, or soapy, or possess other features that mark them as plants of "perceptual salience" (Turner 1988).

*Understandings of Sensory Properties: Leppo` Ke Taste Primaries.*—Leppo` Ke olfactory, gustatory, and tactile sense terms are so numerous that I will not attempt to include and organize them all as others have done (see folk taxonomy schemes for the senses in, for example, Classen et al. 1994; Howes 1991; Johns 1990). For instance, there is the smell or taste of something charred (***tutung***), toasted (***lukui***), raw (***ata***), or rotten (***a` dam***); the sinewy, chewy texture of meat or fibrous plants (***sepit***); food not quite sweet enough to the taste (***nyelebiu***); food that is exquisitely sweet (***me` ding***); the fresh smell of newly fruiting paddy rice (***ba` o kamang***); or the fresh smell of young leaves or a newborn baby whose body has been bathed with *Blumea balsamifera* D.C. (***mengut***). Tactile terms are equally numerous. For instance, ***kesok*** refers to the irritating, painfully itchy quality from contact with urticaceous plants such as *Dendrocnide stimulans,* as opposed to ***katen***, which refers to itchiness without pain, usually the result of allergies or food sensitivities (e.g., salt fish, shrimp paste, mango sap). ***Ngelarek*** describes 'slimy' or 'mucilagenous' substances such as the contents of the fern *Blechum orientale* L.

Indo-Malay groups link their taste taxonomies to health and healing. Brunei Malay recognize seven basic flavors: bitter, astringent, sour, sweet, salty, spicy/hot, and *pahang* (the taste of chicken or certain cooked greens) (Kimball 1979). *Pahang* may be equivalent to the Japanese flavor enhancing or monosodium glutamate quality *umami* or the Leppo` Ke flavor ***jeleme***. Similarly, Leppo` Ke villagers recognize flavor principles of foods and medicines. Given the number of stimuli affecting taste terminology, it is difficult to separate basic from non-basic tastes. Nevertheless, a number of factors favor seven basic flavors: ***pa` it, pa:t, mesem, me, la` it, sanit,*** and ***jeleme***. These seven primaries begin the list of the nutrient and curative organoleptic properties of plants (Tables 1,2).

Pa` it literally and figuratively means bitter. Its foremost function is to chase illness out of the body (***apan tai kawang***, 'so it comes/goes out'). In that capacity, bitter substances are used primarily to alleviate fever (26 remedies). All of the "most effective" plants used for fevers are bitter (Tables 3, 4). In the words of one respondent, "If there is no bitter in the body, one *will* get sick with fever. That's why chloroquine is bitter." Only three of the fever treatments in the Leppo` Ke pharmacopoeia do not contain bitter elements. These non-bitter topical treatments are applied for their cooling (e.g., lemon basil, lemongrass) or sweat-inducing (e.g., shallot) effects. A common dietary prescription for someone who wants to avoid malaria is to increase the amount of bitter greens in their diet.

As an expellant ***pa` it*** may be used to hasten childbirth. The Tebulo birth attendant explained that ***pina*** 'quinine' antimalarial tablets are sometimes given to a woman after her water has broken because the bitterness makes the baby come out faster. Hence, strongly bitter substances are to be avoided during pregnancy unless abortion or miscarriage is intended.

Another function of ***pa` it*** is to shrink (***tai i` ut***) and compress (***tai kupit***). It is therefore employed to address the splenomegaly (spleen enlargement) that accompanies malaria, in addition to other fever regimens.

Bitter substances are also used to treat skin infections (13 remedies), stom-

TABLE 1.—Leppo` Ke common taste, smell and tactile terms, English descriptions, and associated species. Terms are approximately ordered from most to least common properties mentioned in ethnomedicine.

Leppo` Ke term	Description	Example
pa`it	bitter	*Eurycoma longifolia*
pa:t	astringent	*Areca catechu*
sanit	piquant, spicy, stinging or burning	*Capsicum* spp.
panah	hot, warming	mineral lime from *Cipangopaludina* sp.
sengim	cold, cooling	*Kalanchoe pinnata* (Lam.)
nglidah	(no English gloss) externally: cooling and numbing; internally: warming	*Litsea cubeba*
mesem	sour, tart	*Citrus* spp.
me	sweet	honey, sugar
la`it	salty or potent, strong	salt or alcohol
nglerak	slimy, mucilaginous	*Blechum orientale*
kesok	irritating, burning, itchy	*Dendrocnide stimulans*
lalih	zest	*Citrus* spp.
jeleme	*umami,* MSG, flavor-enhancing	tree fungi

achache and diarrhea (13 remedies) and dental caries (8 remedies). One man who had miraculously survived the potentially lethal bites of venomous snakes and centipedes on six occasions attributed his full recovery to having ***daa pa`it,*** 'bitter blood'. Bitterness prevents or banishes poisons, worms or other unwanted intruders such as wind that introduce ailments through the skin, stomach, and mouth.

Pa:t literally means "tight," as in to tie a knot until ***pa:t***. Like ***pa`it, pa:t*** is explicitly recognized as medicinal. Asked why a plant is good for medicine, peo-

TABLE 2.—Four Leppo` Ke primary taste and the first mentioned major disease category they are expected to cure, gleaned from a fill-in elicitation exercise conducted with 20 respondents (11 men and 9 women ranging in age from late teens to eighties and possessing varying degrees of botanical expertise).

	Primary taste terms							
	pa`it 'bitter'		***pa:t*** 'astringent'		***mesem*** 'sour'		***sanit*** 'spicy'	
Disease category	No.[1]	%[2]	No.	%	No.	%	No.	%
Dental caries	.	.	3	15	.	.	.	.
Eye	.	.	.	.	.	.	1	5
Fever	17	85	.	.	.	.	.	.
Gastrointestinal	3	15	15	75	1	5	1	5
Muscle/bone pain	.	.	.	.	.	.	.	.
Respiratory	.	.	.	.	10	50	.	.
Skin (wounds)	.	.	2	10	4	20	9	45
No association[3]	.	.	.	.	5	25	9	45
TOTAL	20	100	20	100	15	75	11	55

[1] Number of respondents that correlated given taste term with disease category.
[2] Percentage of respondents that correlated given taste term with disease category.
[3] Respondents who did not link a given taste term with a disease category.

TABLE 3.—Leppo` Ke disease categories and the four high consensus plants (and one moth larva) ranked as most effective for common health complaints. Plants are listed roughly in descending order from higher to lower consensus based on a combination of structured interviews.

Disease category (description)	Plants used for treatment (Leppo` Ke and Latin binomial)
mayung meko 'chills fever' (malaria)	***manjan*** (*Carica papaya*), ***paket limbang*** (*Eurycoma longifolia*), ***pria*** (*Momordica charantia*), ***aka pa`it*** (*Tinospora crispa*)
peli`en (a large category of numerous, differentiated rash or spot-producing fever diseases)	***ulet samban*** (moth larva), ***lirang tana`*** (*Clerodendron bethunianum*), ***udu peli`en*** (*Gynura* cf. *aurantiaca*), ***bawing*** (*Ocimum tenuiflorum*)
puu 'sore/abrasion' (generally, pustular skin infections)	***aka padem*** (*Spatholobus gyrocarpus*), ***aka pale*** (cf. *Hemigraphis* sp.), ***pulut alim*** (*Mangifera pajang*), ***kayu bine*** (*Macaranga costuleta*)
sakit batek mero (stomachache and severe, uncontrollable diarrhea); ***mero*** 'fruits dropping of a tree in fruiting season'	***li`bun*** (*Psidium guajava*), ***pa`an*** (*Areca catechu*) ***pa`ung lung*** (*Homalomena pendula*), ***puten*** (*Planchonia valida*)
sakit jipen 'toothache' (generally, dental caries)	***lelami*** (*Myrmeconauclea strigosa*), ***unga*** (*Piper betle*), ***bua` abung*** (*Nephelium rambutan-ake*), ***jelemutin*** (*Melastoma affine* cf. *malabathricum*)
suwat 'wound' (generally, fresh, bloody wounds)	***aka padem*** (*Spatholobus gyrocarpus*), ***udu Belenda*** (*Paspalum conjugatum*), ***mata atuk*** (*Callicarpa albida*), ***unga*** (*Piper betle*)

ple will state, for example, "Because ***lî bun*** (*Psidium guajava* L.) is ***pa:t,*** it is good for diarrhea." Because astringency "solidifies the contents of the stomach," it is useful for curing loose stools. Astringent properties are primarily used for gastrointestinal conditions involving diarrhea or dysentery (20 remedies). All of the consensus remedies imbibed for diarrhea with the exception of ***puten*** (*Planchonia valida* Blume) are defined as astringent (Tables 3, 4). All plants recognized as ***pa:t,*** particularly those that are used as substitutes in a betel quid for areca nut (*Areca catechu* L.), are viewed as having healing potential, especially as stomachics and antidiarrheals, whether or not they are a part of the pharmacopoeia. Thus in every forest walk the strongly astringent ***aka kubung*** (no taxonomic identification) was identified first as a betel quid ingredient, but the supposition was always stated that it could be used to treat stomach problems "because it is ***pa:t.***"

Pa:t plants pucker the skin and mouth and are thus useful for bloody wounds and abrasions (14 remedies), and for toothache and dental caries (8 remedies).

Mesem means "sour" or "tart." ***Mesem*** substances function as internal and external cleansers. It is a good therapeutic partner to ***pa:t*** in that both are drying and cleansing, hence good topical treatments for skin lesions. Generally, sour properties are also said to be cleansing, whether used to shine metals, scour away grease, or clean the body. Sour properties are used as fixatives for dye recipes for craft material as well as for the antifungal nail polish and wound healer made with ***selangga*** (*Impatiens balsamina* L.).

Mesem plants are also comprehended as rich sources of vitamins. Citrus fruits

are especially good for coughs and colds because they "hold many vitamins," an explanation more than likely introduced by government health workers.

Me means "sweet." ***Me*** 'sweet' substances are valued as poultice for contusions that are the result of trauma from a fall or bone break. Respondents associated ***me*** with the medicinal properties of honey and sugar, valued as poultice for contusions that are the result of trauma from a fall or bone break. The reasoning behind this use is that honey and sugar are said to dissolve clotted blood (***daa buku***), the hematomas that come with fractures and bruising. Honey is considered warming and so it is not only useful for breaking down "cold" blood obstructions, but is an essential ingredient in warming, strengthening tonics such as mixtures of sun bear gallbladder or ***paket limbang*** (*Eurycoma longifolia*). Here honey is added as a flavorant to tame the bitterness of the main ingredient. It is also considered fortifying.

La`it*** has two meanings. One is "salty." Several villagers linked the use of ***la`it as ***usen***, literally "salt," to caring for wounds or secondarily as a mouthwash for dental problems. People rub salt into their wounds, primarily as an admixture to hemostatic plants such as ***udu Belenda*** (*Paspalum conjugatum* Berg.).

The other meaning of ***la`it*** is "potent" or "strong," as in a particularly volatile alcoholic beverage or powerful medicine. ***Aka pejeling*** (*Aristolochia* sp.) is said to be such a ***la`it*** prophylactic for poisoning, that if you keep a piece of the vine in your pocket and someone has poisoned your drink, the glass will crack or even shatter before you can put it to your lips. ***La`it*** when associated with ***arak*** (whiskey made from distilled *Manihot esculenta* tubers) was noted, especially by older villagers, as an important warming tonic, good for relieving aching muscles and as a soporific.

Sanit means "spicy" or "piquant." It refers to properties found in chili peppers, garlic, ginger, betel leaf, black pepper, and so on, produced by a diversity of chemical compounds (e.g., capsaicin in chili peppers, zingerone in ginger, and piperine in black pepper) that are linked by a shared physiological effect—the hot, burning sensation called ***sanit***. Externally applied, ***sanit*** substances are used to prevent or treat pustular skin infections, as rubifacient for sore muscles and stomachache, and to expel foreign bodies from the eye. The majority of ***sanit*** remedies are used for skin infections (30 remedies).

Taken internally, ***sanit*** substances are utilized for their warming or heating properties; they draw out and extinguish the causative agents of infection and disease such as ***angin/bayu*** 'wind' and ***ulet*** 'worms'. Warming soups or strengthening tonics normally contain chili peppers and/or ginger. Internal curatives for wind and fever are often combined with external rubs from ***sanit*** ingredients such as a poultice of ***bawang bala*** (*Allium ascalonicum* L.), which is administered to help a patient sweat in order to break a fever.

Jeleme has two meanings. One is "bland." It also refers to ingredients that are bland, but at the same time serve as flavor enhancers. Commercial monosodium glutamate, commonly referred to as ***sasa***, epitomizes the quality of ***jeleme***, as do "***sasa Kenyah***" plants ***bekai lan*** and ***bekai lanya*** (*Pycnarrhena cauliflora* Diels and *Coscinium miosepalum* Diels) used for the same purpose. Most villagers reported no outright medicinal use for ***jeleme*** substances. Two respondents in elicitation exercises related ***jeleme*** to dietary proscriptions and prescriptions relevant

TABLE 4.—Leppo` Ke high consensus plants from Table 3 and some of their sensory attributes. Plants are listed in alphabetical order according to their Leppo` Ke names.

	pa`it	*pa:t*	*me*	*sanit*	*nglidah*	*panah*	*sengim*	*lalih*	Other sensory attributes
aka pa`it (*Tinospora crispa*)	X	.	.	.	.	.	.	.	
aka padem (*Spatholobus gyrocarpus*)	.	X	.	X	.	.	.	.	signature: produces red liquid when boiled
aka pale (cf. *Hemigraphis* sp.)	X	X	.	X	.	.	.	.	signature: produces red liquid when boiled
bawing (*Ocimum tenuiflorum*)	.	.	.	X	.	.	X	.	
bua` abung (*Nephelium rambutan-ake*)	X	X	.	.	X	.	.	.	
jelemutin (*Melastoma affine* cf. *malabathricum*)	.	X	.	.	.	.	.	.	
kayu bine (*Macaranga costuleta*)	.	X	.	.	.	.	X	.	signature: produces red liquid when boiled
lelami (*Myrmeconauclea strigosa*)	.	X	.	.	.	.	.	.	ants live in stem
li`bun (*Psidium guajava*)	X	X	.	.	.	.	.	.	only the over ripe fruit is ***jelème***
lirang tana` (*Clerodendron bethunianum*)	X	.	.	.	.	.	.	.	
manjan (*Carica papaya*)	X	.	.	.	X	.	X	.	leaves and latex are bitter; only crushed seeds are ***nglidah*** to the taste
mata atuk (*Callicarpa albida*)	.	X	.	.	.	.	.	.	edible fruit has slight menthol flavor
pa`an (*Areca catechu*)	.	X	.	.	.	.	.	.	betel quid component
pa`ung lung (*Homalomena pendula*)	X	.	.	.	.	.	.	.	fragrant tuber; red
paket limbang (*Eurycoma longifolia*)	X	.	.	.	.	.	.	.	

TABLE 4.—Continued.

	pa`it	*pa:t*	*me*	*sanit*	*nglidah*	*panah*	*sengim*	*lalih*	Other sensory attributes
puten (*Planchonia valida*)	.	X	X	.	.	.	.	.	inner bark has sweet and astringent flavor
pria (*Momordica charantia*)	X	.	.	.	.	.	.	.	
pulut alim (*Mangifera pajang*)	.	.	.	.	.	.	.	X	latex is irritant but medicinal when heated
udu Belenda (*Paspalum conjugatum*)	.	.	.	X	.	.	X	.	stings broken skin
udu peli`en (*Gynura* cf. *aurantiaca*)	.	.	.	.	.	.	X	.	semisucculent
ulet samban (moth larva)	.	.	.	.	X	X	X	.	***parih ba`o*** 'strong smell'
unga (Piper betle)	X	.	.	X	X	.	X	.	betel quid component

to health. People wanting to avoid edema, such as beriberi patients and pregnant and postpartum women, are advised to avoid salt and stick to ***jeleme*** (i.e., bland, non-salty) diets. ***Jeleme*** diet should also be adhered to by those suffering from hot and ***katen*** 'itchy' ailments such as fever blisters, oral thrush, and similar skin ailments that may be the result of allergies or food sensitivities.

There are many Leppo` Ke non-basic taste terms and synonyms. These subsidiary flavors (and associated olfactory and tactile qualities) sometimes can be of consequence to health. For example, ***dangang*** is closely related to bitterness. It is a scratchy, stinging, gagging sensation at the back of the throat when one tastes or smells especially bitter varieties of manioc or bamboo shoots. The term ***dangang*** identifies the bitter-toxic bite of hydrogen cyanide (HCN) that is released into the atmosphere when the tissues of manioc or bamboo shoots are disrupted during collection and processing (Johns 1990). Whereas bitter plants are considered powerful fever medicines, ***dangang*** holds no such value. Rather, too much ***dangang*** in the diet causes or exacerbates skin conditions such as acne or the fungal infection 'ringworm'. ***Dangang*** is related to ***katen*** substances, mentioned above, that are proscribed for ***panah*** 'hot' conditions.

Another example is ***meden***, closest to the English word "gamy" used to describe the taste of wild meats. Scientists have isolated a few fatty acids (principally, 4-methyloctanoic, 4-ethyloctanoic and 4-methylnonanoic) that account for the musky flavor of feral foods such as venison, mutton and turkey (Brennand et al. 1989). However, the Leppo` Ke term ***meden*** is even more precise. It refers specifically to the taste and smell of the fat that lies in and around the intestines of the bearded pig (*Sus barbatus* Müller). It is universally considered foul. When people render pig fat for cooking oil they generally discard ***meden*** adipose tissue except in times of extreme scarcity. Rancid pig fat is also ***meden***. The extremely oily fruit of *Pangium edule* Reinw., used to make a rich fermented condiment (***payang kayu***), may also turn ***meden***. Even some dry shrubs and trees—***lelami*** (*Myrmeconauclea strigosa* Merrill), ***lelami saleng*** (*Ficus* sp.) and ***laran lî bun*** (*Syzygium* sp.)—are said to have a ***meden*** quality. All three of these species have therapeutic applications. However, the sensory attribute ***meden*** in and of itself is not regarded as useful for promoting health or treating disease.

Consensory Plants and Perceptions of Efficacy.—Table 1 presents Leppo` Ke common taste, smell, and tactile terms, English descriptions of each, and associated species. Table 2 presents Leppo` Ke primary taste terms and the major disease categories they are expected to cure as gleaned from one of the sentence completion exercises. Table 3 presents the plants recognized as most effective for a given health complaint in rough descending order from higher to lower consensus based on a combination of structured interviews. Order of preference is based on the combined results of the ranking exercise in addition to information provided in interviews, and through observation of use (a triangulation of methods recommended by McNabb 1990). Like assessments of efficacy, chemosensory assignments were ascertained through triangulation of quantitative and qualitative methods. Any given plant may possess multiple healing characteristics and serve a variety of therapeutic needs. I have presented the most prominent features and functions of plants as told to me by Leppo` Ke consultants. Sensory distinctions

dominated discussions of a plant's power and value. One cultural caveat should be noted; the fundamental concept of ***teneng*** 'appropriateness' prevails in most medical matters. With few exceptions, participants in efficacy protocols commented on the impossibility of ranking therapies and would preface an answer by stating that "it depends on what medicine/s is appropriate" for a given case and patient. My more precise phrasing, "what works best and is most appropriate (***teneng***) for *you* in *your* experience or in your administrations to others" elicited more responses, but always with the warning that the proper fit is situational.

NGLIDAH: A COMPLEX OF HEALING SENSATIONS

The Mystery of Moths, Ping Bawing, and Medicine.—The Leppo` Ke property ***nglidah*** describes a complexity of taste, smell, and tactile qualities for which there is no simple English gloss. ***Nglidah*** plants straddle culinary, therapeutic, and ritual use categories, but are not explicitly tied to any one. Several plants possess this quality, as does ***ulet samban***, a fatty Cossidae moth larva that has the pungent flavor and odor of acrid cilantro and epitomizes ***nglidah*** according to many respondents. Confounding to characterize, ***nglidah*** can be found in the flavor, and/or smell, and/or feel of *Piper betle* L. and related species of *Piper*, in the sweet and strongly citronella-smelling peppercorns of ***beleng la*** (*Lindera pipericarpa* Boerl. or *Litsea cubeba* Pers.), in ***ping bawing*** (*Cymbopogon citrates* Stapf), in a handful of gingers such as ***seriteng*** (*Etlingera* aff. *metriocheilos* (Griff.) R.M.Smith) and ***lia lamut*** (*Alpinia galanga* Willd.), and in aroids such as ***pa` ung lung*** (*Homalomena pendula* (Blume) Bakh.f.) and ***lung adek*** (*Homalomena cordata* Schott), to name the most typical examples. In papaya, only the peppery crushed seeds are considered ***nglidah***. The olfactory emissions of gingers such as *Etlingera* aff. *metricheilos, Etlingera punicea* (Roxb.) R.M. Smith, and the peppery-smelling rhizome of the unidentified *Zingiber* ***lia skala*** are loud and complex. Plants possessing piperine and citronella compounds (e.g., ***unga, beleng la, ping bawing***, and a folk variety of lemongrass that has a strong citronella odor called ***ping bawing beleng la***), as well as commercial citronella mosquito spray, all typify ***nglidah***. Some ***nglidah*** items are only dubbed so in a single sensory mode. For instance, commercial mentholatums, such as the favorite household analgesic and disinfectant cajuput oil, have a cooling and warming effect on the skin that feels ***nglidah***, but does not taste or smell ***nglidah***. Similarly, the anise-like, slightly petroleum-like, menthol smelling and tasting pith of *Etlingera* aff. *metriocheilos* that is used to treat severe leg cramps and atrophy is primarily ***nglidah*** on the skin, possessing a cooling sensation.

Initially I assumed that ***nglidah*** could best be described as cilantro-like, having experienced the refreshing and at the same time buttery rich taste of ***ulet samban***. I was further convinced by tasting a garden weed (unidentified Apiaceae) brought to me by a neighbor who wanted to give me a better sense of the sense ***nglidah***. It too had the distinct flavor of coriander and is a member of the Apiaceae family. I then thought that perhaps it is more the quality of piper and citronella found in the plants described above. Or perhaps it is the menthol or anise element emitted from *Etlingera* aff. *metriocheilos*. The triumvirate of ***panah*** 'warming', ***sengim*** 'cooling', and ***nglidah*** properties typical of ***nglidah*** topical remedies all have the cooling and numbing characteristic of mentholated balms.

FIGURE 3.—***Ulet samban***, moth larvae used as food and medicine, epitomize the flavor, smell, and feel of the sense property ***nglidah*** according to Leppo` Ke consultants.

Perhaps it is the quality of mint? A few respondents tasted a mint candy and a licorice lozenge, describing the licorice as ***nglidah*** but not the mint candy. At first glance, it was impossible to group ***nglidah*** items based on organoleptic similarities. Nevertheless after encountering a number of ***nglidah*** substances, I gained a holistic appreciation of this sense property.

What characteristics do these seemingly disparate species and suite of qualities share? Clearly, all are strongly aromatic and high in essential oils. Many are rubifacients. The majority of ***nglidah*** species, with the exception of the aroids, are important comestibles and masticatories. ***Nglidah*** therapies satisfy a range of needs from pediatric fevers, to stomach complaints, to muscle aches and cramping, and more. According to several respondents, remedies ingested via the skin are especially good for resolving ***pelî` en***, a wide range of spot or rash-producing febrile conditions. All forms of ***pelî` en*** are caused by wind entering the body and ***nglidah*** therapies are especially helpful because they draw out the heat that accumulates deep within the body as a result of ***bayu*** 'wind' ingress. Orally ingested ***ulet samban*** (Cossid larvae, Figure 3) warm the cold interiors of an elder suffering from ***sakit sengim*** 'cold sickness', and cool and absorb heat from the fevered interior of a child sick with ***pelî` en*** when applied topically. *Homalomena pendula* expels intestinal worms from a sick stomach. And *Etlingera* aff. *metriocheilos* is wrapped around joints to revive cramped or paralyzed limbs.

Essentializing Essence Oils.—The enigmatic Leppo` Ke property ***nglidah*** is in fact distinguished by a number of ethnobotanical, evolutionary, chemotaxonomic, and pharmacological commonalities. With one exception (*Carica papaya*), ***nglidah*** plants are Old World tropical species: many are components of the Malesian flora (e.g.,

Etlingera elatior (Jack) R.M.Sm.) and at least one may be native to Borneo (*Amomum ligulatum* R.M.Sm.). The intersection of food, masticatories, and medicines is particularly evident with ***nglidah*** plants. Many of these species are eaten, primarily as herbs and spices; a few have a history of use in the spice trade (e.g., *Lindera pipericarpa, Litsea cubeba, Cymbopogon citratus, Alpinia galanga, Ocimum tenuiflorum*). *Piper betle* leaf and substitutes (e.g., ***unga tana`***, *Piper* sp.) are a ***nglidah*** component of the betel quid. A number have important magico-religious meaning, used in ritual healing and to counter spirit or human curses, for example, as incense and talismans. As medicines, most are administered via the skin (usually in combination with internally consumed therapies) and produce a rubifacient and analgesic effect.

There is chemotaxonomic affinity shared by ***nglidah*** taxa. All ***nglidah*** plants contain terpene and terpene-derivative compounds, especially highly volatile monoterpenes such as α-pinene, 1,8 cineole, limonene, and piperitone. These and a number of other constituents found in ***nglidah*** species account for the citrus, citronella, black pepper and pungent, slightly mentholated and topically numbing, and sometimes coriander and licorice-like qualities. The volatile oils that occur in ***nglidah*** plants can affect a complex range of actions on human physiology with pharmacologic implications for health. Broadly, they are antimicrobial (antibacterial, antifungal, vermifugal) and thus possibly useful for fighting fever and other infections. They possess decongestant and expectorant properties, possibly making them useful for treating respiratory complaints. They are internally and externally counterirritant, possibly making them useful analgesics for muscle and bone distress, as well as for relieving intestinal distress, since they possess carminative, antispasmodic, and appetite-stimulating potential (e.g., Deans and Waterman 1993; de Guzman and Siemonsma 1999; Harborne and Tomas-Barberan 1991; Oyen and Dung 1999). (For an in-depth exploration of the phytochemical and pharmacological implications of ***nglidah*** taxa see also Gollin 2001.)

Interestingly, the high consensus medicine and coveted delicacy, cossid moth larvae, shares most of the above characteristics that for Leppo` Ke consultants epitomizes ***nglidah***. The theme of endemism and the antiquity of ***nglidah*** taxa suggest an ancient origin for this folk category. ***Ulet samban*** is a member of the Cossidae, an ancient family that is widely distributed throughout Asia and Australia (Nielsen and Common 1991). In Tebulo, the moth larve pupate in the pith of ***seleman*** (*Glochidion* cf. *phillipicum* (Cav.) C.B. Rob.) and other trees in different locales. *Glochidion* is an important dye plant, the juicy, blood red fiber of which is squeezed to make a black dye for sunhats and other woven crafts. Grubs live gregariously in galleries excavated beneath the bark and in association with large black horned beetles (*Eurytrachelus titanus*) (also collected and identified for this study). In the case of the Cossidae species collected for this study, the smaller, younger, larvae are a buttery yellow color. As they mature they become yellow-red. The fat, mature larvae take on a blood red color identical to that of the moist red sapwood in which they live. All possess the characteristic aroma of ***nglidah***, but mature larvae are most strongly redolent of acrid cilantro and are regarded as the most potent medicine.

It is also worth noting that the oily, odorous Cossidae larvae are chemically—and by extension pharmacologically—provocative. The striking ***nglidah*** odor of

the Cossidae larvae is not found in the host tree. While the Cossidae specimens are clearly absorbing the red sap of *Glochidion,* they possess an odor that is all their own. Whether sequestering or biosynthesizing compounds *de novo,* or a combination of both, like pills, larvae are chemicals concentrated.

DISCUSSION AND CONCLUSION

Many native systems utilize organoleptic indicators for assembling their pharmacopoeia, favoring certain sensory cues over others. For instance, taste was the primary means of evaluating medicinal plants by the Algonquians of North America (Speck 1917). The Yabashta of the Peruvian Amazon emphasize visual, tactile, and aromatic properties of medicinal plants, but have little interest in their taste (Shepard 1999). For the Kenyah Leppo` Ke a number of organoleptic characteristics of plants are of paramount importance for identifying and utilizing medicines.

In this paper I have accentuated taste and odor cues, and to a smaller extent tactile features, over other signs of a plant's therapeutic value. Physiological distinctiveness may also contribute to a plant's perceptual salience and therapeutic value. Some Leppo` Ke species possess an obvious ***ta` ding***, or 'sign', of their use. For instance, ***utan bang*** (*Amorphophalus* sp.) is applied to skin dispigmentation because the mottled marks on the main stem resemble the blotchy patches of ***litak*** (vitiligo). The connection between red features of plants and blood disorders is an especially common signature in diverse medical systems. Several treatments for bloody wounds, internal hemorrhagic conditions, as well as ***kerî ut daa*** 'low/little blood' (anemia), call for plants with a red exudate, or that yield a red decoction, or infusion or have prominent red parts. For example, ***aka padem*** (*Spatholobus gyrocarpus* Benth.), ***aka pale*** (cf. *Hemigraphis* sp.), ***kayu bine*** (*Macaranga costulata* Pax & K. Hoffm.), ***kayu lenganing*** (*Antidesma venenosum* J.J. Smith), and ***selangga*** (*Impatiens balsamina*) are fresh wound healers; ***paku bala*** (*Stenochlaena palustris* Bedd.) is a blood strengthener used to treat anemia.

An interesting Leppo' Ke example of a non-visual sensory signature is ***udu sin bu` in*** 'domestic pig meat herb' (*Ampelocissus imperialis* Planch.), so named because it smells like pig meat. Applications of the leaves to ***bengo*** pits (infection characterized by deep craters on the skin) are said to encourage the ***sin*** 'flesh' or 'meat' to regrow.

Symbolically meaningful chemical sense properties (e.g., bitterness, astringency, pungency, urtication) and visual cues (e.g., milky latex associated with galactagogues, red plants with the ability to resolve blood conditions, or yellow plants with jaundice remedies), are cultural constructions that often have a biological basis. This does not discount the wealth of plants with obvious chemical signatures (and therapeutic potential) that go wholly ignored by human consumers. Not all plants with a blood red exudate are employed as wound-healers. Not all bitter plants are considered therapy for febrile or gastrointestinal conditions. Rather, such attributes function as a mnemonic for earmarking a subset of taxa in a biologically diverse and chemically complex environment (Etkin 1988). In other words, in plant-dependent societies, a plant that is astringent may be more worth testing for its antidiarrheal potential than one that is not.

Until recently, the most extensive phytopharmaceutical investigations have

been concerned with the search for bitter alkaloids (Deans and Waterman 1993). A number of ethnopharmacological investigations have centering on the salience of bitter, and secondarily astringent, principles in native plant pharmacopoeia (indicating the potential presence of alkaloids compounds in the former and polyphenolics in the latter). Bitter compounds are omnipresent in our floral environment and in pharmacopoeia. Given the therapeutic utility of bitter repellent and toxic botanical compounds for humans, the bitter bias in the ethnopharmacological and ethnobotanical literature is understandable. But certain questions are left unanswered. For instance, few inquires have compared medicinal to non-medicinal flora and also checked for the frequency of bitter contents (Ankli et al. 1999 and Leaman 1996 are two admirable exceptions, a point also made by Casagrande 2001).

Local categories such as ***nglidah*** call attention to the importance of plant medicines high in volatile and essential oils.[1] While traditional use of volatile and essential oils for commercial and folk food flavoring, preservation, and fragrances is well-documented, few ethnobotanical investigations have focused on the role of these aromatics in native botanical therapeutics. This is surprising considering that volatile oils are widely distributed in tropical and temperate angiosperms, especially in mints (Lamiaceae), eucalypts (Myrtaceae), peppers (Piperaceae), citrus (Rutaceae), and bays (Lauraceae) (Cotton 1996).

A rare example is research conducted among the people of Siberut Island off the coast of Sumatra. The curative sensory quality ***makasak*** bears a resemblance to ***nglidah***, characterized by aromatic species such as *Piper betle, Litsea elliptica* Blume, *Acorus calamus* L., and *Cananga odorata* Hook.f. & Thomson (Ave and Sunito 1990). ***Makasak*** plants are used to treat contusions, sprains, and bone fractures.

Another example is research on the Nekematigi people of the New Guinea Highlands. Chemotaxonomically related species that are rich in volatile oils account for the greatest portion of medicinals of the Nekematigi. Volatile oil plant therapies constitute the fundamental "all purpose" medicines, that is, plants with inherently health-restorative properties are prescribed in all cases for their positive effects on a sick person and supplemented with targeted therapies that have negative effects on specific illness agents. The fragrance of Nekematigi medicines is believed to "carry" the power of the plant and the healer's incantations through the body, and is an essential mediator between the patient and the plants she or he consumes. Nekematigi comprehend certain aromatics as being capable of "opening" up the body (Johannes 1986). Like Leppo` Ke ***nglidah*** and ***makasak*** plants used in Siberut, Nekematigi "all purpose" medicinals represent aromatic families such as Zingiberaceae and genera such as *Cinnamomum* (from the aromatic family Lauraceae).

Leppo` Ke ***nglidah*** rubefacients, in addition to being pain-killing, are understood to open up the pores to let internal wind and heat escape. Components such as camphor, menthol, and eugenol found in ***nglidah*** topical treatments stimulate trigeminal responses and produce a variety of actions (Lawless and Heymann 1999). Menthol and camphor (both present in commercial liniments) can either enhance or inhibit warm or cold stimuli depending on the nature of the stimulation (Lawless and Heymann 1999). The monoterpene compound linalool found in ***nglidah*** plants is a major component of several aromatic species, many

of which are used around the globe as sedatives, including for the purpose of interruption and prevention of seizures (Elisabetsky et al. 1995), an application also reported among the Kenyah. Linalool has demonstrated anticonvulsant properties in laboratory analysis (Elisabetsky et al. 1999). Additionally, in Borneo, and certainly among the Kenyah, scent carries symbolic weight that serves as preventive or cure against sickness or misfortune due to foul play by spirits or the malevolent actions of humans (e.g., Conley 1975; Winzeler 1993). The use of aromatics is omnipresent in ritual healing and in daily life in the forms of incense, botanical smoke and steam baths, and the many odoriferous charms found in homes, on baby carriers, in bathing new mothers and infants, and so on (Gollin 2001).

Kenyah Leppo` Ke sensory evaluation of plants—as well as animals, minerals and Western-style pharmaceuticals (Gollin 2001)—is an important means by which people come to know and employ efficacious medicines as evidenced by the chemical provenance of the Leppo` Ke sense property ***nglidah***. Seemingly disparate floral and faunal species defined as ***nglidah*** by the Kenyah Leppo` Ke are in fact related by key chemical notes (e.g., citral, limonene, piperitone). They exert a range of physiological effects that may relieve discomfort (e.g., *Etlingera* aff. *metricheilos* used for joint cramping) and resolve disease (*Litsea cubeba* used for febrile conditions). ***Nglidah***, as well as purely culinary descriptors such as ***jeleme***, ***dangang***, and ***meden***, accentuate an important factor in Kenyah Leppo` Ke sensory acumen. Cuisine is a significant determinant of perception. The taste properties of glutamate and aspartate salts form the building blocks of flavor principles in some ethnic (notably Asian) culinary traditions (Lawless and Heymann 1999: 43). It is not surprising that Japanese have a taste term (*umami*) to describe the distinct flavor-enhancing sensation of miso or sea tangle, or that Leppo' Ke use the term ***jeleme*** to describe certain fungi and leaf additives (e.g., *Pycnarrhena cauliflora*), a quality that goes unnamed in other cultures. Similarly, the properties ***jeleme***, ***dangang***, and ***meden***, while not explicitly medicinal, identify very specific chemistries—the first that of monosodium glutamate, the second the volatile cyanogenic glycosides encountered in manioc and bamboo shoots, and the third possibly the fatty acids of feral food—of consequence to health.

Scholars in a small branch of anthropology known as the "anthropology of the senses," like ethnobiology an intellectual offspring of linguistic and cognitive anthropology, have identified cultural "sensotypes" (Wober 1966). That is, different cultures demonstrate different levels of "sense-ability" based on the prevailing patterns of childhood intake and proliferation of information from the various sense modalities (Wober 1991). Cultural differences in the precision of language to express a particular sense may influence and be influenced by sensory perception. For instance, scholars have explored the relationship between odor taxonomies and sensory perception. Elaborate osmologies (the classification and interpretation of smells) across cultures underscore Leenhardt's paradigm—the thesis that the more comprehensive a society's olfactory vocabulary, the more odors are regarded as revealing, whereas less comprehensive registers suggest a suppression of smells altogether (Leenhardt 1979 in Howes 1988).

My objective in this investigation was to observe and elicit the various senses (primarily smell, taste, and touch) that come into play in health and healing. In

so doing I found that the chemical dénouement of less obvious sensory attributes is an alternative way to explore the link between human cognition and communication (i.e., ethnobiology) and expectations of therapeutic outcome (i.e., ethnopharmacology and ethnobotany), and suggests fertile ground for further study of these related scientific endeavors.

NOTES

[1] The terms "volatile" and "essential" are often used interchangeably. They are somewhat different. A volatile substance is one that evaporates at room temperature and is an essential property of odorous materials. Essential oil is a volatile product obtained from a natural source, possessing the odor and other characteristic properties of the plant. In a narrow sense only volatile products obtained by steam or water distillation are called essential oils (Oyen and Dung 1999).

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CULTIVATING SOCIALITY: AESTHETIC FACTORS IN THE COMPOSITION AND FUNCTION OF PIAROA HOMEGARDENS

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ABSTRACT.—Anthropological analyses of settlement patterns minimize the importance of homegardens. Ethnobiological studies of homegardens usually focus on composition, ecological functioning or economic contribution. Because homegardens form part of the dwelling space, however, the factors that influence them and the functions they serve are as complex and dynamic as the lives of the people who create them. This paper, largely based on a comparison of homegarden maps of three Piaroa communities, explores their composition and economic utility, but also their temporal dynamics, spatial arrangement, symbolic values and aesthetic importance. Piaroa homegardens contribute to the quality of life and are site of sociality for the people who live in them: the pragmatic and aesthetic cannot be separated.

Key words: homegardens, Piaroa, agrobiodiversity, Amazon, Venezuela.

RESUMEN.—Los análisis antropológicos de los patrones de asentamiento tienden a minimizar la importancia de los huertos familiares. Los estudios etnobiológicos de los huertos familiares normalmente estudian su composición, función ecológica o contribución económica. Sin embargo, los huertos familiares forman parte del espacio de la vivienda, mientras que los factores que los influencian y las funciones que desempeñan son tan complejos y dinámicos como las vidas de las personas que los crearon. Esta investigación, basada en una extensa comparación de mapas de huertos familiares en tres comunidades Piaroa, explora su composición y utilidad económica, así como su dinámica temporal, disposición espacial, valor simbólico e importancia estética. Los huertos familiares de los Piaroa contribuyen a la calidad de vida y son un lugar de socialización para la gente que vive en ellos, en los que lo práctico y lo estético no pueden separarse.

RÉSUMÉ.—Les analyses anthropologiques de la structure des communautés minimisent l'importance des jardins domestiques. Les études ethnobiologiques des jardins domestiques se concentrent généralement sur la composition, les processus écologiques ou l'aspect économique. Étant donné que les jardins domestiques font partie de l'espace habité, les facteurs qui influent sur eux ainsi que les fonctions qu'ils desservent sont de ce fait aussi complexes et dynamiques que la vie même des gens qui les créent. Cette étude—basée largement sur la comparaison des cartes des jardins domestiques situé dans trois communautés Piaroa—examine leur utilité économique, leur composition, leur dynamique temporelle, leur disposition spatiale, leurs valeurs symboliques et leur importance esthétique. Chez les Piaroa, les jardins domestiques contribuent essentiellement à la qualité de vie et facilitent les rencontres sociales entre les gens qui y vivent, de sorte que l'on ne peut séparer l'esthétique du pragmatisme.

INTRODUCTION

Anthropological analyses of settlement patterns in nonindustrial societies tend to minimize the importance of homegardens or even to ignore them in carrying out structural analyses of houses and settlements (e.g., Guss 1989; Lévi-Strauss 1963:136–141; Waterson 1990). Studies that explicitly focus on homegardens usually focus on one or two physical characteristics, such as their economic utility (Drescher et al. 1999; Dury et al. 1996; High and Shackleton 2000; Michon and Mary 1994), agroecological functioning (Benjamin et al. 2001; De Clerck and Negreros-Castillo 2000; Fernandes and Nair 1986a; Gajaseni and Gajaseni 1999; Torquebiau 1992), diversity (Padoch and de Jong 1991; Soemarwoto and Conway 1991; Tchatat et al. 1996), or response to changing circumstances (Johnson and Grivetti 2002; Lamont et al. 1999). An emphasis on one or a few of these factors at the expense of the others draws an incomplete and sometimes inaccurate picture of the role of homegardens in the lives of those who cultivate them. Because homegardens form part of the dwelling space, the factors that influence them and the functions that they serve are as varied and complex as the homes that people create. This paper uses quantitative and qualitative data to demonstrate the complexity of Piaroa homegardens botanically and perceptually. I explore the economic utility of Piaroa homegardens, how they change over time, their spatial arrangement and the symbolic and aesthetic values that affect their composition. Finally, I combine these different layers of analysis to present a three dimensional image of a system that is both the result of and a reflection of the lives of the people who dwell in it.

The People.—The Piaroa[1] are a people of the middle Orinoco whose traditional territory is located in the northern part of Amazonas State, Venezuela. In many ways they are typical of Guianese ethnic groups as described by Rivière (1984). According to the ethnographic record, they live in small communities of around 12–60 people, generally organized along kinship lines (Anduze 1974; Boglár 1982; Overing and Kaplan 1988; Overing-Kaplan 1975; Zent 1992). The shaman/headman is responsible for the spiritual well-being and ritual productivity and is also usually the patriarch of the extended family that comprises the community. Communities generally move house site every one to ten years. This may happen because a prominent member has died, because the new gardens are too far from the house, or simply because they prefer to build in a new site. Although there is some idea of territory, the community is generally defined by the people who comprise it, rather than the physical location they occupy. In recent years, however, the Piaroa have increasingly settled in larger and more sedentary settlements, so that most occupy the same site for ten years or more (OCEI 1992). This was true in most of the ten communities that I visited, where I found prominent, complex and intensively managed homegardens.

Homegardens.—The ethnographic literature on the symbolic and cosmological significance of Amazonian homegardens is sparse. Descola (1994) gives one of the most complete descriptions of homegardens, in which he speaks of a central Achuar longhouse, surrounded "by a large yard carefully kept free of weeds and embellished with a scattering of small medicinal or narcotic shrubs, fruit trees

and chonta palms (*Bactris gasipaes*)" (1994:110). Other Amazonian studies describe open plazas with a few plants or small "kitchen gardens" (Hugh-Jones 1979:43; Overing-Kaplan 1975:30–31, 34), but rarely focus on these spaces analytically or describe them with enough detail to clarify their roles. Indeed, in structural analyses of settlement patterns, the house is often carefully described, the swidden analyzed intensively, but the "plaza" may be considered to be largely a void space (e.g., Lévi-Strauss 1963:141) or not be mentioned at all (e.g., Guss 1989). An exception to this is the work done with the Barí by Beckerman (1983) and Lizarralde (1991), but they describe a system that is dominated by manioc and plantain, and intentionally or not, convey a sense of a static system. As discussed below, this system more closely fits the definition of a swidden than of a homegarden.

Ethnobiologists and agronomists have described homegarden systems in some detail and a body of literature has developed that describes functional similarities amongst diverse populations. Fernandes and Nair (1986a), in their seminal compilation of homegarden data from around the world, state that food production is the primary function of almost all tropical homegardens, with market bound products increasing in importance as market economies become more integral to domestic economies. They also say that "almost all homegarden systems have evolved over time under the influence of resource constraints (population pressure and consequent reduction in available land, capital and labour)" (Fernandes and Nair 1986a:31), suggesting that homegardens evolved to compensate for localized resource scarcity. They raise the issue of agrobiodiversity by pointing out that species composition is highest in remote communities, compensating for a lack of trade goods (Fernandes and Nair 1986b). A study in the Peruvian Amazon found that more diverse homegardens compensate for less diverse swiddens (Salick and Lundberg 1990). Lamont et al. (1999) focus on cultural change, concluding that species composition of homegardens in Peru was most impacted by access to tourist markets: species that were used to make souvenirs were located in homegardens. They also found, in contrast to Fernandes and Nair (1986b), that species diversity and richness were equally high in two communities with unequal access to markets (Lamont et al. 1999:316), but that young people in all communities are losing interest, thereby threatening homegarden diversity. Padoch and de Jong (1991), on the other hand, question the idea that complex homegardens are associated with traditional values. They document a continuing tradition of highly diverse homegardens amongst mestizo gardeners in the Peruvian Amazon. They point out that the number of species in these gardens was comparable to that of Javanese homegardens. The low population density in the research area calls into question Fernandes and Nair's finding that homegardens arise as a response to population pressure (1986a). These studies offer valuable insight into the complexity and importance of homegardens to domestic economies around the world, but the culture and aspirations of the people who grow them are largely absent from the analyses, thus the sociocultural motivations for, and implications of, the phenomenon remain essentially unexplored.

Contextualizing the Piaroa Homegarden.—As in Padoch and de Jong's study (1991), the Piaroa case calls into question the association of Amazonian homegardens with indigenousness. Indeed, if homegardens are traditional to indigenous Am-

azonians, why are they so little mentioned in the ethnographic literature? To answer this question it is necessary to understand the temporal dynamics of the Piaroa subsistence system. Even today, most Piaroa practice shifting cultivation, so that swiddens are cleared and planted with the explicit knowledge that they are a temporary site, to be farmed for two to four years before moving on to the next site. New swiddens are created each year. Meanwhile, the older swiddens develop from young fields dedicated almost exclusively to manioc and sometimes maize, to more diverse fallows with planted species as well as pioneer species that have been protected (see Denevan and Padoch 1988). In general, however, once the swidden is no longer producing large manioc crops, it becomes less important to the gardeners, who will focus much of their time and energy on younger swiddens.

The works of Boglar (1982), Overing (1975), Overing and Kaplan (1988) and Zent (1992, 1995) describe how the Piaroa, when they move to a new home site, build a house in the middle of a recently cleared and planted manioc swidden. After a few years, the land no longer supports intensive manioc farming and new swiddens are established increasingly far from the house. Zent (1992:372), who carried out his fieldwork with the Piaroa in the mid-1980s, describes the development of the homegarden: "If active residence is maintained in the house beyond a couple of years, the manioc gardens are cut at progressively greater distances while the housegarden takes on a more polycultivated and arboricultural appearance, dominated by medicinal-magical plants and slower maturing (usually tree) cultigens." He notes, however, that most home sites move within ten years of establishment, thus truncating the development of an intensively managed perennial garden. Instead, the old homesite garden, which may not be visited for many years from fear of lingering malignant spirits (Zent 1995), goes to fallow.

I, however, worked in an area that had been significantly impacted by government attempts to sedentarize the population and by an active Piaroa engagement with the national culture. In the case of the 10–30-year-old communities that I visited, the plots surrounding the home continued to be intensively managed as long as residence was maintained, but the floristic composition, the purpose and the symbolic value of the plots changed as they passed beyond the manioc producing stage. With the Piaroa, then, the act of sedentarization, which is a reflection of the shifting regional political climate (Mansutti 1988), is the most important factor in the development of complex homegarden systems with multiple floristic strata. In other words, rather than being threatened by recent cultural change, Piaroa homegardens are an immediate result of it.

It can be argued that the distinction between a swidden and a homegarden is not clear cut. However, emically, ecologically, and ethnobotanically there is a separation between the manioc swidden and the succeeding ecological stages. Eyzaguirre and Linares (2001:30) offer a description of homegardens in which floristic composition and diversity is an important component. However, the most important feature is that homegardens are part of the gardeners' dwelling space. Indeed, as Overing-Kaplan states (1975:31), the Piaroa term for house, ***iso'de***, includes the house and clearing surrounding the house.[2] It also includes the plants that are part of this clearing. For the Piaroa, then, homegardens are an integral part of their home. They are a significant component of a symbolically structured

and socially experienced pattern of settlement space. The swidden, on the other hand, is part of the agroecosystem that can and often does shift away from the house over a period of years, depending on how long the house remains on the same site. As new swiddens are cleared farther away from the home, the homegarden continues to be intensively managed.

Is it true then that cultural change decreases the diversity of homegardens? Although sedentarization increases homegarden development, it is also associated with increased involvement in the market economy and increased contact with other ethnic groups, including nonindigenous groups. How do these variables affect homegardens? And what is the purpose and symbolic value of homegardens? To answer these questions, I carried out a comparative survey of the homegardens of three Piaroa communities in which the central method was hand-drawn maps of each homegarden with accompanying gardener interviews.

METHODS

The Study Setting.—Between September 1998 and September 1999, I mapped the homegardens of three Piaroa communities in the Manapiare Valley, Estado Amazonas, a riverine area to the east of the state capital of Puerto Ayacucho and the highlands that form the traditional Piaroa homeland (Mansutti 1990, Figure 1). Piaroa presence on this navigable river system is largely the result of a descent from these highlands in order to have greater contact with trade networks and the benefits of government programs such as schools and medical facilities. Thus, these communities arguably represent a shift from the traditional lifestyle associated with the highlands and described in the ethnographic record. Nevertheless, some Piaroa communities along the major rivers are only peripherally connected to the market, have little contact with nonindigenous populations and, in many ways, closely match earlier published descriptions. Even these more isolated riverine communities, however, maintain residence at a single site for upwards of ten years.

Study Communities.—The three study communities were chosen to reflect different levels of interaction with mestizo culture: Caño Seje, with limited contact; Guara, with formalized and intentional contact; and San Juan de Manapiare, with daily, casual and formal contact. The community of Caño Seje is relatively isolated (some 30 km upriver from the regional hub of San Juan) and ethnically unmixed with a population of approximately 30 people organized along traditional kinship lines. Only three inmarrying members of the community speak Spanish with any degree of competency. This community, all of one family, does not live in a single roundhouse as described in the ethnographic literature, but their four huts are clustered together and they cook, eat, hunt, garden and rest together. In this sense, the social organization of Caño Seje more accurately reflects Piaroa "tradition" than the other two study communities. Although a small amount of cacao (*Theobroma cacao*) is traded via the regional agricultural cooperative, involvement with any aspect of mestizo society is minimal. Moreover, there is no land pressure and no direct encouragement to remain sedentarized. In this regard, Caño Seje maintains a relatively traditional social structure and economy. Therefore, its home-

FIGURE 1.—Piaroa territorial occupation in 1960 and in 1995. The study sites are located along the Río Manapiare near the 66° meridian. (Source: Zent 1998: 254).

garden can be seen as a contemporary example of a traditional garden with which the other gardens may be compared. Nevertheless, the current residential site has been occupied for at least ten years, so that the homegarden is a developed, multistratum system.

Guara numbers approximately 75 Piaroa residents and is located 7 km downriver from the town of San Juan. It was established in the 1970s by the construction of 20 concrete block, zinc-roofed houses in two rows surrounding a central clearing. It has a primary school and frequent contact with government and development agents. Approximately 30% of the community speak Spanish. It is heavily involved with the agricultural cooperative that markets cacao, manioc products (*Manihot esculenta*), plantains (*Musa* x *paradisiaca*), and honey in exchange for manufactured goods such as pots, soap, brooms, and clothing. The proceeds from the cooperative have also allowed the community to buy a diesel generator and several outboard motors. The community is divided into six extended family groups that work together in much the same way that the entire community of Caño Seje works together. Nevertheless, through their community-wide business and political representation, they have an added layer of political, social and economic organization that is reflected in the organization of their homegarden, which has been under intensive management for the history of the settlement.

San Juan de Manapiare is the economic and political hub for the region with about 1000 people from at least 13 different ethnic groups (CAICET 1997). It has a Catholic school, a small hospital, shops, electricity, running water and daily flights to the state capital. Most of the Piaroa residents of San Juan live in the same neighborhood (*barrio* Piaroa) which was probably established no later than the 1950s. Most live in concrete block houses, but some have more recent homesteads. Nevertheless, I only clearly identified two homesteads whose homegardens were in formation, rather than already established. The Piaroa of San Juan mix daily with mestizos and Venezuelans through their jobs as wage laborers, in school, in the shops or in the health clinics. As of 2001, a resident of barrio Piaroa was mayor of the town. At least 50% of the residents speak Spanish and almost all of the children attend school. Despite an informal and opportunistic involvement in the market economy, most residents rely upon their subsistence crops for basic nourishment. Two kilograms of rice in the town shops cost an entire day's wage labor, so that subsistence agriculture remains an important part of the economy. The Piaroa residents of San Juan, as in the other two communities, form economic units based upon kinship ties, but unlike Caño Seje, these units are not geographically separated from other units, and, unlike Guara, they have not been able to form a cohesive economic entity, with a functional community-wide organization. Concerted attempts have been made, but infighting has prevented both a formalized involvement in the agricultural cooperative and a stable system of leadership with a universally acknowledged headman and prefect. Again, this disjointed system of economically distinct units is reflected in the homegardens.

Homegarden Maps.—The majority of the data was collected by drawing maps of the homegardens in the various communities accompanied by residents who told me, in a semistructured manner, about names, uses, and purposes of the plants and whether or not they were market bound. I often returned to these homesteads

for further, unstructured discussions about maintenance and development of the garden. The maps are hand drawn diagrams of house clearings, including all buildings, water sources and plants. The results of these maps, combined with the economic and ecological considerations of the residents, allow for a detailed investigation of how homegardens respond to and reflect changing lifestyles.

When I first entered the community of San Juan (SJM), I assigned numbers to each house within the community. I later learned that some families slept in several different houses, but still operated as a single economic unit, so that several of the numbers originally assigned were no longer used. Because changing numbers of gardens would risk confusion and even loss of data, I have simply abandoned the use of several numbers. For example, the absence of SJM10 does not mean that I have not included this garden in my analysis, but rather that it has been absorbed as part of SJM17.

In Guara, on the other hand, I found it difficult to distinguish which plants belonged to which house. The area immediately surrounding the house and extending behind it was usually planted exclusively by the residents of that house. However, the central clearing and the large, cleared areas on either end of the two rows of houses were treated as communal space where people planted more or less as they desired. Therefore, I mapped the garden in Guara as a community garden, rather than as individual homegardens.

I sorted the species into six use categories: food—any plant that has edible parts; medicinal—plants that are used as herbal remedies to treat symptoms of illnes or injury; magical—plants that are used to treat causes of illness, to aid in hunting or to keep people, gardens and homes safe from bad spirits (*mæræ*); "technical"—plants with parts that are used in construction or to make tools, dyes, textiles, dishes or packaging and fish poisons; miscellaneous—largely consists of ornamentals for which nobody knew any other use. In the case that a single species had more than one use, it was counted in each of the relevant use categories.

The number of plants and species in each garden was then collated into a spreadsheet. For composition of gardens, a matrix was constructed scoring all species as present (1) or absent (0). A similarity matrix was calculated from this matrix using Anthropac 4.0 (Borgatti 1996). The multidimensional scaling tool in Anthropac then generated a series of coordinates representing the similarity or difference of species composition between the gardens. Figure 2 is an abstract representation of the similarity of gardens based upon their species composition. Those gardens with more similar compositions will appear closer together on the graph. Because the graph is a spatial abstraction of a complex situation, the axes do not reflect a single factor, so that it is not possible to label the axes. Moreover, the program must sometimes distort, or stress, the relationships in order to fit them into the parameters of the test. The stress value, then, represents the distortion of the data. A stress of over 0.15 is high enough that the results are invalidated (Borgatti 1996). Nevertheless, when I ran a three-dimensional test, rather than a two-dimensional one, the stress was lower and the configuration of the gardens was much the same. I have, therefore, included a two-dimensional graph with high stress for ease of viewing.

To understand more nuanced differences between the homegardens, I have

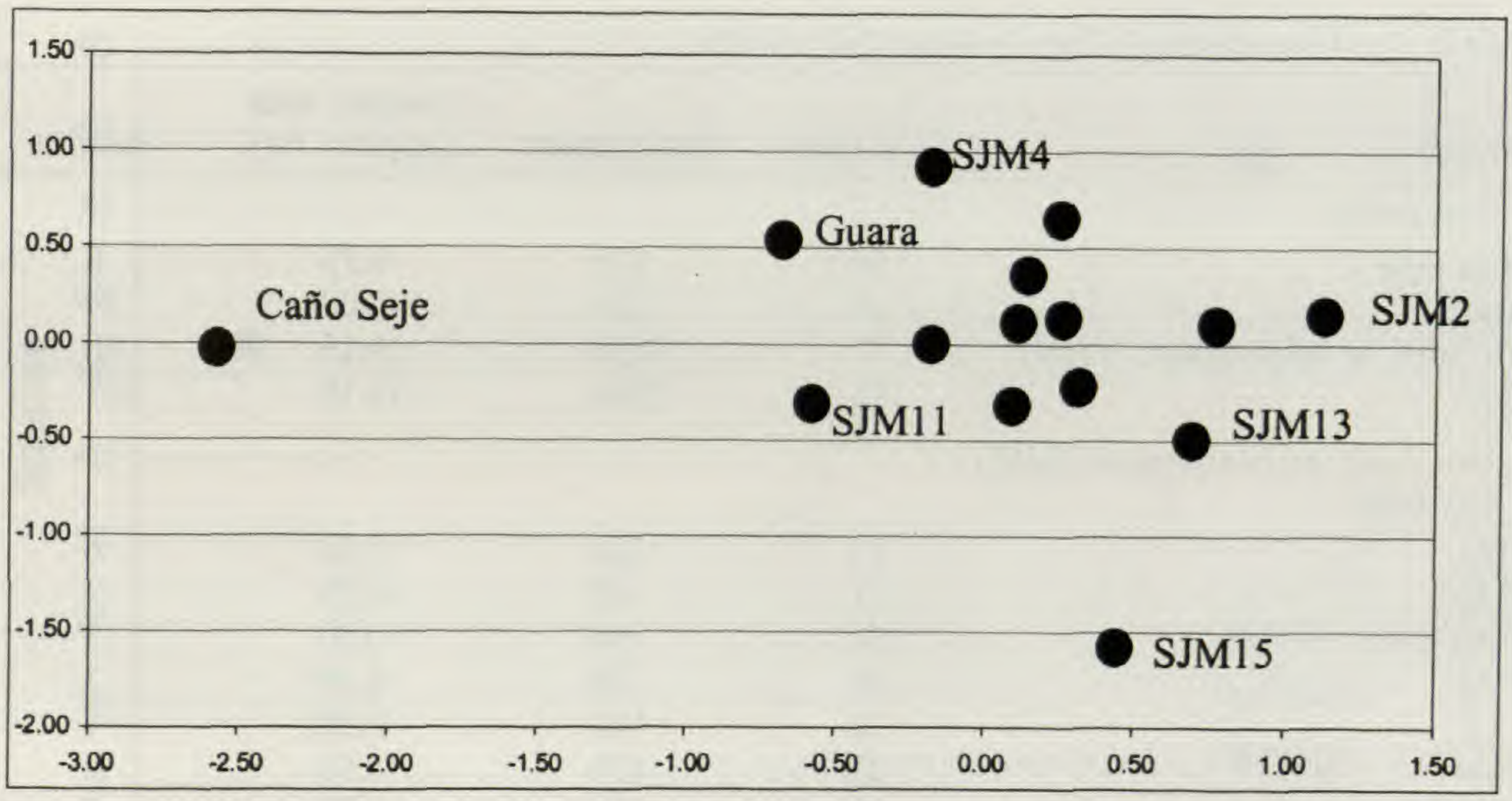

FIGURE 2.—Nonmetric multidimensional scaling of homegarden composition. All species were entered as present (1) or absent (0) and a similarity matrix was generated. The stress is 0.153.

used linear regression. Given that I have multiple gardens from only one community (San Juan), I have used those gardens to establish a correlation between factors. In all cases presented here, the high correlation in San Juan has allowed the calculation of an expected number for the other two communities. Where there is a high difference between the expected number and the actual number, it is then assumed that this difference is worth noting. It would, however, require testing more communities to establish testable means for the different types of communities.

The graphs, averages, standard deviations, linear equations and R^2 values were calculated using Microsoft Excel 97.

In assigning uses and market value to plants, I used information elicited from the gardeners and information gained from the markets, both in San Juan and Puerto Ayacucho, which was the nearest formalized market and export center. In the Manapiare Valley and particularly in San Juan, Piaroa involvement in the market is often informal and opportunistic. Therefore, I counted plants as having market value if that species was sold in the market rather than if it was explicitly planted for the market. In some homegardens, plants that I counted as having market value will not be sold and were not planted for the market.

RESULTS AND DISCUSSION

All of the gardens found in the three study communities, comprising fourteen homegardens and one community garden, were mapped. A total of 2286 individual plants from approximately 106 scientific species representing 113 folk taxa covering a surface area of approximately 10 hectares were identified. The general results are compiled in Table 1. The floristic inventory is summarized in Appendix 1.

TABLE 1.—The results of the homegarden maps.

Garden	Folk taxa	Total plants	Garden area (approx ha)	Adults
a. Summary.				
Caño Seje	54	170	0.75	6
Guara	45	478	~3.00[2]	39[2]
San Juan de Manapiare (total)	77	1636	9.15	60
Total	113	2286	13.15	105
b. San Juan de Manapiare (SJM) gardens.				
SJM1	11	126	0.50	6
SJM2	11	40	0.25	7
SJM3	24	90	0.50	3
SJM4	26	78	0.25[1]	3
SJM5	16	114	0.25[1]	4
SJM6	25	128	0.50	4
SJM7	21	136	0.75	5
SJM8	16	153	1.00	5
SJM11	8	22	0.15[1]	5
SJM12	24	150	0.75	4
SJM13	13	26	1.00	2
SJM15	36	299	1.50	6
SJM17	36	276	2.00	6
SJM avg	20.5	126	0.72	4.6
SJM stdev	9.1	84.6	0.54	1.5

[1] All of the land surrounding these houses was in cultivation.
[2] For reasons discussed in the text, the Guara garden was mapped as a single community garden, rather than a series of individual homegardens.

Homegarden Composition.—A primary purpose of this paper is to understand the factors that influence homegarden composition. Figure 2 shows a two-dimensional analysis of homegarden composition. From this abstract representation of similarities, it can be seen that Caño Seje's homegarden is significantly different from all of the others. Guara, while a slight outlier, is not significantly different from the San Juan gardens, although the high stress makes it difficult to draw conclusions based on such slight differences. In a three-dimensional analysis (stress 0.102), which I have not included due to graphic complexity, Caño Seje and Guara both come out as outliers. Other outliers include SJM15 and, to a lesser extent, SJM4. Thus, the three communities differ significantly in composition, but how do they differ and what does this tell us about the people who grow these gardens? By carrying out linear regression of the San Juan gardens, I am able to answer some of these questions.

Considering the difference in number of gardeners (Figure 3) and number of individual plants in the two communities (Figure 4), Caño Seje shows a much higher diversity than Guara. Applying the linear equation derived from the San Juan gardens, Caño Seje has twice the expected number of species (54 observed vs. 24 expected), while Guara has slightly fewer than expected (44 observed vs. 51 expected). Indeed, the species diversity of the Guara homegarden may be artificially increased due to the inclusion of six different homesteads (Figure 3),

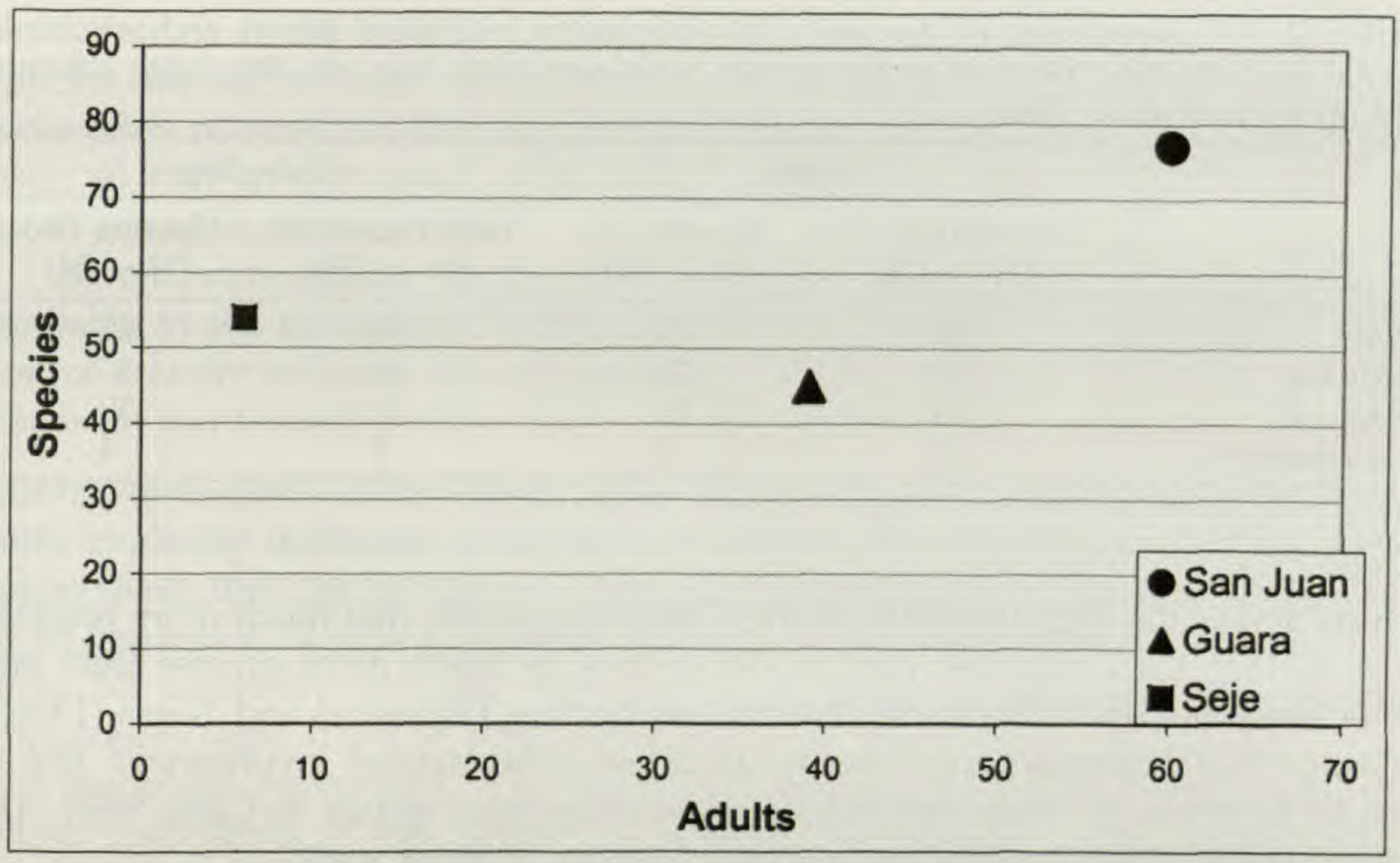

FIGURE 3.—A comparison of the number of adults vs. number of species between the three communities. Caño Seje has a high number of species for the relatively few adults who cultivate it.

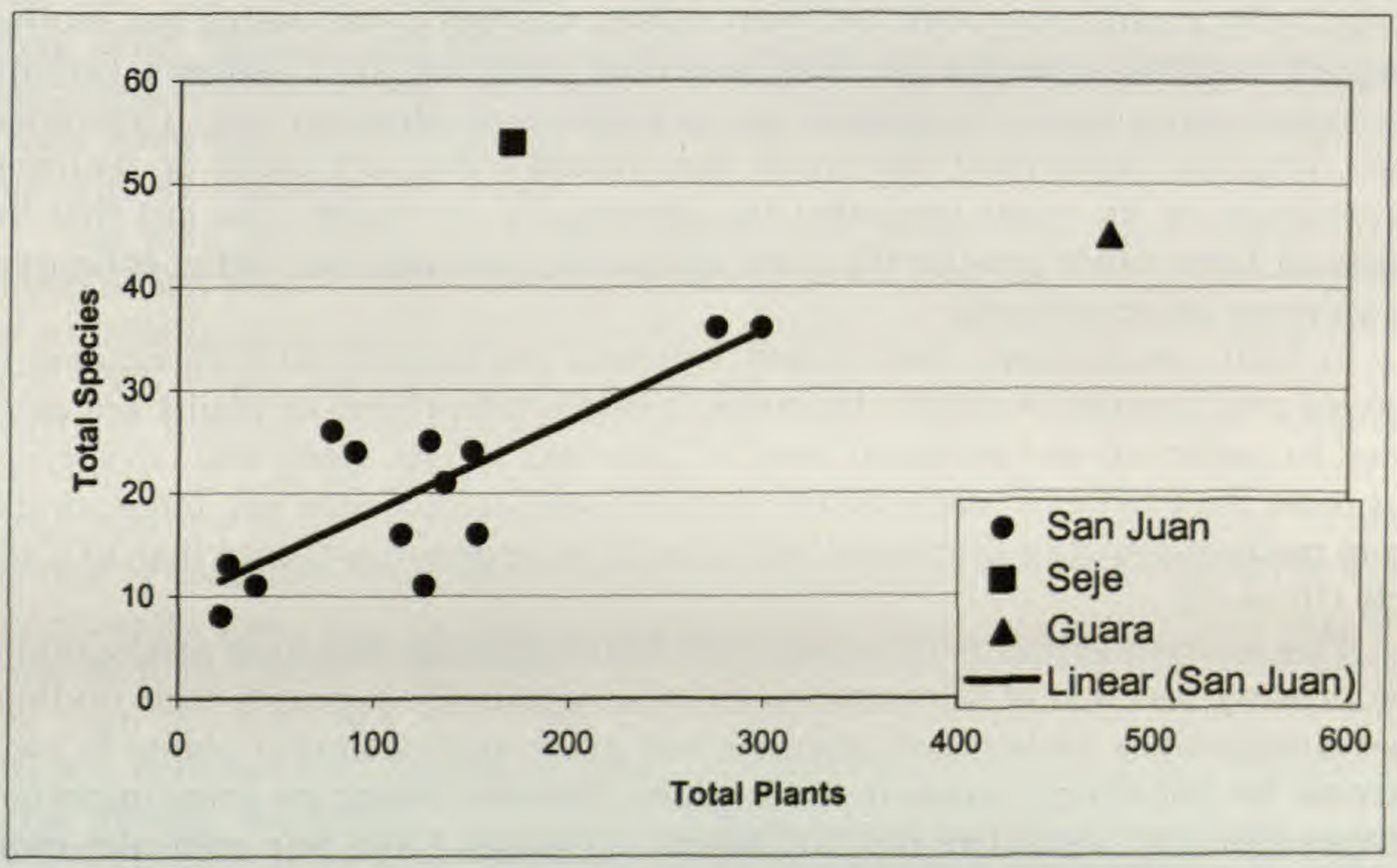

FIGURE 4.—Total plants vs. total species. $R^2 = 0.6653$; $y = 0.0876x + 9.5031$. Caño Seje has more species than expected for the number of individual plants. Guara is as expected.

TABLE 2.—A comparison of the uses of homegarden individual plants and species in Guara vs. Caño Seje. Because many species have more than one use, the usage columns add up to more than 100%.

	Guara		Caño Seje	
	Individuals (%) (N = 478)	Species (%) (N = 45)	Individuals (%) (N = 170)	Species (%) (N = 54)
Food	90	75	75	67
Medicine	18	23	34	17
Technical	13	16	22	30
Miscellaneous	2	7	1	4

which makes the high diversity of the Caño Seje garden that much more remarkable. In fact, the Caño Seje garden (54 species) is much more diverse than any other homegarden in the study, thereby supporting Fernandes and Nair's (1986a) findings that homegarden diversity decreases with market involvement. But is this in response to lower availability of manufactured goods in Caño Seje? Are homegardens compensating for resource scarcity of other sorts?

To understand the economic utility of Piaroa homegardens, the species and individuals of the Caño Seje and Guara homegardens are separated by use (Table 2). Of the six use categories, three were numerous enough to be helpful in a comparative study; food, technical and medicinal. I identified only one homegarden species whose sole use was ornamental. It may be argued that Piaroa homegardens are different from European or North American gardens because the species planted all may be used as food, medicine, for magic or for technical uses. However, simply because a plant can be used for food or medicine does not mean that this is the main reason it has been planted. The most common response when I asked why a particular plant had been chosen was that it was useful, but another frequent response was that the plant was nice, pretty or good (***adiwa***[3]). Perhaps the inflorescence would be pointed out as particularly attractive (e.g., *Oenocarpus* spp., *Syzygium malaccense*), the shade was valued (*Mangifera indica* or *Pourouma cecropiifolia*), or the plant reminded the gardener of the forest. The fact that the gardener knew other uses for the plant did not detract from, but rather enhanced, its value as an ornamental.

In both communities, food plants represent the majority of both number of species and number of plants. However, a higher proportion of plants are dedicated to medicinal and technical uses in Caño Seje. In fact, Caño Seje (16 species) has more than twice as many technical species as Guara (7 species). Interestingly, more medicinal species (but fewer individuals) were grown in Guara than in Caño Seje (10 vs. 9).

This analysis supports Fernandes and Nair's findings that food production is the primary function of homegardens. It also tentatively supports their findings that communities farther from markets will grow more technical plants to compensate for not having access to trade goods. However, there are some important caveats that may invalidate this conclusion. Although Caño Seje cultivates more technical plants, many of the species are available in the forest immediately surrounding the community. Moreover, Guara has easier access to western medi-

cines, but its residents still grow more medicinal species. Finally, the technical species that *can* be used for thatching roofs, basketry or making blowgun darts were often not used in this way. Many species—particularly palms—had several uses, so that an individual palm may be classed as technical even though it is more generally used as food.

Based primarily on the fact that Caño Seje grows technical plants that are available in the immediate vicinity, I argue that factors other than localized resource scarcity influence the composition of Piaroa homegardens. One factor that has been mentioned in other studies is also significant here: market agriculture.

Market Agriculture.—SJM5, SJM6, SJM8, SJM15 and Guara homegardens had large plots explicitly dedicated to market agriculture. At 16, 25, 16, 36 and 45 species respectively they are not more or less diverse than the other gardens (the average of all gardens is 24 with a standard deviation of 13). This suggests that the market does not markedly decrease homegarden diversity. In fact, market agriculture encourages some types of innovation and experimentation in homegardens. Piaroa gardeners experiment with growing a new species before entering into full blown cultivation of that species. In several homegardens, men planted one or two individuals of *Theobroma cacao, Citrus* spp. or *Musa* spp. experimentally. They would use these first individuals to test the suitability of the soil, humidity and precipitation, and the growth rate and ecology of these species that they have never before cultivated in this area. If they are successful, they then plant more individuals and establish an orchard, whose fruit is destined for the market. The market encourages the Piaroa to cultivate new crops and the homegarden gives them an area under constant supervision where these experiments can be monitored several times a day.

Another impact of the local market is increased theft, a prevalent problem in San Juan. The swiddens are usually far from the house, but often visited by people from other families and ethnic groups. Given that a single papaya can be immediately sold for enough money for a full meal or several beers in town, valuable fruits often disappear. Growing them in the homegarden diminishes, but does not entirely eliminate, the risk.

San Juan and Guara also differ in land availability. The much higher population of San Juan (~1000 including all ethnic groups) has led to a marked scarcity of suitable land for expansion into cash cropping. In some cases, including SJM15 and SJM8, where families wish to enter into formal marketing of large crops, they establish them in home gardens.[4] Whereas Guara locates such crops, with one exception, in cleared plots in secondary forest. Therefore, it is possible that, as postulated by Salick and Lundberg (1991), the diversity of homegardens increase as that of swiddens decreases and that homegardens are more resistant to agrobiodiversity loss than swiddens. However, this factor is only one of many that impacts homegarden composition and these hypotheses do not hold in explaining the high diversity in Caño Seje's homegarden, which not only boasts the most diverse homegarden, despite no threat of theft and no land scarcity, but also the most diverse swiddens.

Origin of Homegarden Species.—To understand why Caño Seje residents cultivate such a diverse homegarden, it is necessary to understand more about Piaroa per-

ceptions of and relationships with their homegardens. To do so, I analyse the gardens by a new criterion: origin of propagative material. I assigned homegarden species and individuals to one of three categories based upon their origin (Table 3). I used the *Flora of the Venezuelan Guayana* (Steyermark et al. 1995–2004) to confirm the ecological origin of species. One notable aspect of Table 3 is that the proportion of wild species in gardens is higher than the proportion of wild individuals, while the opposite is true for introduced individuals. In other words, people plant many individuals of a relatively few introduced species while they plant a few individuals of a wide variety of wild species. The high number of introduced individuals may be partially explained by the percentage of these species that have market value (86%). Similarly, relatively few wild plants have market value (15%), but those that do are planted in far higher numbers than those that do not.

Traditional Plants.—Plants are defined as traditional if they have been domesticated (as opposed to simply cultivated) by Amazonians and whose introduction to the Piaroa occurred before living memory. Traditional plants consist of 20–30% of all categories. Most of these species are not valuable in the market because they are too common to fetch a good price; they are the main focus of swiddens so that the vast majority of residents in the Manapiare region grow them for subsistence; they are considered low prestige by those with enough money to buy food; or a combination of all of these factors. Exceptions to this are pineapple (*Ananas comosus*) and papaya (*Carica papaya*), both of which are valuable, fetching about US$1 per fruit in 1999. Pineapple particularly affects the composition of SJM15, where many individuals are grown for the market.

By using the equation derived from linear regression of San Juan gardens, I compare the Caño Seje garden with that of Guara (Figure 5). There are fewer traditional species in Caño Seje homegardens than might be expected (10 observed vs. 15 expected) while the number of traditional species in Guara is virtually as expected (15 observed vs. 13 expected).

Introduced Plants.—Introduced species are those that have been introduced to the Piaroa within living memory. There are far more introduced species in Guara (15 observed vs. 14 expected) than in Caño Seje (8 observed vs. 17 expected) (Figure 6), which apparently confirms the hypothesis that the market encourages the cultivation of introduced species. However, although it seems that the high proportion of introduced plants in Guara reflects a turning toward the market economy, there are several introduced species grown in homegardens that are not destined for the market, including mangos and medicinal plants.

Mangos.—Previous ethnographic accounts either do not list mango (*Mangifera indica*) at all (Monod 1987; Overing and Kaplan 1988; Overing-Kaplan 1975), or list it in floral inventories, but make no special mention of it (Zent 1992). Nevertheless, the mango has been grown by the Piaroa for at least 20 or 30 years, and is now the most widespread and influential species in Manapiare homegardens. Whereas Anduze (1974) mentions that an old homestead can be identified by a peach palm (*Bactris gasipaes*) grove, many old homesteads in the Manapiare Valley

TABLE 3.—The origin of species and individuals cultivated in homegardens.

Category	Definition	Species		Individuals % of all plants (N = 2286)
		No. of folk species	% of all species	
Wild plants	Plants which are found wild in forest and savannah exploited by the Piaroa	61	54	21
Introduced plants	Plants introduced to Piaroa from Old World or other parts of the New World within living memory	22	19	49
Traditional plants	Plants that were domesticated before living memory	30	27	30
Total		113	100	100

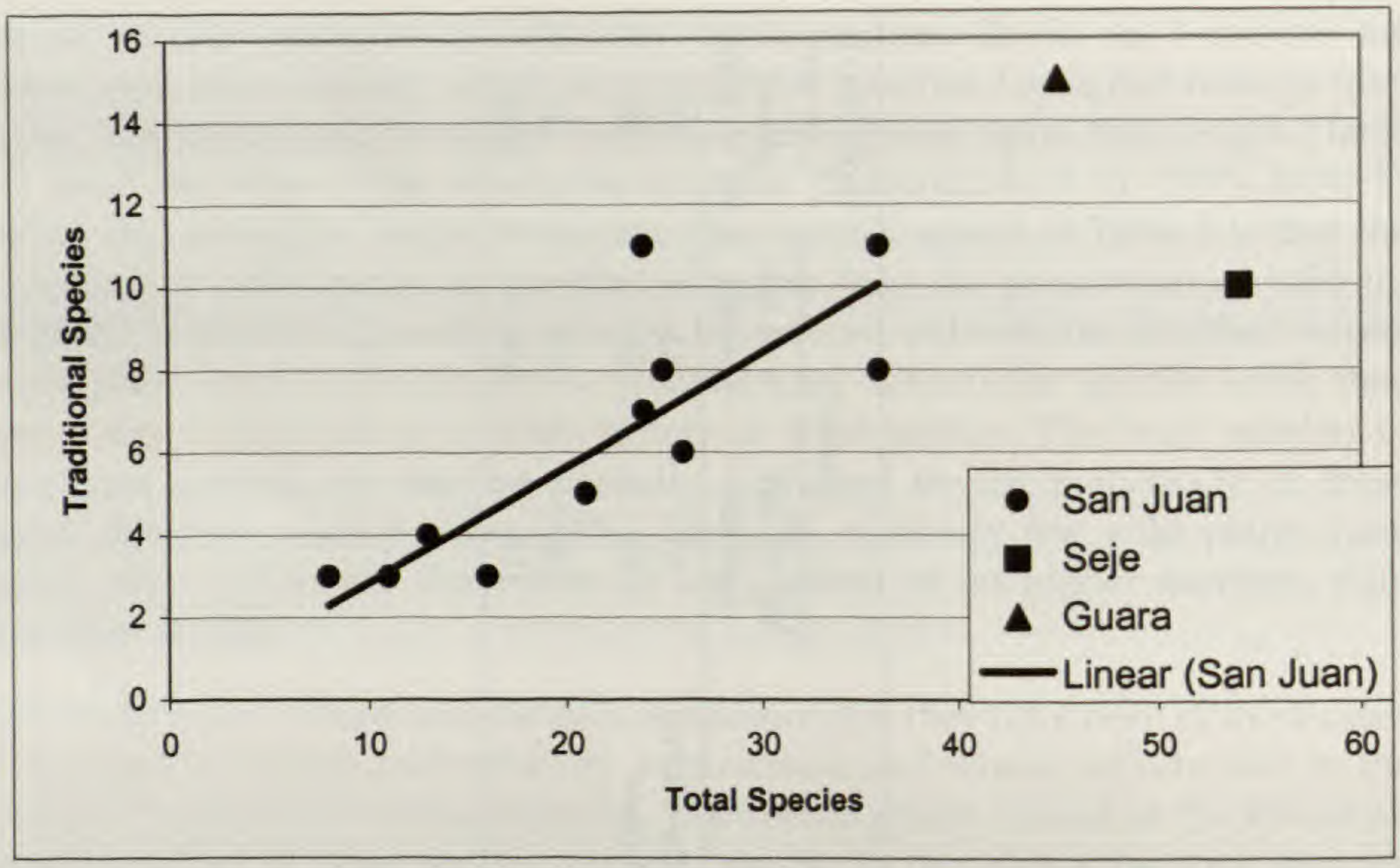

FIGURE 5.—Total species vs. traditional species. $R^2 = 0.7039$; $y = 0.2776x + 0.0677$. Caño Seje has fewer traditional species than expected. Guara has slightly more traditional species than expected.

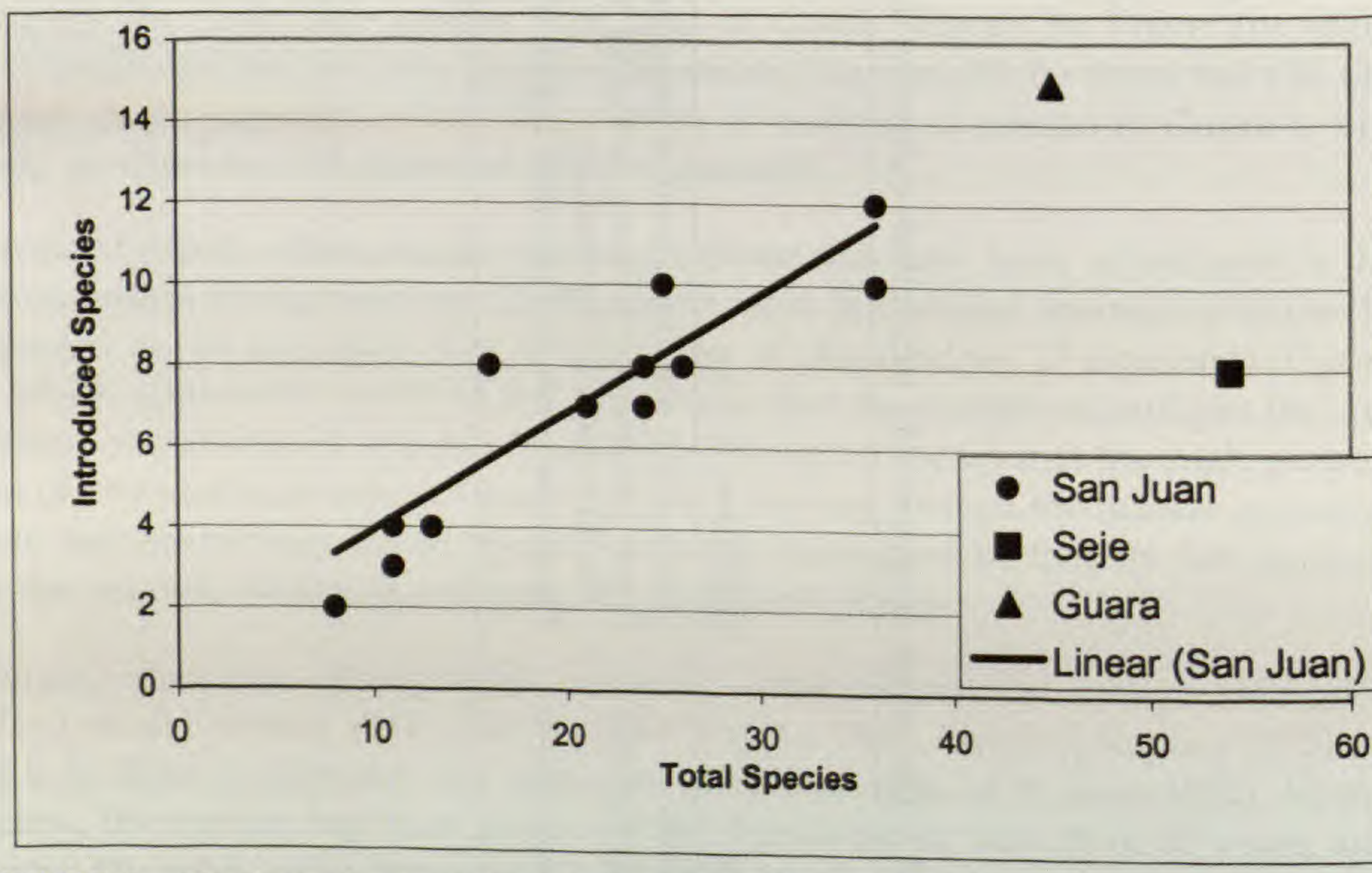

FIGURE 6.—Total species vs. introduced species. $R^2 = 0.7965$; $y = 0.2921x + 0.9998$. Caño Seje has fewer introduced species than expected. Guara has slightly more introduced species than expected.

are marked by a mango grove. Thus mangos represent a recent shift in the basic profile of homegardens and in the regional landscape ecology.

The popularity of mangos also explains an apparent contradiction in the data. Eighty-six percent of introduced species have market value and yet those species only make up 58% of the individuals planted (cf. 47% of wild individuals have market value). If, as postulated above, the market encourages the cultivation of many individuals of few species, we would expect to see a much higher proportion of individuals with market value. However, a great many introduced individuals are mangos (382). Although mango is loved for its shade, its fruit, and the relative absence of weedy growth underneath, it is so common in Venezuelan Amazon communities that the fruits literally rot in the streets. Therefore, it has no market value for the Piaroa. If mango is removed from the calculations, the percentage of introduced individuals with market value increases to 88% which correlates with the number of introduced species planted and supports the hypothesis.

Adoption of Mestizo Medicinals.—Several homegardens in San Juan and Guara included a number of medicinal species in small plots within the larger garden. Many of these plants were species such as *Pereskia guamacho, Kalanchoe* spp., *Justicia secunda,* and lemons (*Citrus aurantifolia*) that have no Piaroa name and have been introduced by mestizo neighbors or by Roman Catholic nuns who live within the community. I saw very few examples of traditional Piaroa remedies being grown in San Juan homegardens. Where traditional remedies were used, they were normally harvested from wild populations, the nearest of which may be several days' journey away. The phenomenon of adopted medicinal plants is so complex and important to the lives of the Piaroa that it is beyond the scope of this paper to address (see, however, Heckler n.d.). Nevertheless it is worth noting this important source of new species in homegardens that somewhat compensates for the lower number of wild species as compared to the Caño Seje garden.

Wild Plants.—Wild plants are those that have been reported (e.g., Melnyk 1995; Zent 1992) or that I witnessed growing wild in the forest surrounding Piaroa settlements. The garden in Caño Seje is characterized by a high number of wild species (observed 36 vs. expected 22, cf. Guara observed 15 vs. expected 18) (Figure 7), many of which I found or were pointed out to me growing within an hour's walk of the community (see Heckler 2001, 2002). This factor alone accounts for the exceptionally high diversity of the Caño Seje garden.

Just how recently these species have been incorporated into homegardens, such as SJM6 with 7 wild species, SJM4 with 12 wild species, and Caño Seje with 36 wild species, is illustrated by comparing cultivated species of wild origin with a list of utilized wild species compiled by Zent in the mid-1980s (1992:226–229, 231–233). Twenty-one species that were reported only as wild in his study have been brought into cultivation by Piaroa living in Manapiare Valley. Particularly the palm species that are found in most homegardens in San Juan are considered only wild as recently as Melnyk's work in the early 1990s (Melnyk 1995). Anduze (1974:41) states that the only palm that the Piaroa consider cultivatable is peach palm (*Bactris gasipaes*), whereas I catalogue 12 cultivated palm species (Appendix 1). The Piaroa are therefore incorporating many new species into their gardens.

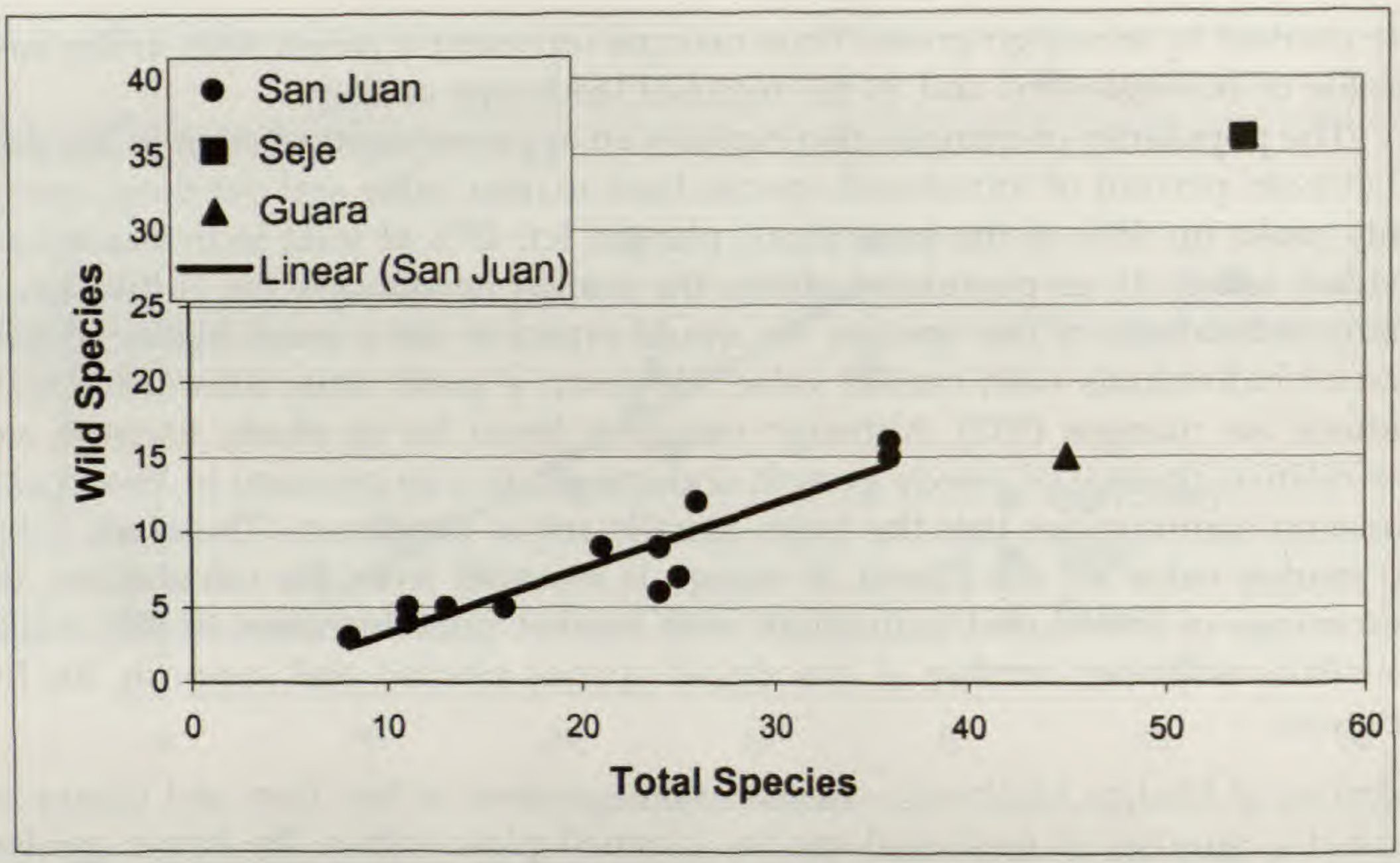

FIGURE 7.—Total species vs. wild species. The correlation of San Juan gardens is high (R^2 = 0.8625; y = 0.4302–1.0674). Caño Seje has a much higher number of wild species than expected. Guara has a slightly lower number of wild species than expected.

The high number of locally abundant wild species, however, indicates that Caño Seje gardeners are not compensating for lack of access to these plants. Therefore, we must look elsewhere to explain the cultivation of previously wild species. To better understand this phenomenon, I turn to the ethnographic record.

The culture/nature dichotomy, as associated with other dichotomies, e.g., domestic/wild, sacred/profane, central/peripheral, male/female has been a basic analytical theme in studies of settlement structure (Descola 1994:110–130; Ellen 1986; Hugh-Jones 1979; Lévi-Strauss 1963). According to these studies, the settlement and clearing represent a domestic[5] space that is carved out of the surrounding wilderness. While the applicability of Cartesian dichotomies to other cultures is now called into question (e.g., Ingold 2000), the Piaroa do separate cultivated and wild plants. Not only is this difference linguistically encoded (***kumæwæ*** 'planted' vs. ***de'a hawæ*** 'forest plant' or in original, ***mæyæsı̨ hawæ*** 'savanna plant'), but Piaroa origin myths generally describe the creation of cultivated plants as separate from the creation of wild plants (Overing and Kaplan 1988). Whereas ***Kuemoi*** is the father of "cultivated plants" (Overing and Kaplan 1988:398), "wild fruits" were created in the stomach of ***Wahari*** from the cellulose of hallucinogenic plants (Overing and Kaplan 1988:400). Oddly, ***Ohwoda'æ*** (male) is the "mother of plants" (Overing and Kaplan 1988:400), but maize, manioc and other staples are created separately. Similarly, the important hallucinogens are attributed to various minor characters in Piaroa mythology. Therefore, the shift to cultivation of wild species must be accompanied by a shift in cosmological perceptions which may, in turn, reflect a larger shift in Piaroa conceptions of the degree of influence they may exert over their surroundings.[6] The shift in what anthropologists formerly viewed as the rigid structural underpinnings of perception is seen else-

where in studies of cultural change. For instance, Ellen (1999) writes how Nuaulu (Seram, Indonesia) perceptions of the environment are highly adaptive in the face of changing political climates and external pressures. Therefore the structural analysis, in which fundamental oppositions and metaphorical images are reflected in community organization, generation after generation, may be an inaccurate way of representing indigenous conceptual relationships with the forest.

My data suggest that rather than being encoded in cultural perceptions and cosmology, the choice of which plants to cultivate reflects the different goals of individual cultivators. Wild plants are generally plants of the forest that are associated with foraging and other forest activities. When a person chooses to plant a wild seedling in her garden, she is bringing a bit of forest into her environs, behaving in a way that is not necessarily in keeping with traditional cosmological ideas, but indicating that she values and still wishes to be connected with the forest in some way. It is interesting that despite recognized need, very few traditionally wild medicinals have been brought into cultivation. Those that have been are not the powerful and potentially dangerous remedies used only by shamans (but see *Anadenanthera peregrina* in Caño Seje), but spiritually unproblematic herbal remedies used mainly on children.

Indigenous peoples, whether intentionally or unintentionally, have affected the ecology and species composition of the forest (Balée 1989, 1993; Posey 1985; Rival 1998). Through planting along commonly used trails, manipulating species that indicate past residential sites, and managing enriched fallows they have left their footprints in the forest, as it were (Balée 1994). Bringing wild plants into the domestic space can be seen as an inversion of this process—the footprint of the forest is stamped in the cultural space. This may be the first step in the domestication of the species as suggested by Casas et al. (2001), but the continued process of domestication, transplantation, and escape of cultivars makes for an ongoing dialectic between the house clearing and the surrounding forest. Not only the biological concepts of domesticated, cultivated, and wild, but also the social concept of the culture/nature dichotomy, are blurred in the homegardens of the Piaroa.

Temporal Development.—Piaroa homegardens are not simply fallows in the vicinity of the house. They are a result of years of intensive management of the domestic space. In some situations, they evolve from a swidden. In others, the homegarden is established in a new clearing, but it does not immediately become a full grown, multistratum system. Most of the gardens had already matured at the time of my study, but one garden was notable for its young age. SJM13 with 13 species but only 26 individuals (Table 1) was part of a new homestead, cleared by a young couple at the edge of the existing settlement. The relatively high number of species suggests the beginning of a complex homegarden, but their garden was marked by the absence of the mature fruit trees, particularly mangos, that were common in almost every other San Juan garden. The trees that had been planted were small and immature.

Another garden with few individuals is SJM11 with only 8 species and 22 individuals. This garden was maintained by an elderly woman who had come to San Juan when her daughter married into one of the families one or two years

earlier. Her house was squeezed onto a small piece of land between several larger and more prominent households. Her recent move to the community, her advanced age and the limited amount of space available are the main factors contributing to her sparse homegarden.

In a mature garden, such as SJM15, new plantings took place every year so that new strata were continually being added to the ecological profile of the garden. In fact, in SJM15, there was a small nursery with seedlings in starter trays. The primary gardeners, two sisters, often asked people for seeds from different types of fruits and planted them experimentally before transferring them to the homegarden. Before one of my journeys to Caracas, they asked me to bring back grape seeds, since they had heard that grapes were nice and wanted to try to grow some. They clearly enjoyed gardening for the sake of gardening. It became clear throughout my field work that some women maintained highly diverse homegardens out of love for the products of their labor, rather than out of any necessity for extra food or medicinal crops. This interest is reflected in their swiddens (Heckler 2004) and their knowledge of wild plants (Heckler 2001:253–254), but also in their homegardens. They garden to maintain a home environment that they enjoy and that reflects their knowledge and interest. In some cases, this interest is manifested in experimentation with plant species that they have adopted from their mestizo neighbors (SJM15 with 10 introduced species and SJM17 with 12 introduced species) or in the planting of wild plants in the homegardens. In this way, small portions of cultural and genetic diversity are maintained in the short term. In the long term, however, it means that the composition of the homegarden is constantly in flux and often reflects values other than economic utility or resource conservation, namely sociality, conviviality, and general quality of life (McCallum 2001; Overing and Passes 2000).

Spatial Arrangement.—The Piaroa have obtained and continue to obtain the propagative materials and ideas of what plants they would like to have near their home from their immediate surroundings, whether those surroundings be forest or other ethnic groups. In Caño Seje, the social and domestic environment is dominated by social and cosmological relationships with the forest; in Guara, it is dominated by a development project that enables it to enter into cash cropping; and in San Juan, it is dominated by people representing a wide variety of ethnic groups. The socioeconomic changes being experienced by the different communities are reflected in changing community and homegarden organization.

In Caño Seje, the family spends much more time in the forest than members of the other communities and primary forest is significantly closer to the community. This is demonstrated in part by a greater knowledge of wild forest plants than in the other two communities (Heckler 2002). This relationship with the forest is reflected in the presence of many wild species in the domestic space.

In Guara, the community, as a unit, is involved in an agricultural cooperative in which all the men of the community take part and from which all the families benefit with material goods. Guara's communal social arrangement is physically reflected in the homegardens where boundaries between homes are indistinct at best. At the time of my study, one man maintained an orange orchard (*Citrus*

sinensis) in the central clearing, from which he harvested fruit to send to market. Despite his openly acknowledged ownership of the orange trees, children of the community were quite free with the fruits and I was often presented with his oranges as gifts from other families' children. When these oranges were sold to the cooperative, the compensation was in the form of goods and equipment that benefited the community as a whole, rather than the individual or his immediate family. As a further reflection of the communal nature of Guara's garden, there is a collection of plants used in minor hunting rituals planted at one end of the community clearing that belonged jointly to several of the older men (*Caladium* spp. and *Renealmia* sp.).[7]

In San Juan, on the other hand, families have come to the community from different regions, for different reasons, and at different times. They work independently at manual labor for mestizo or white residents of the community and they struggle amongst each other for political control of the community. Indeed, despite several attempts during the past 20 years and despite the fact that the cooperative's regional operations are based in San Juan, the agricultural cooperative has failed to establish community-wide production. A few community members grow small amounts of produce which they then send on the cooperative boat, but conflict between families has impeded any large-scale efforts to grow cacao, *Citrus* spp. or plantains. In San Juan, families live in clusters of buildings arranged on clearings that are adjacent to, but clearly separated from those of their neighbors by boundaries, often marked by rows of trees or a strip of weedy vegetation. The great variability of the San Juan homegardens represents the eclectic backgrounds and aspirations of San Juan Piaroa. For some, entering the market is of great importance and they have a great many market bound plants. While for others, their homegardens are places where they can reaffirm their connections to the forest and the lifestyle that they were born into, so they surround themselves with forest plants. While for others, their ties with different ethnic groups encourage them to grow introduced plants. This is seen in SJM2, where one of the gardeners is employed as a gardener at the Salesian Mission and has planted various species on the instigation of the nuns, including *Coix lacryma-jobi* (Job's tears).[8] The nuns had asked their employee to grow Job's tears in order to make a necklace to present to a visiting bishop. Another example is the gardeners of SJM15 who, related by marriage to a Yabarana medicinal expert and her mestizo husband, cultivated several introduced medicinals that they had obtained from the Yabarana healer.

Homegardens as Living Spaces.—The most neglected aspect of homegarden studies is their role as a dwelling space. Just as homes evolve and take form as people live in them, reflecting the life histories of their residents (Ingold 2000:186), so homegardens evolve with the lives of their gardeners. Several homegardens in the study clearly demonstrated this phenomenon. SJM2 was remarkable for having a well-groomed lawn of soft, green grass. It was the only incidence of a ground cover in any of the homegardens. The women of the household spent hours each evening weeding and trimming the grass with machetes while the rest of the family sat on the lawn, chatted, ate, and relaxed. This particularly pleasant

venue was a regular destination for many members of the community (including myself) who enjoyed the cool of the evening and the sunset in the company of this hospitable family. Other households had benches or mats woven of palm (various species) that they set out for the same purpose and the household members spent a great deal of leisure and social time in their homegardens (especially SJM6 and SJM15).

The species composition of the homegarden is explicitly manipulated to encourage and serve as a backdrop for the social activities of the family. In fact, the homegarden is the most important site of sociality and conviviality, used freely by men, women, children, and visitors for a great variety of activities. Men have conferences and weave baskets, women chat, prepare food and string bead necklaces, visitors are offered food and beverages, children play, boys practice their blowgun skills, soccer games arise, people get drunk, and shamans smoke tobacco and sometimes chant. Nor do gender-based divisions of labor show themselves as starkly as in other spaces: both men and women cultivate plants in homegardens. They may plant different species—men will more often plant cash crops and magical plants, women plant herbal remedies, annatto (*Bixa orellana*) and cotton (*Gossypium barbadense*)—but they do so in overlapping spaces and with relative freedom. Even in the highly structured domestic spaces described by ethnographers throughout Amazonia, the homegarden is a conjunctive space par excellence (see Descola 1994:131–132). If homegardens are considered only as practical contributors to household economy, perhaps the most important of their roles, that of a setting for the crucial business of "living well," is overlooked (see Belaunde 2001; Gow 2000:52; Londoño-Sulkin 2000:170; Overing and Passes 2000: 2).

CONCLUSIONS

Due to the sheer complexity of homegarden systems and the factors that affect them, I have resorted to exploring various conceptual layers of homegarden utility and meaning: the economic, the utilitarian, the structural, the temporal, and the aesthetic, one at a time. In the end, however, it is misleading to suggest that these layers exist superimposed upon each other to be independently peeled back. Rather they exist together, only artificially separated for the purpose of analysis. In this sense, presenting them sequentially in this paper does not accurately represent this dynamic, living space in which Piaroa life histories unfold.

The best way of thinking about a Piaroa homegarden is as a multivalent contribution to quality of life. Although homegardens contribute to all sectors of Piaroa economy—food, building materials, medicinals, market crops, and hunting magic—this is not necessarily their primary purpose. They are the sites of social activity with shade plants, ornamentals, favorite snacks, experimental seedlings and, to a lesser extent, charms for luck and medicinals for minor health problems. They also serve as a source of pride, creative expression and a reflection of the gardener's self esteem. They are a creative work for some members of the society and for others they are the results of the owners' perspective on which plants are valuable and which need to be protected from theft. They are the sites of much

the agricultural experimentation that accompanies the first stage of cultivation or even plant domestication (see also Casas et. al. 1996). But more than anything else, homegardens are a living space for the Piaroa, one which evolves with and reflects their lifestyles and goals.

NOTES

[1] The term "Piaroa" is exogenous, probably derived from the word ***de'aruwa*** meaning master of the forest. The Piaroa chose the autodenomination ***Uhuottüjä*** at a political conference in 1992. This term has since been transcribed at least five different ways (e.g., Melnyk 1995; Oldham 1996; Zent 1992), making it extremely difficult to find in indexed literature searches. Unlike other exogenous names, "Piaroa" has no negative connotations and the Piaroa use it in their daily conversations with non-Piaroa. For these reasons, I continue to use the term "Piaroa."

[2] Zent (1995) uses the term ***isode pætʰæ*** (literally house swidden) to refer to the homegarden, which is also the term that I used in discussing homegardens with the Piaroa. However, the term ***pætʰæ*** mostly refers to the swidden phase dominated by manioc, so that there is some ambiguity about the appropriateness of this term for post-manioc homegardens. It was generally used only when the plants needed to be distinguished from the house and the clearing.

[3] The orthography used is IPA. It is also the same as that used by Zent (1992). Nasalization is marked by a cedilla under the corresponding letter.

[4] In contrast, most homegarden crops sold in San Juan are small harvests that are opportunistically sold to neighbors from wheelbarrows.

[5] Note that the terms "domestic" and "domesticated" are used in two distinctive ways in this paper. The first refers to the perceived distinction between "human space" and "non-human space"; the second is a specific agricultural term referring to plant species that have been permanently genetically altered by human intervention.

[6] Stanford Zent, personal communication (March 2003).

[7] While shamans maintain what Boglár (1971:335) called "model gardens," they are hidden and separate from the public homegarden. Because the relationship between the shaman and his plants is personal and sacred, I will not discuss these gardens further without explicit permission from each shaman involved.

[8] Although *Coix lacryma-jobi* is associated in the public consciousness with indigenous artifacts, and some groups do indeed wear *C. lacryma-jobi* (e.g., the Hoti, Zent pers. comm.), I never saw the Piaroa wearing them and they only used them for making necklaces to sell. The literature of the introduction of *C. lacryma-jobi* to South America is sparse, but the introduction probably occurred between 1925 and 1938 (Vallaeys 1948).

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APPENDIX 1.—The complete inventory of plants found in the homegardens of the three study communities. # 1: food; 2: medicinal; 3: magical or religious; 4: technical; 5: *barbasco* (fish poison); 6: miscellaneous. * I: introduced plant; W: plant that is found growing wild in the forest; T: plant that is traditionally cultivated by the Piaroa.

Family	Plant name	Piaroa name	Use#	Origin*	Total	Comments
Acanthaceae	*Justicia secunda* Thunb.	No name	2	I	23	medicinal
Agavaceae	*Sansevieria* sp.	No name	3	I	3	*mapanare*
Anacardiaceae	*Anacardium occidentale* L.	***æræræ***	1	T	51	cashew
	Mangifera indica L.	***mąkụ***	1	I	382	mango
	Spondias mombin L.	***rụbị, ruwi***	1, 2	W	16	hobo, *jobo*
Annonaceae	*Annona muricata* L.	***wanawana***	1	T	12	*guanabana*
	Anaxagorea sp.	***kæpʰæ, mereti***	4	W	1	
	Anaxagorea sp.	***kæpʰæ, reru***	4	W	1	
Apocynaceae	*Couma macrocarpa* Barb. Rodr.	***upʰæ***	1	W	1	
	Thevetia peruviana K. Schum	No name	2, 6	I	7	
Araceae	*Caladium* spp.	***yærukyæ***	3	W	10	
Arecaceae	*Astrocaryum chambira* Burret	***yæri***	1, 4	W	5	
	Astrocaryum sp.	Not known	1	W	1	
	Attalea butyracea (Spruce) Burret	***kuruwa***	1	W	71	*coroba*
	Attalea maripa (Aubl.) Mart.	***wæ'chæ***	1, 4	W	38	*cucurito*
	Attalea sp.	***mapai***	1	W	6	
	Attalea sp.	Not known	1	W	2	wild transplant
	Bactris gasipaes H.B.K.	***pæhæri***	1, 4	T	82	peach palm, *pejiguao*; sold
Arecaceae	*Cocos nucifera* L.	***coco***	1	I	25	coconut; sold
	Euterpe precatoria Mart.	***nenea***	1, 4	W	1	*manaca*
	Mauritia flexuosa L.f.	***wari***	1, 4	W	2	*moriche*
	Oenocarpus bacaba Mart.	***pʰou pɨ 'ori***	1, 4	W	26	*seje pequeño*; sold
	Oenocarpus bataua Mart.	***bare pɨ 'ori***	1, 2, 4	W	3	*seje grande*; sold
	Indet.	—	1, 4	W	9	unidentified pinnate palm seedlings: *Attalea, Oenocarpus* or *Euterpe*
Asteraceae	Indet.	—	2	T	2	medicinal
Bignoniaceae	*Crescentia cujete* L.	***dara***	4	T	35	*totuma*
Bixaceae	*Bixa orellana* L.	***mụyụ***	4	T	11	annatto, *onoto*
Bromeliaceae	*Ananas comosus* (L.) Merr.	***kænæ***	1	T	105	pineapple, *piña*; sold
Cactaceae	*Pereskia guamacho* F.A.C. Weber	No name	2	I	3	*guamacho*

APPENDIX 1.—Continued.

Family	Plant name	Piaroa name	Use#	Origin*	Total	Comments
Caricaceae	*Carica papaya* L.	***mapaya***	1, 2	T	43	papaya; sold
Cecropiaceae	*Pourouma cecropiifolia* Mart.	***nai***	1	T	14	Amazon grape, *uvilla, cucura*; sold
	Pourouma sp.	***tʰætʰæ***	1	W	1	
Chrysobalanaceae	*Licania pyrifolia* Griseb.	***weru, bare***	1	I	28	*merecure*
Clusiaceae	*Rheedia madruno* Planck & Triana	***mupʰi***	1	W	6	*tupire*
	Vismia sp.	***uræri***	2	W	4	
	Indet.	***duduku***	1	W	1	
Cochlospermaceae	*Cochlospermum* sp.	***reru***	4, 6	W	4	
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	***wiriyæ***	1	T	35	sweet potato, *batata*
Costaceae	*Costus* spp.	***i'etʰa***	2	W	13	*caña de india*
Crassulaceae	*Kalanchoe pinnata* (Lam.) Pers.	***hura hawapɨ***	2	I	16	
Cucurbitaceae	*Citrullus vulgaris* Schrad. ex. Eckl. & Zeyh.	***patiya***	1	I	6	watermelon, *patilla*; sold
	Cucurbita pepo L. *maxima* Duch	***kawiya***	1	T	1	squash
	Lagenaria siceraria (Mol.) Standl	***mori'ki***	4	T	0	gourd vine
Dioscoreaceae	*Dioscorea alata* L.	***wʰære***	1	T	2	yam, *ñame*
Euphorbiaceae	*Croton* sp.	No name	3	T	1	*carcanapire*
	Jatropha gossypifolia L.	No name	2	I	2	*tuatua*
	Manihot esculenta Crantz.	***ire***	1	T	201	manioc, yuca
	Phyllanthus sp.	***ræme***	5	T	1	*barbasco*
	Indet.	Not known	2	T	1	tree with medicinal use
Fabaceae	*Anadenanthera peregrina* (L.) Benth.	***yɨ'æ***	3	W	1	*yopo*
	Arachis hypogaea L.	***masi***	1	T	1	groudnut, peanut
	Hymenaea courbaril L.	***wǫ'ɨ 'tæ***	4	W	6	*algarrobo*
	Inga sp.	***ruwæ, kuyuwi i'are***	1	W	1	*guamo*
	Inga sp.	***ruwæ, teɨ***	1	W	1	
	Inga sp.	***ruwæ, wipo***	1	W	1	
	Inga sp.	***ruwæ,*** misc.	1	W	83	sold
	Lonchocarpus utilis A.C. Sm.	***wodu***	5	W	13	*barbasco*
	Sclerolobium cf. *guianense*	***mukwæ***	4	W	1	
	Swartzia macrocarpa Spruce ex. Benth.	***chænæchæchæ***	4	W	1	
	Tamarindus indica L.	***tamarindo***	1	I	1	tamarind
Lauraceae	*Persea americana* L.	***æpʰæ***	1	I	3	avocado

APPENDIX 1.—Continued.

Family	Plant name	Piaroa name	Use#	Origin*	Total	Comments
Malvaceae	*Gossypium barbadense* L.	***pụhą***	4	T	3	cotton, *algodón*
Malpighiaceae	*Malpighia glabra* L.	Not known	1	T	4	acerola, *cereza*
Marantaceae	Indet.	—	2	T	6	
Moraceae	*Artocarpus altilis* (Parkinson) Fosberg	Not known	1	I	3	breadfruit
	Brosimum foetida Ducke	***æpʰi***	1	W	1	
	Brosimum sp.	***turi***	1	W	2	
	Cecropia sp.	***mæ'chæ***	4	W	42	
	Ficus sp.	***pʰaratæ***	1	W	3	strangler fig, *matapalo*
Musaceae	*Musa* spp.	***pæruru***	1	I	121	plantain, *plátano*; sold
	Musa spp.	***sanatɨ pæruru***	1	T	5	banana, *cambur*
Myristicaceae	Indet.	—	1	W	2	
Myrsinaceae	*Stylogyne longifolia* (Mart. ex Miq.) Mezl.	***kwamani***	1	W	2	
Myrtaceae	*Myrcia* sp.	—	1	W	2	
	Psidium guajava L.	***wayaba***	1	I	75	guava
	Syzygium malaccense (L.) Merr & Perry	***pomaga***	1	I	14	*pomalaca*
	Indet.	***kasari***	1	W	3	
	Indet.	***yuku***	1	W	1	
Piperaceae	*Piper* sp.	***æ'ụpą***	2	W	13	
Poaceae	*Coix lacryma-jobi* L.	***yąmɨ rau***	4	I	1	Job's tears; sold
	Cymbopogon citratus (D.C.) Stapl.	Not known	2	I	14	lemon grass
	Saccharum officinarum L.	***naha***	1	I	6	sugarcane, *caña*; sold
	Zea mays L.	***yąmɨ***	1	T	4	maize
Polygonaceae	*Coccoloba* sp.	***ærækwalpo'æ dau***	1	W	2	
Rutaceae	*Citrus aurantifolia* Swingle	***rimoni***	1, 2, 4	I	64	lemon, *limon*
	Citrus paradisi Macfad.	***naranha***	1	I	3	grapefruit
	Citrus reticulata Blanco	***madarina***	1	I	21	mandarine; sold
	Citrus sinensis Pers.	***naranha***	1	I	281	orange, *naranja*; sold
Sapotaceae	*Pouteria caimito* (Ruiz & Pavon) Radlk.	***humari***	1	T	34	*caimito, temare*; sold
Solanceae	*Pradosia* or *Elaeoluma*	***mara***	1	W	16	
Simaroubeaceae	*Simaba cedron* Planch.	***ikiu hawapɨ***	2	W	1	
Solanaceae	*Capsicum annuum* L.	***ræ'te***	1	T	7	chili, *ají*

APPENDIX 1.—Continued.

Family	Plant name	Piaroa name	Use#	Origin*	Total	Comments
	Capsicum annuum L.	***ræ'te, de'a***	1	W	1	wild, permitted regrowth
	Solanum sessiliflorum Dunae	***nu'a***	1	W	1	*topiro, tupiro*
Sterculiaceae	*Guazuma ulmifolia* Lamarck.	***chæmiri***	4	W	4	*cabeza de negro*
	Theobroma cacao L.	***kakao***	1	T	23	*cacao*; sold
	Theobroma grandiflorum (Willd. Ex Spreng.) K. Schum	***barewa***	1	W	1	*cupuaçu*
Theophrastaceae	*Clæwija lancifolia* Desf.	***wi'æ ukwąpą dau***	1, 4	W	1	*arbolita de ardilla*
Tiliaceae	*Apeiba tibourbou* Aublet.	***wi'iri***	2	W	8	
	Triumfetta semitriloba Jacq.	***æwiri ohiya***	2	W	5	
Vitaceae	*Vitex* sp.	***ahæ dau***	1	W	3	
Zingiberaceae	*Renealmia* sp.	***u'atʰɨ sa'uru***	2, 3	W	12	ginger, *gengibre*
Indet.	—	Not known	?	W	1	large-leaved herbaceous (*Gunnera*-like)
Indet.	—	Not known	2	W	14	medicinal
Indet.	—	***cilantro***	2	I	8	not *Coriandrum sativum*
Indet.	—	***kiyuwe dau***	4	W	1	
Indet.	—	***mæra***	1	T	1	creeping vine
Indet.	—	***mærisiri***	2	W	2	
Indet.	—	***mereti ohiya***	2	W	1	
Indet.	—	***wayari iwiri dau***	3	W	1	
Indet.	—	***yu'a***	1	W	3	not *A. peregrina*
Indet.	—	Not known	6	T	12	purple ornamental
Indet.	—	***yæru***	1	W	1	sour fruit

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SUBSISTENCE HUNTING BY THREE ETHNIC GROUPS OF THE LACANDON FOREST, MEXICO

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ABSTRACT.—This study compares hunting practices and preferences of Lacandon, Tzeltal, and Mestizo hunters from five communities adjacent to Montes Azules Biosphere Reserve in the Lacandon Forest, Chiapas, Mexico. We conducted interviews and directly observed animals taken by hunters during one year. Wildlife was hunted by most Indian and Mestizo residents primarily for food and to reduce crop damage. Per capita, Lacandon hunters extracted more wildlife biomass than both Tzeltal and Mestizo hunters. Total biomass extracted from 32 wildlife species was 8160 kg/year. Ungulates and rodents made up 87% of the total biomass harvested. Paca, red brocket deer, white-tailed deer, and collared peccary were the species with the greatest harvest rates. Harvest rates were positively correlated with the intrinsic rate of natural increase of species (r_{max}). Species that reproduce faster were hunted more frequently. There were no correlations between harvest rates and body mass, standing biomass, density, or local economic value of game species. Our results suggest that r_{max} of species should be considered when managing subsistence hunting and that hunting should be regulated, preferably through community-based management, for the benefit of both residents and local wildlife populations.

Key words: Chiapas, Lacandon Forest, Maya, Mexico, subsistence hunting.

RESUMEN.—El propósito de este estudio fue documentar y comparar las prácticas y preferencias de cacería de los residentes de la Selva Lacandona, Chiapas, México. Durante un año realizamos entrevistas y observamos las presas cobradas por cazadores lacandones, tzeltales y mestizos de cinco comunidades adyacentes a la Reserva de la Biósfera Montes Azules. La mayoría de los residentes indígenas y mestizos utilizaron la fauna para obtener alimento y reducir daños a sus cultivos. Los cazadores lacandones extrajeron más biomasa per capita de animales silvestres que los cazadores tzeltales y mestizos. La biomasa anual extraída de 32 especies fue de 8160 kg, 87% de la cual correspondió a ungulados y roedores. El tepezcuintle, el temazate, el venado cola blanca y el pecarí de collar fueron las especies con las mayores tasas de extracción. Las tasas de extracción se correlacionaron positivamente con la tasa intrínseca de incremento natural de la población (r_{max}). No se ha encontrado correlación entre las tasas de extracción y la masa corporal, biomasa en pié, densidad o valor económico local de las especies cazadas. Nuestros resultados sugieren que r_{max} debería considerarse a la hora de ma-

nejar la cacería de subsistencia y que la cacería debería ser regulada mediante el manejo comunitario y para beneficio de los usuarios y de las poblaciones locales de fauna silvestre.

RÉSUMÉ.—Cette étude documente et compare les pratiques et préférences de chasse des habitants de la forêt Lacandon au Chiapas, Mexique. Pendant une année, nous avons réalisé des entrevues et observé les animaux abattus par les chasseurs lacandons, tzeltals et métis de cinq communautés adjacentes à la Réserve de la Biosphère Montes Azules. La plupart des Métis et des Amérindiens chassent la faune principalement pour la viande et afin de réduire les dommages faits aux cultures. Les chasseurs lacandons prélèvent proportionnellement plus de biomasse que les chasseurs tzeltals et métis. La biomasse annuelle des 32 espèces chassées est de 8160 kg. Les ongulés et les rongeurs représentent environ 87 % de ce total. Les espèces les plus exploitées sont l'agouti, le daguet rouge, le cerf de Virginie et le pécari à collier. Le nombre d'animaux abattus est positivement corrélé au taux intrinsèque d'augmentation des espèces (r_{max}). Ainsi, les espèces dont le taux de reproduction est plus élévé sont chassées plus fréquemment. Toutefois, le nombre d'animaux abattus n'est pas corrélé à la masse corporelle, ni à la biomasse, ni à la densité, ni à la valeur économique allouée localement aux espèces. Les résultats de cette étude indiquent que le r_{max} des espèces devrait être pris en considération lors de la gestion de la chasse de subsistance. De plus, la chasse devrait être régulée par la communauté, au bénéfice des habitants et de la faune locale.

INTRODUCTION

Historically people have used wild animals for many purposes, such as food, clothing, medicine, tools, ritual objects, and companionship (Campbell 1983). Currently, hunting in rural areas is primarily for subsistence. We define subsistence hunting as the extraction of wild terrestrial vertebrates to obtain food, pelts, medicine, or other materials that are either consumed by the hunter and his family or exchanged for other goods (e.g., food, tools), but not sold in established markets (Ojasti and Dallmeier 2000; Redford and Robinson 1991; Stearman 2000).

In central and southern Mexico, rural communities have harvested wildlife for centuries. Ancient Aztec and Mayan Indians hunted many mammal, bird, and reptile species for meat, pelts, feathers, bones, fat, oil, pigments, medicine, and other materials that were either locally consumed or exchanged for other goods (Fagan 1984). Today, both indigenous and non-indigenous rural inhabitants of Mexican tropical forests regard wildlife as an important source of protein and hides (Escamilla et al. 2000; Jorgenson 1995; Mandujano and Rico-Gray 1991; Naranjo 2000). In the southeastern Mexican states of Campeche, Chiapas, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán, the majority of people using wild animals are local farmers with low income, although there are a small number of sport hunters from the main cities. These local farmers are subsistence hunters who use wildlife primarily for meat, and they take the skin, heart, liver, stomach, brain, and other organs to feed themselves and their families. Occasionally, subsistence hunters sell the skins, fangs, and claws of large cats (i.e., jaguar, puma, and ocelot), the meat and hides of deer, peccaries, and pacas, and juvenile spider monkeys, parrots, scarlet macaws, and toucans to visitors from nearby cities or to local military troops (Guerra 2001). However, hunters do not involve them-

selves regularly in this commerce, because they know it is illegal and authorities may confiscate their guns (Naranjo 2002).

The preferences of subsistence hunters for different wildlife species are usually influenced by their main economic activity, access to domestic meat, ethnic origin, geographical isolation, local wildlife availability, and biological attributes of species (e.g., Hames and Vickers 1983). Subsistence hunters in neotropical rainforests often search for large-bodied species rather than for small animals, because of their greater quantities of meat and fat that yield more energy per unit effort (Bennett and Robinson 2000). However, hunters are more likely to encounter small, more abundant and productive species, and these animals usually make up their most common prey (Hill and Padwe 2000; Robinson and Bodmer 1999). Species such as peccaries, tapirs, deer, pacas, large primates, guans, curassows, crocodilians, iguanas, large turtles, and other large vertebrates are often the preferred species in neotropical rainforest, even though the most frequently hunted prey are often smaller species (Ayres et al. 1991; Bodmer 1995; Mena et al. 2000). In spite of their lower harvest rates, large-bodied animals usually make up the largest proportion of biomass extracted from terrestrial wildlife (Stearman 2000; Townsend 2000; Vickers 1991).

The Lacandon Forest of Chiapas is the southwestern sector of the Maya Forest and is one of the most important tracts of rainforest remaining in Mexico (Vásquez and Ramos 1992). It has large populations of vertebrates that are harvested by both indigenous and Mestizo subsistence hunters (Medellín 1994; Naranjo 2002). As in other parts of the neotropics, deforestation and overhunting in the Lacandon Forest are apparently impacting wildlife populations. However, these impacts need to be addressed further to find appropriate conservation strategies that consider both the human and wildlife components. This study compares the hunting practices by indigenous and Mestizo communities around Montes Azules Biosphere Reserve to determine the human component of subsistence hunting. Analyses test whether actual harvest rates are correlated with density, body mass, productivity, and economic value of wildlife species. This information is used to suggest appropriate conservation measures.

METHODS

Two localities adjacent to Montes Azules Biosphere Reserve (MABR) were studied (Figure 1). These study sites are located in the northeastern portion of the state of Chiapas (lat. 16°05′–17°15′N, long. 90°30′–91°30′W), which is delimited by the Guatemalan border on the east, north, and south, and by the Chiapas highlands on the west. The predominant climate of the Lacandon Forest is warm and humid with abundant summer rainfall (García and Lugo 1992). Average monthly temperatures range from 24°C to 26°C with maxima in May (28°C) and minima in January (18°C). Mean annual rainfall is 2500–3500 mm, with roughly 80% of the rain falling between June and November. The area was originally covered by over a million hectares of rainforest, of which about half remain. MABR is the largest protected area in the Lacandon Forest with over 3300 km^2. It harbors some of the largest Mexican populations of hardwood trees. Large-bodied vertebrate species still exist in the Lacandon Forest and are hunted by

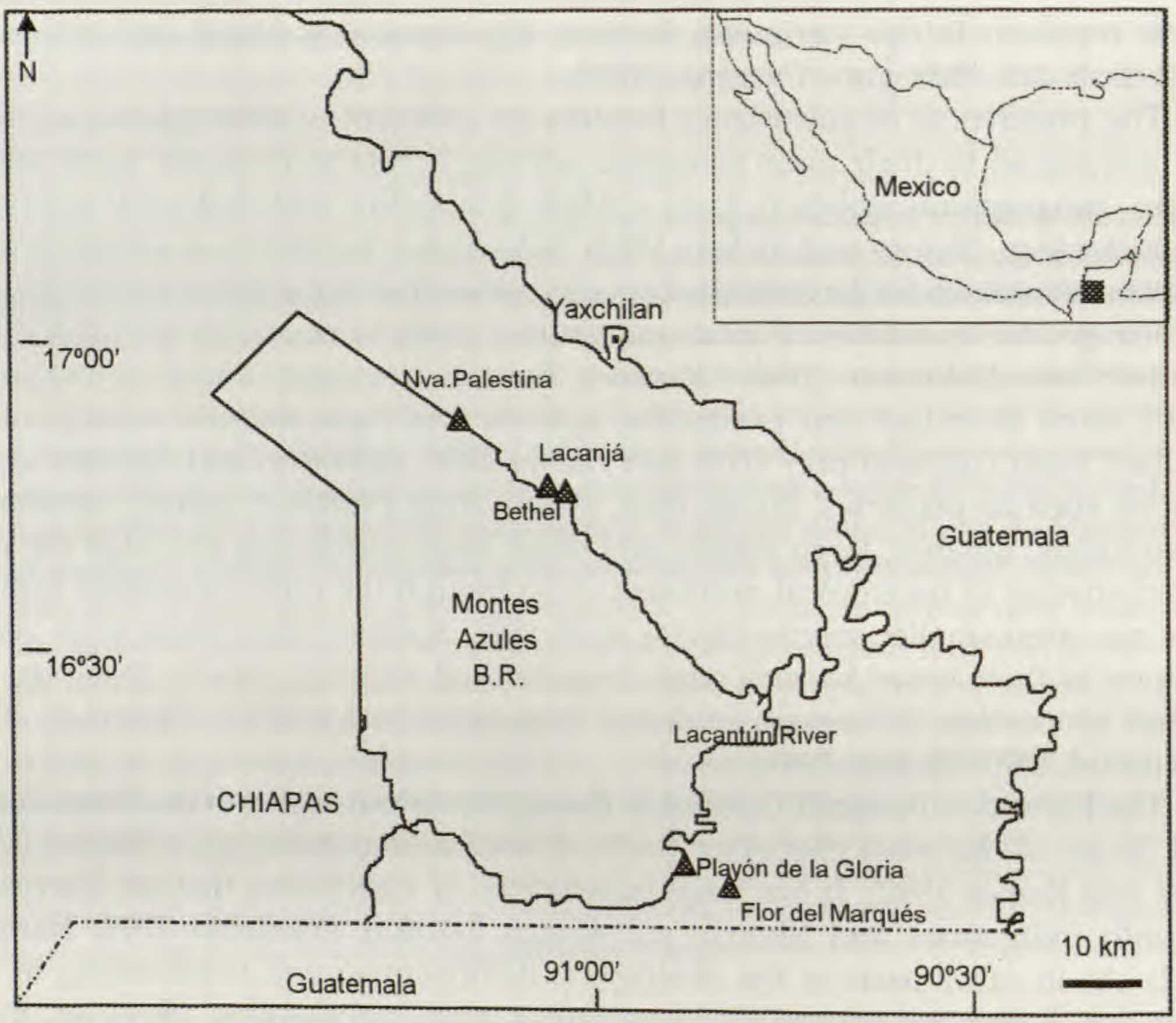

FIGURE 1.—Communities that participated in the study in the Lacandon Forest, Mexico.

both Indian and Mestizo residents (Medellín 1994; Naranjo 2002; Vasquez and Ramos 1992).

The first study site has three Indian communities of two different Mayan sociolinguistic groups: the Lacandon villages of Lacanjá-Chansayab (population 350) and Bethel (population 200) and the Tzeltal village of Nueva Palestina (population 15,000). Lacandon Indians have lived the study area for over three centuries (McGee 1990). They practice slash and burn agriculture (corn, beans, and squash), extraction of *Chamaedorea* palm leaves, fishing, hunting, and selling services and handicrafts to tourists (INI 1981; Naranjo 2002). Tzeltal Indians migrated from the highlands of Chiapas in the early 1970s and were relocated by the government in the community of Nueva Palestina. Their primary economic activities are both subsistence and commercial agriculture (corn, beans, and chili peppers) and cattle ranching. Subsistence hunting and fishing are complementary sources of food and income for the Tzeltal (Naranjo 2002).

The second study site includes the communities of Playón de la Gloria (population 300) and Flor del Marqués (population 200), which are inhabited by Mestizo immigrants from other regions of Chiapas and Oaxaca. These communities were founded in the mid-1970s and their residents farm corn, beans, chili peppers, cacao, and coffee. They also raise cows and pigs that they sell in the local market (Mariaca et al. 1997). Mestizo residents complement their diets by hunting and

TABLE 1.—Population size, number of hunters, and number of interviews conducted in five communities of the Lacandon Forest, Mexico (1999–2000).

	Bethel	Lacanjá-Chansayab	Nueva Palestina	Flor del Marqués	Playón de la Gloria
Ethnic Group	Lacandon	Lacandon	Tzeltal	Mestizo	Mestizo
Population	210	350	15,000	200	300
Hunters	30	50	850[b]	25	35
Interviews	44	43	45	44	56
Confidence interval (%)[a]	13.2	14.0	14.6	13.1	11.8
Catchment area (km^2)	113.1	201.1	452.4	28.3	28.3
Number of species used	35	37	32	42	37
Size rank	2	4	5	1	3
Isolation rank	3	5	4	1	2

[a] Calculations based on Krejcie and Morgan (1970); $\alpha = 0.05$ and $p = 0.50$.
[b] Only the 45 most active hunters were monitored during the study.

fishing (Naranjo 2002). The two Mestizo communities receive less economic and technical support from the government than the Lacandon and Tzeltal communities (Mariaca et al. 1997).

Hunting Patterns.—One of the authors (EJN) gathered information on wildlife use during multiple visits to the Lacandon Forest since the late 1980s. From September 1999 through August 2000 systematic records of hunting were collected through regular visits to the five communities. A total of 232 formal interviews were conducted (range: 40–56 per community) through structured questionnaires of men and women of age 15 or older. Although we interviewed between 12 and 22% of the total population in each village (except for Nueva Palestina), our confidence intervals (based on Krejcie and Morgan 1970) ranged from 11.8 to 14.6% in the communities visited (Table 1).

Field guides for birds (Howell and Webb 1995; Peterson and Chalif 1973) and mammals (Emmons and Feer 1997; Reid 1997) were used to help identify species during interviews. The active subsistence hunters were identified after the third visit to each community and they kept monthly records of their hunting. We asked people about the mammals, birds, and reptiles they hunted, as well as the hunting methods, sites, seasons, and uses of the animals. Only terrestrial vertebrates weighing 0.25 kg or more were used in this analysis. Two additional sources of information on hunting were the mammalian skulls and hides kept by hunters, as well visual records of people returning home with prey. Visual records include the species, sex, approximate age category (young, juvenile, or adult), weight, location and date of capture, and hunting method used. To improve the reliability of the results, only data from visual records of hunting are used in the numerical and statistical analyses.

Harvest Rates.—Catchment size is calculated as the area of a circle, centered on a village, with a radius of the maximum distance hunters were observed to travel. Harvest rate, determined from catchment area and hunting frequency, is the number of animals hunted/km^2/yr (Robinson and Redford 1991; Robinson and Bodmer 1999). Hunting effort, defined as the number of hunter-days/km^2/yr, is based

TABLE 2.—Hunting records and numbers of terrestrial vertebrate species used by residents from five communities of the Lacandon Forest, Mexico (1999–2000).

Classes	Number of species used		Visual hunting records	
	Data from interviews	Visual records	*n*	%
Mammals	29	19	626	80.1
Birds	15	9	148	18.9
Reptiles	6	4	8	1.0
Total	50	32	782	100.0

on data obtained through interviews and visual records. Relationships among the logarithmic values of harvest rates, body mass, metabolic biomass, r_{max}, economic value, and density are assessed with Pearson's correlation tests (Sokal and Rohlf 1995).

RESULTS

Hunting Patterns.—Fifty-one terrestrial vertebrate species were used by residents of the five communities visited during the study (Tables 2 and 3); we collected 782 visual hunting records (including 353 mammal skulls) of 32 species. Eighty percent of these records are of mammals (n = 19 species), 19% birds (n = 8), and 1% reptiles (n = 5).

To test whether Indian hunters take a wider diversity of species than Mestizo hunters, and whether residents of small and undeveloped villages rely more on wildlife than residents of larger, more developed communities, we compared the numbers of species between communities and ethnic groups. The number of species used by the five communities was tested against the size, isolation, and the percentage of residents interviewed in each community.

There were no differences in the numbers of species used between communities ($\chi^2 = 2.87$; $n = 5$; $p = 0.58$) and ethnic groups ($\chi^2 = 0.47$; $n = 3$; $p = 0.49$). The number of hunters is positively correlated with community population size (Pearson's $r = 0.99$; $n = 5$; $p < 0.0001$), but the numbers of species used is not correlated with community size, isolation, or percentage of residents interviewed ($p > 0.05$). The ten most frequently hunted species recorded in the interviews were: paca (*Agouti paca,* 92.5% of interviews), red brocket deer (*Mazama americana,* 89.6%), great curassow (*Crax rubra,* 87%), crested guan (*Penelope purpurascens,* 84.8%), collared peccary (*Tayassu tajacu,* 84.5%), nine-banded armadillo (*Dasypus novemcinctus,* 81.1%), great tinamou (*Tinamus major,* 79.9%), white-tailed deer (*Odocoileus virginianus,* 77.4%), coati (*Nasua narica,* 72.9%), and white-lipped peccary (*Tayassu pecari,* 61.5%).

Both Indian and Mestizo residents use wildlife primarily as a source of food (72.6% of interviewees), hides (3.2%), medicine (2.2%), raw materials for handicrafts (2.2%), and pets (1.4%). In addition, a considerable number people hunt animals to reduce damage to crops or to domestic animals (18.3%). Hunters from all five communities use primarily three hunting tools: 22-caliber rifles (38.8%),16-gauge shotguns (17.4%), and machetes (11.7%). Twenty-one percent of hunters

TABLE 3.—Terrestrial vertebrates used by residents from five communities of the Lacandon Forest, Mexico (1999–2000).

Taxa	English name	Part used	Purpose[a]	Record[b]
MAMMALS				
Didelphimorphia				
Didelphis marsupialis Linnaeus, 1758	Common opossum	meat	F, D	I, V
Philander opossum (Linnaeus, 1758)	Gray four-eyed opossum	meat	F, D	I, V
Xenarthra				
Tamandua mexicana (Saussure, 1860)	Northern tamandua	meat	F	I, V
Cabassous centralis (Miller, 1899)	Northern naked-tailed armadillo	meat, skin	F, C	I
Dasypus novemcinctus Linnaeus, 1758	Nine-banded armadillo	meat, skin	F, C	I, V
Primates				
Alouatta pigra Lawrence, 1933	Black howler monkey	meat, fat	F	I, V
Ateles geoffroyi Kuhl, 1820	Geoffroy's spider monkey	meat, fat	F, P, S	I, V
Carnivora				
Procyon lotor (Linnaeus, 1758)	Northern raccoon	meat	F, D, P	I, V
Nasua narica (Linnaeus, 1766)	White-nosed coati	meat	F, D, P	I, V
Potos flavus (Schreber, 1774)	Kinkajou	meat	F, P	I, V
Eira barbara (Linnaeus, 1758)	Tayra	meat	F, D	I
Conepatus semistriatus (Boddaert, 1784)	Hog-nosed skunk	meat, fat	F, M	I, V
Lontra longicaudis (Olfers, 1818)	neotropical river otter	meat, skin	F, C, S	I, V
Herpailurus yaguarondi (Lacépède, 1809)	Yaguarundi	skin	D, C, S	I
Leopardus pardalis (Linnaeus, 1758)	Ocelot	skin, fangs	D, C, S	I, V
Leopardus wiedii (Schinz, 1821)	Margay	skin	D, S	I, V
Panthera onca (Linnaeus, 1758)	Jaguar	skin, fangs, claws	D, C, S	I, V
Puma concolor (Linnaeus, 1771)	Puma	meat, skin, fangs, claws	F, D, C, S	I, V
Perissodactyla				
Tapirus bairdii (Gill, 1865)	Baird's tapir	meat, fat	F	I, V
Artiodactyla				
Tayassu pecari (Link, 1795)	White-lipped peccary	meat, skin, fat, fangs	F, C, S	I, V
Tayassu tajacu (Linnaeus, 1758)	Collared peccary	meat, skin, fat, fangs	F, D, C, S	I, V
Mazama americana (Erxleben, 1777)	Red brocket deer	meat, skin	F, C, S	I, V
Odocoileus virginianus (Zimmermann, 1780)	White-tailed deer	meat, skin, antlers	F, C, S	I, V

TABLE 3.—Continued.

Taxa	English name	Part used	Purpose[a]	Record[b]
Rodentia				
Orthogeomys hispidus (Le Conte, 1852)	Hispid pocket gopher	meat	F, D	I
Sciurus aureogaster Cuvier, 1829	Gray squirrel	meat	F	I, V
Coendou mexicanus (Kerr, 1792)	Mexican porcupine	meat, skin	F, C	I
Agouti paca (Linnaeus, 1766)	Paca	meat, fat	F, P, S	I, V
Dasyprocta punctata Gray, 1842	Central American agouti	meat	F, P	I, V
Lagomorpha				
Sylvilagus brasiliensis (Linnaeus, 1758)	Forest rabbit	meat, skin	F, C	V
BIRDS				
Tinamiformes				
Tinamus major (Gmelin, 1789)	Great tinamou	meat	F	I, V
Crypturellus boucardi (Sclater, 1860)	Boucard's tinamou	meat	F	I, V
Anseriformes				
Cairina moschata (Linnaeus, 1758)	Muscovy duck	meat	F	I
Falconiformes				
Micrastur semitorquatus (Vieillot, 1817)	Collared forest falcon	meat, feathers	F, C, S	I
Galliformes				
Ortalis vetula Wagler, 1830	Plain chachalaca	meat	F	I, V
Penelope purpurascens Wagler, 1830	Crested guan	meat, feathers	F, C	I, V
Crax rubra Linnaeus, 1758	Great Curassow	meat, feathers	F, C	I, V
Odontophorus guttatus (Gould, 1838)	Spotted wood-quail	meat	F	I
Columbiformes				
Columba spp. Linnaeus, 1758	Pigeon	meat	F	I, V
Psittaciformes				
Ara macao (Linnaeus, 1758)	Scarlet macaw	meat, feathers	F, P, C, S	I, V
Amazona autumnalis (Linnaeus, 1758)	Yellow-cheeked parrot	feathers	F, P, S	I, V
Amazona farinosa (Boddaert, 1783)	Blue-crowned parrot	feathers	F, P, S	I, V

TABLE 3.—Continued.

Taxa	English name	Part used	Purpose[a]	Record[b]
Strigiformes				
Pulsatrix perspicillata (Latham, 1790)	Spectacled owl	meat	F	I
Piciformes				
Pteroglossus torquatus (Gmelin, 1788)	Collared toucan	meat, bill	F, P, S	I
Ramphastos sulfuratus Lesson, 1830	Keel-billed toucan	meat, bill	F, P, S	I, V
REPTILES				
Testudines				
Dermatemys mawii Gray, 1847	White river turtle	meat, shell	F, C	I, V
Trachemys scripta (Schoepf, 1792)	Red-eared slider	meat, shell	F, C	I, V
Kinosternon spp.	Mud turtle	meat	F	I, V
Crocodylia				
Crocodylus moreletii (Dumeril & Dumeril, 1951)	Morelet's crocodile	meat, skin	F, C, S	I
Squamata				
Ctenosaura similis Gray, 1831	Spiny iguana	meat	F	I
Iguana iguana (Linnaeus, 1758)	Green iguana	meat	F, P, S	I, V
Boa constrictor (Linnaeus, 1758)	Boa	meat, skin	F, C, S	I, V

[a] C: craft for domestic use; D: avoid damage; F: food; M: medicine; P: pet; S: sale.
[b] I: interview, V: visual record.

TABLE 4.—Hunting effort estimated for three ethnic groups of the Lacandon Forest, Mexico (1999–2000).

	Lacandon	Tzeltal	Mestizo
Hunting events per month (A)[a]	5.1 (3.8)	1.2 (1.2)	4.2 (4.5)
Number of days per hunting event (B)[a]	2.0 (1.2)	3.5 (3.9)	1.3 (0.6)
Number of hunters (C)	80	850[c]	60
Capture area (km^2) (D)	314.2	452.4	56.6
Effort (man-days/km^2-year)[b]	31.1	94.7[c]	69.5

[a] Arithmetic means followed by standard deviations (in parenthesis).
[b] Effort: (A × 12 mo) (B × C)/D.
[c] If only the 50 most active hunters are considered, effort drops to 5.6 man-days/km^2-year.

interviewed use trained dogs to stalk prey on a regular basis, and 13% of hunters prefer to stalk their prey at spots intentionally or naturally baited with native fruit (e.g., fruits of *Attalea butyracea, Licania platypus,* and *Pouteria sapota*). A few hunters (5.6%) construct rustic box-traps to capture pacas, guans, and tinamous.

Hunting activity is most intense during the dry season between November and March, when farmers have more spare time. The areas most commonly used for hunting are mature forests within communal lands near agricultural plots (58.5%), followed by cornfields and pasturelands (26.4%), secondary vegetation (14.1%), and mature forests inside MABR (1.0%). Estimates of hunting effort (man-days/km^2-year) show that if all Tzeltal hunters of Nueva Palestina (n = 850) are considered, then effort expended by Indian and Mestizo hunters is similar. Mestizo hunters have a relatively high hunting effort, even though their catchment areas are much smaller than those of Indian communities. Lacandon hunters have lower effort than Tzeltal hunters if all hunters are considered. However, if only the most active hunters of Nueva Palestina (n = 50) are included, then Tzeltal hunters have a considerably lower hunting effort than both Lacandon and Mestizo hunters (Table 4).

Biomass Extracted and Harvest Rates.—The total biomass extracted from the 32 wildlife species hunted in all five communities was 8160 kg/year. Mammals account for 95.5% of the total biomass harvested, birds 3.9%, and reptiles 0.6% (Tables 5 and 6). Ungulates make up 66.6% of total biomass harvested, followed by rodents (20.8%), edentates (3.5%), cracids (3.4%), carnivores (2.6%), and primates (2.0%). The six species with the greatest total biomass harvested are paca (1674 kg; 20.5% of total biomass), red brocket deer (1469 kg; 18%), white-tailed deer (1137 kg; 13.9%), collared peccary (1130 kg; 13.8%), Baird's tapir (1050 kg; 12.9%), and white-lipped peccary (647 kg; 7.9%).

Mestizo hunters harvested fewer individuals (χ^2 = 254.1; df = 36; $p < 0.0001$) and less biomass (χ^2 = 4126.9; df = 36; $p < 0.0001$) than Lacandon and Tzeltal hunters. This is likely due to Mestizo hunters (n = 60) being greatly outnumbered by Indian hunters (n = 930) in this study. Total biomass harvested per hunter shows that Lacandon hunters took 41.1 kg/hunter, Tzeltal hunters took 4.0 kg/hunter and Mestizo hunters took 24.2 kg/hunter. Lacandon hunters extracted more biomass of red brocket deer, both peccary species, and paca. In contrast,

Tzeltal hunters took more biomass from paca, Baird's tapir, and white-tailed deer, while Mestizo hunters harvested more biomass from collared peccaries and pacas than from any other species (Tables 5 and 6).

Harvest rate of all species combined was 28.4 kg/ km^2/year. Collared peccary (23.2% of total biomass harvested per km^2), paca (17.7%), red brocket deer (16.5%), and white-tailed deer (12.2%) were harvested at greater rates than other species (Kruskal-Wallis' $H = 57$; df = 31; $p = 0.003$) (Table 7). Mestizo hunters harvested fewer individual animals per capita than Lacandon hunters, but they extracted game biomass at a rate 2.8 times greater than both Lacandon and Tzeltal hunters. This difference is due to the harvest rates of mammals; Mestizo hunters harvested collared peccaries, nine-banded armadillos, white-nosed coatis, jaguars, paca, red brocket deer, and white-tailed deer at greater rates than both Lacandon ($\chi^2 = 56.8$; df = 18; $p < 0.0001$) and Tzeltal ($\chi^2 = 64.2$; df = 18; $p < 0.0001$) hunters. The differences in harvest rates between Lacandon and Tzeltal hunters were slight, as were the harvest rates of birds and reptiles among the three ethnic groups ($p > 0.05$).

To investigate why some species are hunted more frequently than others we look at the correlates of hunting pressure, which include density, standing biomass, intrinsic rate of natural increase (r_{max}), body mass, and economic value. The correlations show that the most frequently harvested species (paca, nine-banded armadillo, and red brocket deer) were those with the highest values of r_{max}, that is, the most productive species ($r = 0.68$; df = 12; $p < 0.015$; Figure 2). However, there are no correlations between harvest rates and body mass, standing biomass, density, or economic value of wildlife species ($p > 0.05$).

DISCUSSION

Hunting Patterns.—Subsistence hunting is a predominantly opportunistic activity in the Lacandon Forest. Most residents of the study area are farmers and/or livestock raisers who take advantage of their visits to the croplands or pasturelands to hunt (Naranjo 2002). Three were few full-time hunters in the five communities visited, which may indicate that residents of the study area, under the current social and economic conditions, do not consider wildlife harvest very profitable. Hunting appears to be an important subsistence activity for the local people, since more than eight tons of wild meat were extracted by only five communities in a year. Most residents do not have enough money to buy meat every day, and not all raise domestic animals. Therefore, wildlife still represents a valuable resource in terms of protein for many people of the Lacandon Forest.

The number of wildlife species used did not differ significantly between communities. Previous studies have shown that indigenous groups tend to use more wildlife species than non-indigenous colonists (Redford and Robinson 1987). In this study, however, the Mestizo hunters of Flor del Marqués took more species than Tzeltal and Lacandon hunters. This is likely due to unequal government support for communication, education, health, and economic development among the rural communities of the Lacandon Forest. While some Lacandon (e.g., Lacanjá-Chansayab) and some Tzeltal communities (e.g., Nueva Palestina) have benefited from numerous subsidies, paved roads, electricity, and agroforestry proj-

TABLE 5.—Numbers of individuals and annual biomass harvested for 19 species of mammals extracted by three ethnic groups of the Lacandon Forest, Mexico (1999–2000).

Mammal taxon	Mean weight kg	Lacandon n	Lacandon kg	Tzeltal n	Tzeltal kg	Mestizo n	Mestizo kg	Total n	Total kg
Didelphis marsupialis	2	—	—	—	—	1	2	1	2
Tamandua mexicana	4	—	—	—	—	2	8	2	8
Dasypus novemcinctus	4	9	32	25	88	46	161	80	280
Alouatta pigra	5	15	75	—	—	1	5	16	80
Ateles geoffroyi	8	8	61	2	15	1	8	11	84
Procyon lotor	6	4	24	—	—	—	—	4	24
Nasua narica	5	7	32	—	—	5	23	12	54
Potos flavus	3	2	6	1	3	2	6	5	15
Eira barbara	5	1	5	—	—	—	—	1	5
Leopardus wiedii	4	3	11	4	14	1	4	8	28
Panthera onca	45	—	—	—	—	2	90	2	90
Tapirus bairdii	210	1	210	4	840	—	—	5	1050
Tayassu pecari	31	16	493	4	123	1	31	21	647
Tayassu tajacu	16	20	314	18	283	34	534	72	1130
Mazama americana	22	52	1123	8	173	8	173	68	1469
Odocoileus virginianus	42	4	168	19	800	4	168	27	1137
Orthogeomys hispidus	+	—	—	6	2	—	—	6	2
Agouti paca	6	75	450	172	1032	32	192	279	1674
Dasyprocta punctata	3	1	3	5	15	—	—	6	18
Total edentates		9	32	25	88	48	169	82	288
Total primates		23	136	2	15	2	13	27	164
Total carnivores		17	77	5	17	10	122	32	216
Total ungulates		93	2308	53	2219	47	906	193	5433
Total rodents		76	453	183	1049	32	192	291	1694
Total Mammals		218	3006	268	3388	140	1403	626	7797

+: < 0.5.

ects, many others (e.g., Flor del Marqués and Playón de la Gloria) have remained largely ignored (Mariaca et al. 1997). Indeed, the poorest hunters of the five communities relied more heavily on wildlife as a source of animal protein, hunted greater number of species, had higher mean harvest rates, and spent more time hunting. The relatively low effort expended by Lacandon hunters is likely due to their better economic situation, which allows them to hunt less than people in other communities; as a result they have a smaller impact on animal populations within their catchment areas.

Hunters consider ungulates, pacas, and cracids to be the most important game species. This agrees with hunting studies in other neotropical sites (Begazo 1999; Bodmer 1995; Jorgenson 1995; Robinson and Redford 1991; Vickers 1991). However, primates were not as important for hunters of the Lacandon Forest as they are in other places in Latin America (Mittermeier 1991; Redford and Robinson 1987). At least two factors may help to explain this difference. First, the Lacandon Forest is considerably poorer in primate species than South American forests. Second, Tzeltal and Mestizo hunters very rarely hunt monkeys because of cultural concerns ("monkeys look like small people"). In the past, Lacandon Indians hunt-

TABLE 6.—Numbers of individuals hunted and biomass harvested for 13 species of birds and reptiles used by three ethnic groups of the Lacandon Forest, Mexico (1999–2000).

Taxon	Mean weight	Lacandon		Tzeltal		Mestizo		All combined	
	kg	n	kg	n	kg	n	kg	n	kg
Birds									
Tinamidae	1.1	5	5.5	—	—	1	1.1	6	6.6
Micrastur semitorquatus	0.8	1	0.8	—	—	—	—	1	0.8
Penelope purpurascens	2.5	29	72.5	5	12.5	—	—	34	85
Crax rubra	3.5	48	168	3	10.5	4	14	55	192.5
Ara macao	0.9	2	1.8	—	—	—	—	2	1.8
Amazona spp.	0.5	23	11.5	15	7.5	7	3.5	45	22.5
Strigidae	0.5	—	—	1	0.5	—	—	1	0.5
Ramphastos sulfuratus	0.4	4	1.6	—	—	—	—	4	1.6
Total Birds		112	261.7	24	31	12	18.6	148	311.3
Reptiles									
Dermatemys mawii	10	2	20	—	—	—	—	2	20
Trachemys scripta	1.5	—	—	—	—	2	3	2	3
Crocodylus moreletii	20	—	—	—	—	1	20	1	20
Ctenosaura similis	2.5	—	—	—	—	2	5	2	5
Iguana iguana	4	—	—	—	—	1	4	1	4
Total Reptiles		2	20	—	—	6	32	8	52
Total Vertebrates		332	3287.4	292	3418.6	158	1454.0	782	8160.0

ed and consumed primates (Baer and Merrifield 1971; March 1987), but our results suggest that these mammals are no longer important as food resources for the Lacandon. Likewise, Jorgenson (1995) found that young Mayan hunters of the Yucatán Peninsula hunted fewer monkeys than their parents and grandparents. Ayres et al. (1991) documented a decline in wild meat consumption due primarily to increased accessibility to the meat of domestic animals in a rural Brazilian community. It is likely that an analogous situation has occurred in the Indian communities of the Lacandon Forest, where dietary choices seemed to have shifted because of a higher availability of poultry, pigs, and canned meat.

Biomass Harvested and Harvest Rates.—About two-thirds of the total vertebrate biomass harvested comes from ungulates, which also are the most frequently hunted animals. Researchers in Quintana Roo (Jorgenson 1995) and Campeche (Escamilla et al. 2000), too, have found that ungulates are usually the most important vertebrate taken. In the Lacandon Forest, collared peccaries, white-tailed deer, and red brocket deer comprise most of the biomass harvested, while a lower biomass of tapir and white-lipped peccary is harvested due to their proportionally lower abundances in persistently hunted areas of southeastern Mexico. The white-tailed deer is taken at greater frequencies in the Yucatán Peninsula, where it is considerably more abundant than in the vicinities of MABR (Escamilla et al. 2000; Jorgenson 1995). Conversely, the paca is a more important food source for local hunters of the Lacandon Forest than for Mayan hunters of Campeche and Quintana Roo. By number of individuals (36% of total) and biomass extracted (21%), it represents the most important hunted animal in the Lacandon Forest. Although paca are persistently hunted and have a modest productivity (one or two young

TABLE 7.—Harvest rates (kg/10 km²-year) of 32 species of terrestrial vertebrates hunted by three ethnic groups of the Lacandon Forest, Mexico (1999–2000).

Species	Lacandon	Tzeltal	Mestizo	Total	%
Mammals					
Didelphis marsupialis	—	—	0.2	0.2	0.1
Tamandua mexicana	—	—	1.4	1.4	0.5
Dasypus novemcinctus	0.4	1.7	19.2	21.3	7.5
Alouatta pigra	1.0	—	0.4	1.4	0.5
Ateles geoffroyi	0.9	0.3	0.7	1.9	0.7
Procyon lotor	0.5	—	—	0.5	0.2
Nasua narica	0.4	—	4.0	4.4	1.6
Potos flavus	0.1	—	1.1	1.2	0.4
Eira barbara	0.1	—	—	0.1	+
Leopardus wiedii	0.2	0.3	0.6	1.1	0.4
Panthera onca	—	—	11.9	11.9	4.2
Tapirus bairdii	2.6	13.9	—	16.5	5.8
Tayassu pecari	6.2	2.7	2.7	11.6	4.1
Tayassu tajacu	4.5	5.9	55.5	65.9	23.2
Mazama americana	24.0	1.9	21.0	46.9	16.5
Odocoileus virginianus	2.9	13.0	18.6	34.5	12.2
Orthogeomys hispidus	—	+	—	+	+
Agouti paca	7.6	19.8	22.8	50.2	17.7
Dasyprocta punctata	—	0.3	—	0.3	0.1
Birds					
Tinamidae	0.1	—	0.2	0.3	0.1
Micrastur semitorquatus	+	—	—	+	+
Penelope purpurascens	1.6	0.3	—	1.9	0.7
Crax rubra	3.4	0.2	1.9	5.5	1.9
Ara macao	+	—	—	+	+
Amazona spp.	0.2	0.1	0.5	0.8	0.3
Strigidae	—	+	—	+	+
Ramphastos sulfuratus	+	—	—	+	+
Reptiles					
Dermatemys mawii	0.3	—	—	0.3	0.1
Trachemys scripta	—	—	0.5	0.5	0.2
Crocodylus moreletii	—	—	1.8	1.8	0.6
Ctenosaura similis	—	—	0.7	0.7	0.3
Iguana iguana	—	—	0.7	0.7	0.3
Total	57.1	60.5	166.4	283.9	100.0
Mean (std. dev.)	1.8 (4.5)	1.9 (4.7)	5.2 (11.5)	8.9 (16.9)	

+: < 0.05.

per year; Smythe 1983), they are widely distributed in the Lacandon study areas, and appear to tolerate hunting pressure and habitat disturbance (Emmons and Feer 1997). Hunters of all ethnic groups repeatedly mentioned that they like paca, due to the excellent taste of its fatty meat.

Redford and Robinson (1987) found that Indian hunters harvested wildlife at higher rates than colonists. However, Redford and Robinson's harvest rate is defined as the number of animals taken annually by a hunter. In this study, we define a community's harvest rate as the weight or number of animals taken

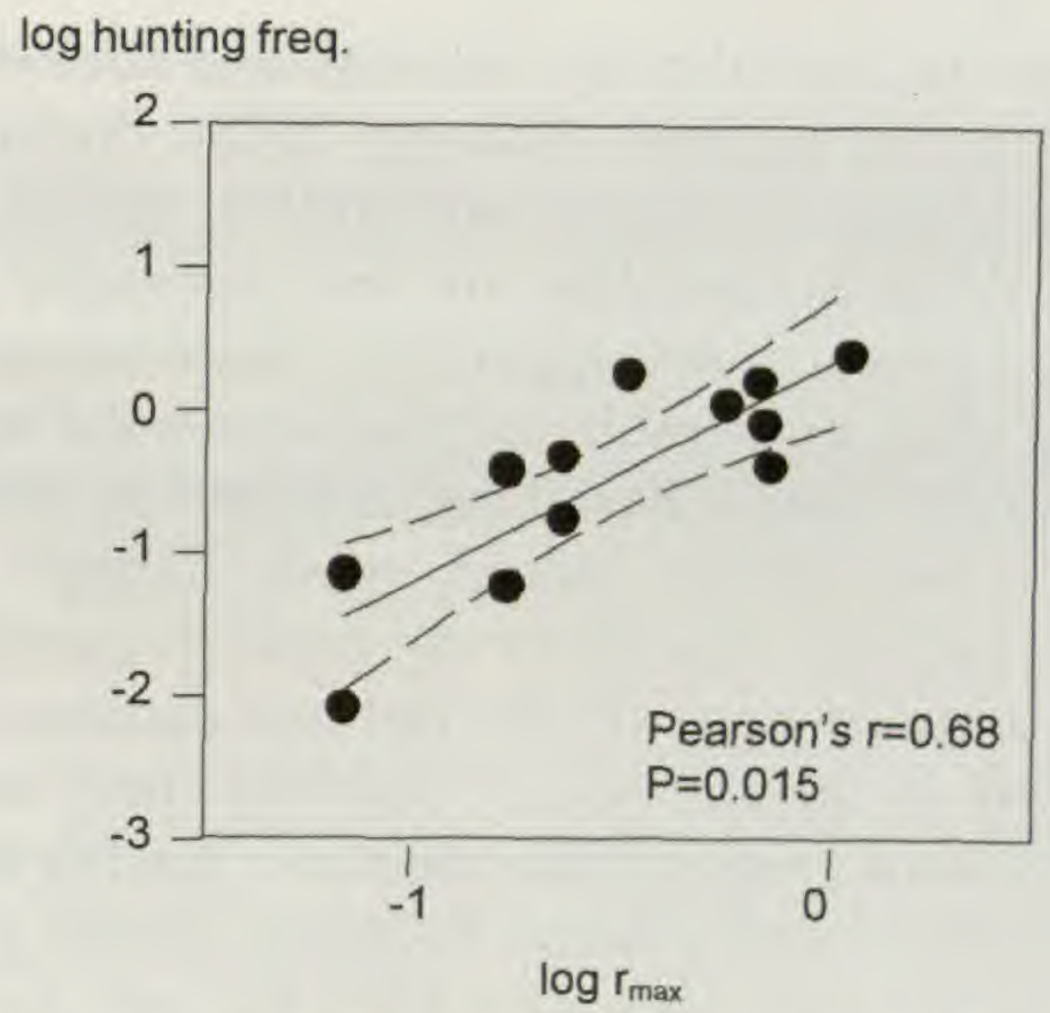

FIGURE 2.—Logarithmic correlation between intrinsic rates of natural increase (r_{max}) and harvest rates (individuals/year) of the 12 most important mammals hunted in the Lacandon Forest, Mexico.

annually in the catchment area (kg/km^2/yr or number/km^2/yr). Thus, using our own definition, we found that overall harvest rates of Mestizo hunters were higher than those of Indian hunters in the study area. Using Redford and Robinson's definition, our data suggest that Lacandon communities took more animals per consumer (or hunter) than Mestizo communities. The Tzeltal community is considerably larger and more populous than the other four villages, and it was not possible to keep records of all hunting events. Thus, only the most active hunters were surveyed (around 50 men) among the estimated 850 people who hunted in the community. It is very likely that wildlife biomass and harvest rates may have been underestimated in this village.

The average wildlife biomass harvested in the five communities was only 0.5 kg/person/year. However, if the largest community (Nueva Palestina) is excluded from this analysis, then the annual use of wildlife rises to 4.5 kg/person/year (5.9 kg/person/year for the Lacandon, and 2.9 kg/person/year for the Mestizo). These quantities are notably greater than the 1.8 kg/person/year estimated for the Mayan community of X-Hazil, Quintana Roo (Jorgenson 1995). The biomass consumed in the Lacandon Forest looks insignificant when compared to that consumed by the Sirionó Indians of eastern Bolivia (110 kg/person/year; Townsend 2000), the Huaorani of the Ecuadorian Amazon (61 kg/person/year; Mena et al. 2000), and the Aché of eastern Paraguay (45 kg/person/year; Hill and Padwe 2000). The relatively low consumption of terrestrial wildlife biomass by communities of the Lacandon Forest and the Yucatán Peninsula may be an indication that most rural people are involved in the market economy and obtain meat of domestic animals more easily and less expensively. The relatively low consumption also shows that there are a fewer full-time hunters; wildlife populations have been depleted, and now it is economically unprofitable to rely on wildlife as the main source of animal protein.

Impact on Wildlife Populations.—This study shows that hunting in the Lacandon Forest is determined not only by biological attributes of the species, such as their

reproductive productivity, but also by cultural and socioeconomic factors that influence the preferences of hunters (Naranjo 2002). Preferences of subsistence hunters appear to be having an impact on wildlife species in different ways in the Lacandon Forest. While species that are less vulnerable to overhunting (e.g., armadillo and collared peccary) are apparently maintaining healthy populations at persistently hunted sites, vulnerable species such as the tapir, the white-lipped peccary, and both primate species have been depleted by overexploitation or habitat fragmentation (Naranjo 2002). Indeed, many hunters interviewed for this study have noticed a constant decline of the most frequently harvested wildlife species around their communities over the last two decades. This decline in wildlife population has led to an increase in hunting effort and more man/hours hunting in larger catchment areas outside their own territories. This is particularly evident in the largest community, Nueva Palestina, where groups of 3–5 hunters occasionally spend up to seven days searching for prey more than 15 km from the community.

It is clear that subsistence hunting should be regulated for the benefit of both residents and wildlife populations of the Lacandon Forest. Under the current land tenure system in the area, a community-based management scheme (Bodmer and Puertas 2000) seems plausible for wildlife species, especially at Lacanjá-Chansayab, Bethel, and Nueva Palestina. These communities make up a large part of the intact rainforest of the Lacandon Forest. With the help of government agencies, conservation organizations, and local universities, people from key communities around MABR could be trained for planning and conducting model projects on sustainable wildlife use.

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APPENDIX 1.—Local names of terrestrial vertebrates used by residents of the Lacandon Forest, Mexico. Tzeltal names are based on Aranda and March (1987), and Manuel Girón-Intzin (personal communication). Lacandon names are based on Aranda and March (1987), and Baer and Merrifield (1971). MN: Mestizo names are used for these species.

Taxon	Spanish name	Tzeltal name	Lacandon name	Mestizo name
MAMMALS				
Didelphimorphia				
Didelphis marsupialis	*tlacuache común*	***uch***	***ooch***	*tlacuache*
Philander opossum	*tlacuache cuatro ojos*	***uch***	***ooch***	*tlacuache cuatro ojos*
Xenarthra				
Tamandua mexicana	*hormiguero arborícola*	***tulan k'ab***	***chab***	*oso hormiguero*
Cabassous centralis	*armadillo cola desnuda*	***mail chan***	***wai-wech***	*armadillo*
Dasypus novemcinctus	*armadillo nueve bandas*	***mail chan***	***wech***	*armadillo*
Primates				
Alouatta pigra	*mono aullador negro*	***max saraguato***	***baa'ts***	*saraguato*
Ateles geoffroyi	*mono araña*	***max***	***mash***	*chango*
Carnivora				
Procyon lotor	*mapache*	***me'el***	***a'ka'bak***	*mapache*
Nasua narica	*coatí*	***wax***	***ts'oy***	*tejón, pizote*
Potos flavus	*martucha*	MN	***ak'a'mash***	*mico de noche*
Eira barbara	*tayra*	***me'el***	***sanjor***	*viejo de monte*
Conepatus semistriatus	*zorrillo espalda blanca*	***pai***	***pai***	*zorrillo*
Lontra longicaudis	*nutria*	***jaal-tz'i***	***tsura'ija***	*perro de agua*
Herpailurus yaguarondi	*leoncillo*	***choj***	***ek-barum***	*onza, gato de monte*
Leopardus pardalis	*ocelote*	MN	***ek-shush***	*tigre cangrejero*
Leopardus wiedii	*tigrillo*	***chin balam***	***chak'shikin***	*tigrillo*
Panthera onca	*jaguar*	***balam***	***barum***	*tigre*
Puma concolor	*puma*	***balam***	***chak-barum***	*león, puma*
Perissodactyla				
Tapirus bairdii	*tapir centroamericano*	***tzimin***	***c'ash-i-tzimin***	*danta, tapir*

APPENDIX 1.—Continued.

Taxon	Spanish name	Tzeltal name	Lacandon name	Mestizo name
Artiodactyla				
Tayassu pecari	*pecarí de labios blancos*	MN	***kekem***	*jabalí, senso*
Tayassu tajacu	*pecarí de collar*	***jalal***	***kitam***	*jabalí de collar*
Mazama americana	*venado temazate*	***chij***	***yuk***	*cabrito, temazate*
Odocoileus virginianus	*venado cola blanca*	***chij***	***ke***	*venado*
Rodentia				
Orthogeomys hispidus	*tuza*	***baj***	***baj***	*tuza*
Sciurus aureogaster	*ardilla gris*	***chuch***	***cu'uc***	*ardilla*
Coendou mexicanus	*puercoespín*	***wamal chitam***	***k'ish pach***	*puercoespín*
Agouti paca	*tepezcuintle*	MN	***jareu***	*tepezcuintle*
Dasyprocta punctata	*agutí*	MN	***tsub***	*cereque, guatuza*
Lagomorpha				
Sylvilagus brasiliensis	*conejo tropical*	***t'ul***	***tu'ur***	*conejo*
BIRDS				
Tinamiformes				
Tinamus major	*tinamú mayor*	***stzumut***	***ash***	*perdiz real*
Crypturellus boucardi	*tinamú*	***chin stzumut***	***nok'er***	*perdiz*
Anseriformes				
Cairina moschata	*pato real*	***pech'***	***cusa'***	*pato real*
Falconiformes				
Micrastur semitorquatus	*halcón de bosque*	***licawal***	***sic***	*gavilán*
Galliformes				
Ortalis vetula	*chachalaca*	***chachalaca***	***bach***	*chachalaca*
Penelope purpurascens	*cojolita, pava*	***x'uman***	***cosh***	*cojolita*
Crax rubra	*hocofaisán*	MN	***c'ambur***	*faisán*
Odontophorus guttatus	*codorniz*	***tzirim***	MN	*codorniz*
Columbiformes				
Columba spp.	*paloma*	MN	***ch'ic susuwir***	*paloma*

APPENDIX 1.—Continued.

Taxon	Spanish name	Tzeltal name	Lacandon name	Mestizo name
Psittaciformes				
Ara macao	*guacamaya roja*	MN	***yajaw t'ut***	*guacamaya*
Amazona autumnalis	*loro mejilla amarilla*	MN	***t'ut***	*perico*
Amazona farinosa	*loro cabeza azul*	MN	***jach t'ut***	*perico cabeza azul*
Strigiformes				
Pulsatrix perspicillata	*buho de anteojos*	***xoch***	***ikim***	*tecolote*
Piciformes				
Pteroglossus torquatus	*tucán collarejo*	MN	***pichik***	*tucán*
Ramphastos sulfuratus	*tucán cuello amarillo*	MN	***pin***	*tucán*
REPTILES				
Testudines				
Dermatemys mawii	*tortuga blanca*	MN	***jach ak***	*tortuga blanca*
Trachemys scripta	*tortuga jicotea*	MN	***s'in ak***	*jicotea*
Kinosternon spp.	*tortuga casquito*	MN	***majan ak***	*casquito*
Crocodylia				
Crocodylus moreletii	*cocodrilo de pantano*	MN	***ayim***	*cocodrilo, lagarto*
Squamata				
Ctenosaura similis	*iguana espinosa*	MN	***juj***	*garrobo*
Iguana iguana	*iguana verde*	MN	***juj***	*iguana*
Boa constrictor	*boa*	***chan***	MN	*mazacuata*

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FACTORS AFFECTING LOCAL KNOWLEDGE OF PALMS IN NANGARITZA VALLEY, SOUTHEASTERN ECUADOR

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ABSTRACT.—Our investigation of factors and processes affecting local knowledge of natural resources focuses on knowledge loss and knowledge transfer between communities, and on the way socioeconomic circumstances affect the knowledge levels of individuals. The study took place in southeastern Ecuador in an area inhabited by an indigenous group as well as by settlers of mixed origin from other parts of Ecuador. We used quantitative statistical methods to study processes and factors affecting people's knowledge of palms. The results indicated that both loss and transfer of knowledge were taking place. Village placement and context were seen to be the most important factors with regard to people's knowledge and to the processes of knowledge loss and transfer. In addition, factors such as ethnicity and gender also seemed to play a role.

Key words: knowledge loss, knowledge transfer, marginality, quantitative ethnobotany, Shuar.

RESUMEN.—En este estudio se han investigado los factores y procesos que afectan al conocimiento local de los recursos naturales. El enfoque de nuestro trabajo se centró en la pérdida y en la transferencia de conocimiento entre las comunidades, así como también en la forma en la cual las circunstancias socio-económicas afectan al nivel de conocimiento de cada individuo. El estudio se llevó a cabo en el sureste de Ecuador, en un área habitada tanto por un grupo indígena como por colonos de origen diverso provenientes de otras partes de Ecuador. Se han utilizado métodos estadísticos cuantitativos para estudiar los procesos y factores que afectan al conocimiento de las personas en relación a las palmas. Los resultados indican que además de pérdida está habiendo transferencia de conocimiento. La situación y contexto de la aldea parecen ser los factores que más influyen en el conocimiento de las personas y en los procesos de pérdida y transferencia de conocimiento. Además los factores étnicos y de género parecen jugar también un papel relevante.

RÉSUMÉ.—Dans cette étude nous discutons des facteurs et des processus qui influent sur la connaissance locale des ressources naturelles. Nous nous intéressons surtout à la perte de connaissance, à la transmission de celle-ci entre différentes communautés et à la façon dont des circonstances socio-économiques agissent sur le niveau de connaissance des individus. L'étude s'est déroulée dans le sud-est de l'Équateur où coexistent une communauté indigène ainsi que des immigrants d'origine mixte issus de régions autres de l'Équateur. Des méthodes statistiques quantitatives ont été utilisé dans le but d'étudier les facteurs et les processus qui influent sur les connaissances des individus touchant les palmiers.

Les résultats montrent que la perte tout comme la transmission des connaissances sont des processus qui ont toujours cours en ce moment. L'emplacement du village et son contexte constituent les facteurs les plus importants en ce qui concerne les connaissances des gens et les processus de perte et de transmission. De plus, d'autres facteurs tels que l'ethnicité et le sexe semblent également jouer un rôle.

INTRODUCTION

Local or traditional knowledge and management systems have in recent decades become increasingly used as models for sustainable development and resource utilization (Coomes 1995; Gliessman 1992). However, local technologies and knowledge of resource utilization as well as the natural environments they deal with seem to be rapidly disappearing (Bennett 1992; Benz et al. 2000; Dasmann 1991; Joyal 1996; Ladio 2001; McNeely 1992). This has lead to two different approaches among researchers and practitioners of conservation and local resource management. One approach has been to make as many and detailed as possible inventories of local knowledge of plants and animals before this knowledge is irretrievably lost. Records of the knowledge are then published and/or stored in databases together with corresponding voucher specimens, where they may be more or less accessible to the general public and to the people from where it originated in particular (Agrawal 1995). The other approach focuses on the ways knowledge and management systems evolve, how people adapt to changing circumstances, which factors influence their decision making and how knowledge is accumulated, transmitted and lost (Alcorn 1995; Brodt 2001; Coomes 1995; Oldfield and Alcorn 1987; Ruddle 2000; Wiersum 1997).

The philosophy behind the first approach is related to biological *ex situ* conservation in gene and species banks advocated by some conservationists. However, this approach to nature and knowledge conservation has been criticized for trying to preserve a frozen picture of knowledge, practices or gene pools of one moment in time, removed from its natural and cultural context (Agrawal 1995; Oldfield and Alcorn 1987). The second approach, too, has a counterpart in the fields of ecology and conservation, where recent decades have seen an increasing focus on dynamics and processes (Simberloff 1988). The two approaches should, however, not be seen in opposition to each other, but instead as complementary with their differing foci: the first one being more static and content-oriented, the second one being more dynamic and process-oriented. Our study belongs to the more process-oriented kind, focussing on knowledge loss, transmission and transformation, and on how social and economic factors might influence these processes.

Knowledge Loss and Acculturation.—Knowledge loss is often seen as the consequence of what is called acculturation processes, which can be divided roughly into two categories, "loss of interest" and "loss of learning opportunities," although it is not always possible to distinguish clearly between the two.

Loss of interest in traditional or local knowledge about plants and other natural resources can be due to the availability of alternative industrially manufactured products and opportunities for alternative livelihood strategies, such as wage work, cash-oriented agriculture, or migration to urban centers (Anyinam

1995; Benz et al. 2000; Joyal 1996; Ladio 2001; Ladio and Lozada 2001). People may prefer these alternatives because they are perceived to be superior (Sillitoe 1998) or because traditional practices are time consuming or stigmatized, especially those of ethnic minorities (Luoga et al. 2000). Often, alternative livelihood options depend on proximity to urban centers, which gives access to a greater variety of consumer goods and to services such as schooling and health care (Zent 1999).

Loss of opportunities for learning may be due to the disappearance of whole vegetation types or particular species that formerly provided important natural resources to local communities (Anyinam 1995). Extinction or decline of plants and animals quickly leads to the demise of detailed associated knowledge, though some anecdotal information or stories about certain ancient uses may persist. Other factors leading to knowledge loss include efforts by national or religious authorities to integrate or assimilate minority groups. Such efforts, whether in the name of civilization, religion, economy or conservation, may include incentives for or prohibition of traditional practices or resource use (Anyinam 1995; Zent 1999). Nationalization or privatization of community resources may lead to changes in resource use practices and loss of the associated knowledge as well.

Imposition of a national language and schooling system, which may eliminate the idioms in which knowledge is embedded and the time available for learning, observing and practicing more traditional knowledge and technologies may inhibit transmission of traditional knowledge of resources (Benz et al. 2000; Luoga et al. 2000; Ohmagari and Berkes 1997). Likewise, emigration to urban centers often interrupts the transmission of local knowledge, which in large part may have to be learned through practice and observation in close proximity to the resources themselves rather than through language (Sillitoe 1998).

Knowledge Transfer and Transformation.—Even if traditional knowledge is not lost, it may be transformed, as new technologies and products are incorporated into local or traditional knowledge systems. These processes occurred in ancient and recent times, and continue to this day (Agrawal 1995; Brodt 2002). Not only do "traditional" peoples incorporate new, modern technologies, but nonindigenous or immigrant groups also sometimes acquire local knowledge and resource management systems. The most well-known example is probably that of the Amazonian *ribereños* or *caboclos,* small-scale farmers of mixed origin who settled along rivers in the Amazon basin several hundred years ago (e.g., Hiraoka 1995). These "neo-traditional" groups (Begossi 1998) have developed successful subsistence systems incorporating elements learned from indigenous as well as nonindigenous sources. Another Amazonian example of newcomers' knowledge accumulation is that of Japanese immigrants to Brazil who, within fifty years, have managed to develop an intensive and apparently sustainable form of cash-oriented agriculture (Subler and Uhl 1990). In addition to exchanges between areas and communities, *in situ* development of new techniques, products and resources continuously happens within communities, leading to the creation of new practices and knowledge and to the loss of the old ones.

Importance of Socioeconomic Factors.—How knowledge loss, transfer, and creation balance each other depends on a multitude of factors, both within the human

communities, and in the social, political, economic and ecological environment. Among the most often mentioned influential factors are gender, age, education, and wealth. The effect of these may yet depend on other factors and therefore vary from setting to setting. For example, differences in men's and women's knowledge will depend on the degree of gender-related division of labor in a society (Berlin et al. 1981). Wealth may also have different effects depending on specific circumstances. Wealthier people may or may not have an interest in promoting common resource management systems depending on potential gain and availability of other options (Holmes 2003; Varughese and Ostrom 2001). Similarly, increasing formal education has in some cases been associated with a decrease in local environmental knowledge (Luoga et al. 2000; Ohmagari and Berkes 1997); at other times, it has lead to more sustainable resource use practices and environmental awareness (e.g., Godoy 1994). Nevertheless, with an increasing number of studies based on comparable quantitative methods we hope it will be possible to identify more general mechanisms lying behind the varying influence of factors such as education or wealth.

Processes of knowledge loss, transfer and transformation, and the importance of socioeconomic factors are the subject of this study, which took place in the Andean foothills of southeastern Ecuador sloping down towards the Amazon basin. The area is inhabited by the Shuar, an indigenous group with additional settlements further down in the Amazon basin. Within the last five decades, settlers of mixed ethnic origin have arrived from the Andean highlands in search of land, bringing very different agricultural practices and ways of life. This setting is representative of what is happening in many places, not only in the rest of South America, but also in other parts of the world. Apart from its representativeness, the juxtaposition of two different communities with different histories, cultures, and experiences provides a good opportunity to study processes such as knowledge loss and knowledge transfer within changing human and natural contexts. Although dynamic processes ideally would be investigated through long-term studies, research reality seldom allows this. Instead, inferences about ongoing processes of knowledge loss and knowledge transfer can be made by analyzing patterns of knowledge distribution at one moment in time (Zent 1999). This is the approach followed in the present study, focusing on the following three questions related to changes in knowledge:

First, to what degree does acculturation lead to knowledge loss among the indigenous population of the area? We address this question by looking at the age-related distribution of knowledge (see Phillips and Gentry 1993). We expected that older generations would have significantly more knowledge than younger ones. Such a pattern can be either a result of lifelong learning and gradual knowledge accumulation or of knowledge erosion. In the case of knowledge erosion, however, we would expect that there would be a more pronounced knowledge gap between different age groups, because knowledge loss often is a very abrupt process (e.g., Hanazaki et al. 2000; Phillips and Gentry 1993). In addition to age-related patterns, we recorded whether certain reported practices or uses had disappeared from the area.

Second, to what degree is knowledge transfer taking place? Much learning takes place early in life (Zarger 2002). Individuals will, however, keep accumu-

lating as well as modifying and re-evaluating knowledge throughout life on the basis of present and past personal experiences (Garro 2000). Therefore, we investigated whether people's birthplace and residence time in the area had an effect on their knowledge levels. In addition to comparing how much people knew we also compared what they knew, i.e., what plant species were used for which purposes. Similar use of the same plants would indicate knowledge transfer between the two ethnic groups.

Third, is it possible to identify factors operating at the scale of the individual, household, village, or community that affect people's knowledge levels? Especially in situations where the social, economic and physical environment is rapidly changing, it is important to know which factors influence knowledge in which ways. We used quantitative statistical analyses to identify socioeconomic factors that show relationships with people's knowledge levels. Although statistical correlations do not prove causal relationships and are prone to many sources of error, we believe they can be used profitably as the basis of cautious interpretations. Moreover, quantitative statistical methods make it easier to conduct comparisons between different studies and settings and, with an increasing number of studies available, may in time enable us to discern specific from general tendencies.

STUDY AREA

The field work took place in a part of the Nangaritza river valley (lat. 4°14′–4°26′ S, and long. 78°37′–78°40′ W) in southeastern Ecuador in Zamora-Chinchipe province. At 800–1000 m above sea level, the area is located between the Andean cordillera and the Amazon basin. Partly as a consequence of this transition zone placement the area is characterized by high biodiversity. The natural vegetation consists of lower montane rain forest (Neill 1999), which so far has been spared large-scale destruction (Palacios 1996).

The original inhabitants of the area belong to the ethnic group of the Shuar, also sometimes called Jívaro. Both names have sometimes been used as a general term referring to five different but related ethnic groups. Here we use the name "Shuar" in a more restricted sense, referring to the group that sometimes has been denoted "Untsuri Shuar" in the literature (Bennett et al. 2002; Descola 1996; Harner 1972). The traditional way of life of this group was seminomadic and based on swidden agriculture. People lived in isolated family households, periodically shifting their habitation whenever essential resources such as game or certain wild plants became scarce.

Today, the Shuar in the Nangaritza valley live in permanent villages along the main river and its tributaries. They practice a form of swidden agriculture, growing traditional staples along with some cash crops and raising livestock. Villages usually consist of a nucleus comprising a school, soccer field, community building, and up to twenty households, with additional households located within an hour's walk of the village center. The Shuar are one of the most well organized ethnic groups in Ecuador and have their own local administrative units and a national federation. The federation represents the interests of the Shuar vis-à-vis the national state and is actively taking steps with regard to the preservation of their culture, e.g., in the form of written publications in their own language. It

also actively provides modern commodities, such as radio communication equipment, and secures support from various Ecuadorian as well as foreign nongovernmental organizations (NGOs). Schools in Ecuador may teach in indigenous languages as well as in Spanish. In the study area, not all of the schools in the Shuar villages had teachers who were themselves Shuar and who could teach the children in Shuar. Nearly all of the Shuar in the area spoke and understood Spanish and interviews were conducted in Spanish, although plant names were recorded in Shuar. Shuar plant names have generally been spelled as indicated by informants.

In addition to the Shuar, colonists of mixed origin have arrived in the area since the beginning of the 1960s (Palacios 1996). Most of them originally came from highland areas (2000–3000 m) in the neighboring province (Provincia de Loja) near the towns of Amaluza and Saraguro. The climate in these areas is both drier and cooler. The vegetation around Amaluza consists of dry scrub vegetation and montane evergreen forest, while the vegetation around Saraguro is described as consisting of shrub vegetation and evergreen montane forest (Balslev and Øllgaard 2002; Neill 1999). In addition, grass *páramos* (Andean vegetation above the timberline) are found in the more elevated parts (> 2900 m) in both areas. The colonists mostly make a living as farmers cultivating subsistence and cash crops, to varying degrees engaging in cattle farming and timber extraction (Schulenberg and Awbrey 1997). These latter cash-oriented activities are more prominent among the colonists than among the Shuar.

Seven different villages (five Shuar villages and two colonist ones) are included in this study. The villages differ in size (ranging from 30–40 inhabitants to a few hundred), available facilities (such as village shops, church, school, and radio contact), setting, and accessibility. The most accessible village has electricity as well as a water supply and can be reached from the nearest road within an hour by boat (at the time of the study a road to this village was under construction). In contrast, the most remote villages can be reached only after three to four hours by boat and/or several hours of walking; these settlements generally lack electricity (apart from petrol or solar generators in some) and sometimes sanitary installations.

METHODS

Fieldwork was carried out from March through July 2001 and consisted of an interview survey of people's use and knowledge of palms and the collection of voucher specimens.[1] Altogether 90 interviews were conducted with 29 colonists and 61 Shuar. We attempted to conduct interviews with representatives of 10–20 households in each village (depending on village size) and to include about equal numbers of men and women (51 and 39, respectively) as well as representatives of different age groups (the youngest interviewee was 15 and the oldest one 75 years old).

Interviews were conducted with a fixed questionnaire covering the interviewees' socioeconomic situation (age, income, education, family size, etc.) as well as their knowledge of useful palms. Questions regarding palms were open-ended and centered around different use-categories established *a priori* and had the fol-

lowing form: which palms can be used for . . . [use category]? Researcher-determined categories were used in order to facilitate quantification and comparison between the two communities of different ethnic background. The use categories employed in the questionnaire were: "food," "construction," "medicine," "tools and artisanry," "firewood," "religious, ritual or decoration purposes," and "other uses." In addition, interviewees were asked if there were any palm uses or products that had gone out of use. The questionnaire was administered in Spanish, which was spoken fluently by all colonists and Shuar informants. Local palm names were recorded in Spanish or Shuar and as far as possible matched with voucher specimens and in the field. The local names were used as the basis for the analyses.

Palms were chosen as "model plants" for the study because they constitute a generally well recognized plant group among local people. Therefore, misunderstandings between researchers trained in western sciences and local people based on different concepts of plant groups can largely be avoided when working with palms. One exception to this was the case of the Panama hat plant, *Carludovica palmata* Ruiz & Pav. (Cyclanthaceae), which was sometimes mentioned during interviews as a useful palm even though it is not in the Arecaceae; in these cases, we included it in the analysis as part of those informants' emic category of useful palmlike plants. Most informants did clearly group the Panama hat plant and other Cyclanthaceae on one hand and the palms on the other.

Palms are among the most useful tropical plants and are abundant in the western part of the Amazon basin (Henderson et al. 1995). We have shown that Shuar and Mestizos recognize palms as a group, which suggests that they have a conceptual framework that would allow them to easily integrate knowledge about newly encountered palms by observation and experimentation.

In Ecuador, palms are used, cultivated or tended, and are generally considered very useful by rural people in most parts of the country, including the highlands (Borchsenius et al. 1998), where most of the colonists came from. We assumed that colonists would be favorably disposed towards learning about and experimenting with palms in their new surroundings, even though they had never before encountered the palm species present in the Nangaritza area. Therefore, palms should provide a good test case for investigating knowledge transfer between indigenous people and colonists and for discovering how quickly and to what degree newcomers adapt to the local natural environment.

Different measures of palm knowledge were calculated (Table 1). The simplest way to measure people's knowledge level is to count the number of species and uses they know. In addition, each person's relative knowledge (based on both number of uses and number of species known) compared to the "average informant" was calculated.

Multiple regression was used to test for statistical relationships between socioeconomic factors and palm knowledge. A backward elimination procedure was employed to select which factors should be included in the final model. Significance (at $\alpha = 0.05$) of the factors and of the model was evaluated by means of permutations (using *Permute! 3.4,* Casgrain 2001). The number of permutations was in all cases 999. The different measures of palm knowledge were employed as dependent variables in separate analyses, while the socioeconomic data listed

TABLE 1.—Dependent variables used in the analyses and the average values for these variables, as well as minimum and maximum values (in parentheses) found in the study and standard deviations.

Dependent variable	Description	Mean value (min; max)	Standard deviation
Number of palms	Total number of folk species a person mentioned as useful during the interview	5.4 (1;13)	2.75
Number of uses	Total number of uses a person knows summed across all palms she knows	14.12 (1;40)	8.05
Relative use value (RUV_i)	A measure of a person's knowledge relative to that of other people in the survey; calculated as the number of uses a person knows for a species divided by the average number of uses people know for this species and subsequently summed for all species and divided by the number of useful species	1 (0.015;12.64)	1.86

in Table 2 were used as independent (explanatory) variables. An aggregate variable called "wealth" was constructed by standardizing and summing all economic indicators (resulting in values between 0 and 1). Analyses were carried out once with this aggregate measure as one of the independent variables and once with all the separate economic variables, but without the aggregate variable. The multiple regression was used to simultaneously investigate our three main questions

TABLE 2.—Independent variables used in the analyses.

Independent variable	Variable type
Village	Nominal (7 levels)
Age	Continuous
Gender	Nominal (2 levels)
Ethnicity	Nominal (2 levels—Shuar and colonist)
Civil state	Nominal (2 levels—married and single)
Family size	Continuous (number of people in household)
Education	Continuous (years of formal school attendance)
Birthplace	Ordinal (3 levels—highlands, Amazon; Nangaritza valley study area)
Time in residence	Continuous (% of a person's lifetime spent in the area)
Number of small animals	Continuous (sum of chicken, ducks, guinea pigs, and turkeys a person owns)
Number of large animals	Continuous (sum of pigs, cows, and horses a person owns)
Number of crops	Continuous (0–12)
Farm size	Continuous (ha)
House materials	Aggregate ordinal (6 levels; the sum of the two separate ordinal values for roof and wall/floor materials respectively)
Wealth	Aggregate continuous (values ranging from 0 to 1 constructed by standardizing and summing the variables "no. of small animals," "no. of large animals," "no. of crops," "farm size," and "house materials"

(concerning knowledge loss, knowledge transfer and socioeconomic factors influencing knowledge levels). Knowledge loss was investigated by testing for an effect of age; knowledge transfer was investigated by testing for an effect of birthplace and residence time. The remaining independent variables (Table 2) were included to investigate possible sources of within-community heterogeneity.

Distribution and diversity of palm knowledge of colonists and Shuar was in addition compared by means of rank-abundance diagrams depicting the richness and abundance of uses and species known (Benz et al. 2000). Rank-abundance diagrams give an indication of how evenly knowledge is distributed within a community and whether high average knowledge levels are due to few very knowledgeable informants or evenly distributed knowledge among members of a community. To make rank-abundance diagrams for the two communities comparable despite differences in sample size, random samples of the same size as the colonist sample were taken from the Shuar sample and were ranked. This was repeated 100 times and on the basis of these 100 subsamples an average rank abundance curve for the Shuar was created.

RESULTS

Uses of 25 different folk species were recorded (Table 3). More detailed descriptions of the different applications of palms have been provided elsewhere (Byg 2002). There was considerable spread in the number of palms as well as number of uses reported by individual people (Table 1). No vouchers could be obtained for some palms that were mentioned only few times and that were said to be very rare or to be found only in other areas. These have nevertheless been included in the analyses as "folk-" or "ethno-species" (Phillips et al. 1994), and their identity has been inferred from relevant literature to the extent possible.

Knowledge Loss and Acculturation.—No significant effect of age on any of the knowledge indicators was found. Twenty-six informants reported outdated uses (mainly weapons/hunting gear and construction materials) for altogether nine palm species (Table 3). Rank abundance curves based on the number of uses and number of species known (Figure 1) were of a sigmoidal shape, similar for both communities, indicating a more or less normal distribution of knowledge. The curve for Shuar was, however, placed higher than the curve for colonists, indicating higher average knowledge levels among Shuar informants both with regard to palm uses and species.

Knowledge Transfer.—Neither birthplace nor residence time showed any significant relationship to palm knowledge in the multiple regression analyses.

Socioeconomic Factors.—The most important factors related to palm knowledge in our analyses were ethnicity, village location, gender, civil state, education, and different measures of agricultural practices (Table 4, Figures 2, 3). However, there were significant interactions between village location and most of the other variables, which implies that the relationship found between, e.g., people's education and palm knowledge depends on which village they live in. In addition, there

TABLE 3.—Folk species and their uses mentioned in 90 interviews comprising indigenous as well as nonindigenous people in seven villages in the Nangaritza valley in southeastern Ecuador.

Species (voucher no.) Local name (***Shuar***, *Spanish*)	Uses (no. of reports)	Previous uses (no. of reports)
Aiphanes weberbaueri Burret (JV680) ***awant***	Heart (3); fruits (2); drink (1)	Fruits: juice
Aphandra natalia (Balslev & A.J. Hend.) Barfod (no voucher, Bennett et al. 2002; Borchsenius et al. 1998) ***tinktiuki***	Heart (1); fruits (1)	—
Astrocaryum chambira Burret (no voucher, Bennett et al. 2002; Borchsenius et al. 1998) ***kumai***	Heart (1); fruits (1)	—
Bactris gasipaes Kunth (Byg28) ***uwi***, *chonta*	Heart (69); fruits (72); drink (14); larvae (5); thatch (1); hunting gear: bows (2), blowgun (14), spear (14); firewood (23); decoration: blowgun (1), fruits (1), leaves (3), spears (5); medicine: unknown (1), heart—anti-infectious (1), ear pain (7), purification (1), pain (1), leaves—ear pain (1); other: fruits—fodder (2); leaves—fodder (1), woven cloth (1); stem—musical instruments (1), furniture (2), flag pole (1), tiles (1), water container (2)	Stem: blowgun (5), bow (1), musical instruments (1), spear (7); leaves: ear pain (1), woven cloth (1)
Bactris setulosa H. Karst. (photo) ***kamanchar***	Heart (4)	—
Carloduvica palmata (Byg38) ***pumpuná***, *pajo toquillo*	Heart (3); thatch (2); other: leaves—woven fabrics (1), hats (1)	—
Ceroxylon amazonicum Galeano (photo) ***paik***, *ramo*	Decoration: leaves (7)	Leaves: Easter decorations (1)
Euterpe precatoria Mart. (Byg65) ***sakae***	Heart (30); fruits (1); house posts (4); thatch (3); hunting gear: bows (2), blowgun (2), spear (2); other: leaves—hats (1), traditional woven clothes (1)	Stem: blowgun (2), bows (1), spears (2)

TABLE 3.—Continued.

Species (voucher no.) Local name (***Shuar,*** *Spanish*)	Uses (no. of reports)	Previous uses (no. of reports)
Geonoma sp. (Ruiz & Pav.) Mart. or *G. deversa* (Poit.) Kunth (no voucher, Bennett et al. 2002; Borchsenius et al. 1998) ***turuji***	Thatch (1)	—
Hyospathe elegans Mart. (Byg50) ***takanak***	Thatch (1)	—
Iriatea deltoidea Ruíz & Pav. (Byg44) ***ambakai,*** *cacho de toro, palma negra, pambil, palma*	Heart (75); fruits (10); larvae (3); house posts (61); thatch (50); hunting gear: blowgun (7), bows (2), spear (19); firewood (55); decoration: leaves (3), spears (4), stem (1), carved figures (1), blowgun (1), unknown (1); Medicine: heart—purification/purgative (1), malaria (1), bile (1); other: stem—furniture (3), fences (3), flag pole (4), animal pens/stables (2), support for banana plants (1), tiles (1), wood work (1), temp. knife (1); young leaves—broom (1)	Stem: blowgun (1), bows (1), tiles (1), furniture (1), carved figures (1), fences (1), spear (4); heart: bile (1), purification (1); leaves: thatch (1)
Mauritia flexuosa L.f. (photo) ***achu***	Heart (29); fruits (26); larvae (1)	—
Oenocarpus bataua Mart. (Byg33) ***kunkuki,*** *palma real*	Heart (61); fruits (43); larvae (9); house posts (1); thatch (4); hunting gear: spear (2), darts (4), blowgun (1), dart container (1), fish trap (7); basketry (5); firewood (5); decoration: cultivated as ornamental tree (1), leaves (14), dart container from young leaves (1); medicine: unknown (1), fruits—hair loss (1); heart—purification (1); other: fruits/seeds—key ring (1), oil (2); leaves—broom (4), candle sticks (1), fodder (1), dart container (1); shade tree for cattle (1), spoon (1)	Heart and fruit: food (1)

TABLE 3.—Continued.

Species (voucher no.) Local name (***Shuar, Spanish***)	Uses (no. of reports)	Previous uses (no. of reports)
Oenocarpus mapora H. Karst (Byg49, Byg66) ***shimbi***	Heart (10); fruits (9); house posts (3); thatch (8); hunting gear: darts (2), fish trap (7), spear (1); basketry (3); firewood (1); decoration: leaves (1)	—
Pholidostachys synanthera (Mart.) H.E. Moore (no voucher, Bennett et al. 2002) ***kampanak***	House posts (2); thatch (14)	—
Phytelephas tenuicaulis (Barfod) A.J. Henderson (no voucher, Borchsenius et al. 1998; Henderson 1995) ***chapi***	Heart (1); fruits (1)	—
Prestoea ensiformis (Ruíz & Pav.) H.E. Moore (Byg39) ***tinkiwi***	Heart (46); fruits (5); house posts (4); thatch (19); hunting gear: arrows (1), blowgun (1), spear (1); basketry (2); firewood (1); decoration: leaves (2); other: young leaves—woven fabrics (1); spoon (1)	—
Socratea exorrhiza (Mart.) H. Wendl. (Byg48) ***kupat***	Heart (8); house posts (4); thatch (2); firewood (1); Medicine: heart—snake bite (4); other: stem—furniture (2); leaves—branding of canoes (1)	Heart: food (1); stem: house posts (1), furniture (1); leaves: thatch (1)
Wettinia maynensis Spruce (Byg31 & Byg32) ***terena,*** *huevo de toro, palma blanca, pambil*	Heart (16); fruits (1); larvae (2); house posts (57); thatch (64); hunting gear: blowgun (6), bow (2), spear (17); firewood (43); decoration: leaves (4), spears (2), stem (1); other: leaves—broom (6); stem—fences (1), flag pole (1), hen house (1), temporary knife (1)	Stem: blowgun (1), bow (1), spear (5), thatch (1),
? (no voucher) ***jiri***	Thatch (1)	—
? (no voucher) ***sakaeyam***	Heart (1); fruits (1)	—

TABLE 3.—Continued.

Species (voucher no.) Local name (***Shuar***, *Spanish*)	Uses (no. of reports)	Previous uses (no. of reports)
? (no voucher) ***shinki***	Heart (1); fruits (1); larvae (1); house posts (1); thatch (1); hunting gear: bow (1), blowgun (1)	Stem: blowgun (1), bow (1)
? (no voucher) ***wiantiam***	Heart (1); fruits (1)	—
? (no voucher) ***wuanka***	Heart (4)	—
? (no voucher) ***yayu***	Heart (6)	—

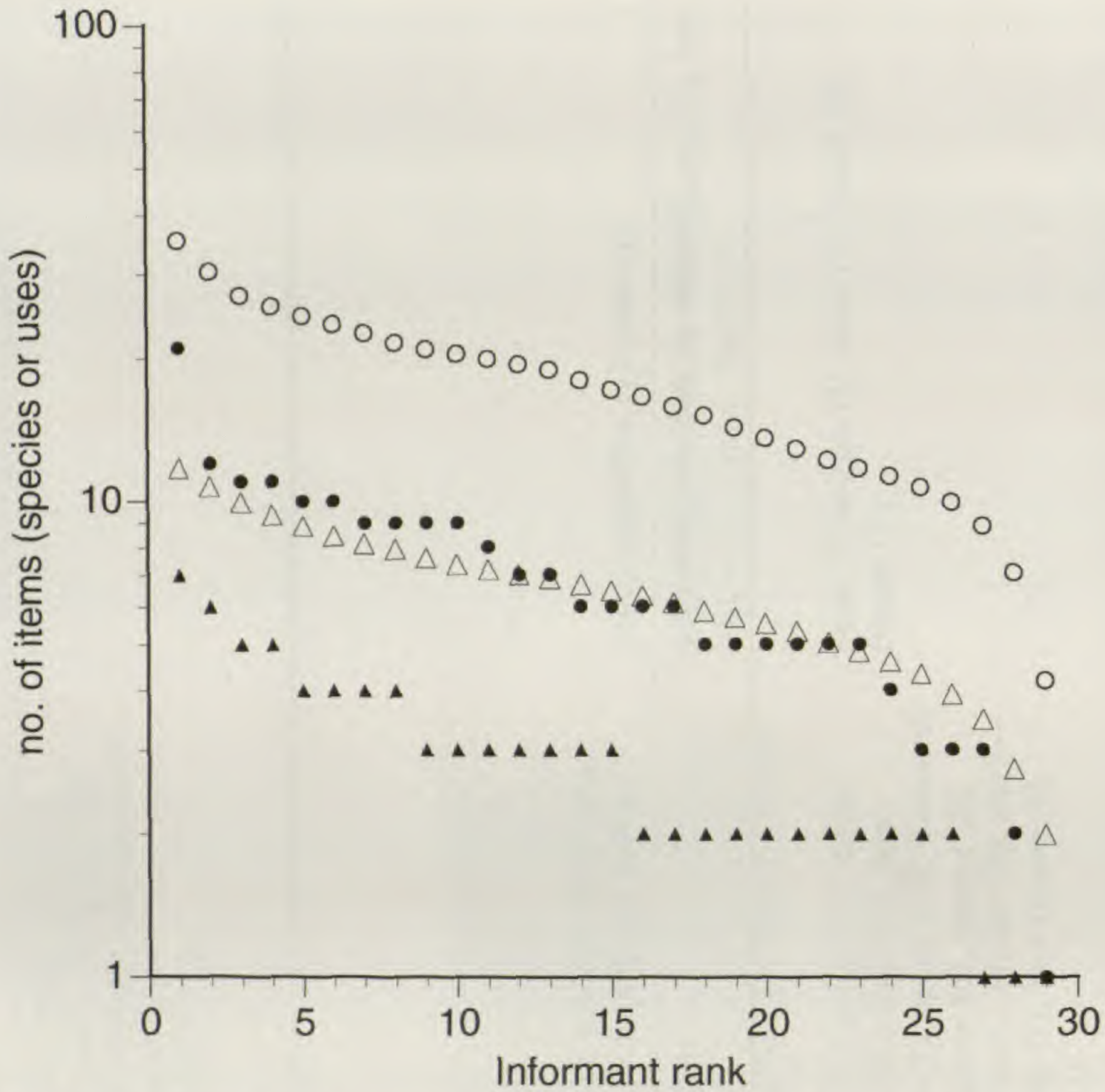

FIGURE 1.—Rank-abundance diagram for the number of palm uses (circles) and species (triangles) known by Shuar (clear symbols) and colonists (filled symbols), respectively. To obtain equal sample sizes for the two communities, 100 random samples of 29 interviewees were taken from the Shuar data set, and in each sample interviewees were ranked according to the number of uses or species known to create an average rank-abundance curve.

were also interactions between ethnicity and the variables gender and education. Despite these interactions, a few general tendencies can be discerned: Shuar have on average higher knowledge levels than colonists, men have higher knowledge levels than women, and married persons know more than unmarried persons. In addition, there was a positive relationship between the length of formal education (years of school attendance) and wealth on the one hand, and palm knowledge on the other hand. In models where the aggregate variable "wealth" was split up into its components, it was mainly the number of farm animals owned which was found to be significant, but no clear tendencies could be discerned as the relationship differed between villages.

For the dependent variable "relative use value" (RUV_i), no significant model was obtained with the aggregate variable "wealth." However, a near-significant model containing the independent variables village, age, gender, ethnicity, education, and the interactions ethnicity*gender, ethnicity*education, village*gender, and village*education was obtained.

TABLE 4.—Results of multiple regression analyses (carried out as a backward elimination procedure) of the relationship between various socioeconomic variables and people's knowledge of palm uses in seven villages in southeastern Ecuador. R^2 values indicate the proportion of variation explained by the model. Terms in brackets indicate the nature of a relationship where it was possible to discern general tendencies across all villages and ethnic groups. P-values should only be seen as approximate indicators of the significance of the models as the repeated testing in stepwise analyses leads to an inflation of α-levels (Sokal and Rohlf 1995).

Dependent variable	No. of uses known	No. of palms known	RUV_i
Model with aggregate variable "wealth"	village gender (men > women) ethnicity (Shuar > colonists) civil state (married > single) education (+) ethnicity*gender village*education village*gender $R^2 = 0.71$, $P = 0.001$	village gender (men > women) ethnicity (Shuar > colonists) civil state (married > single) education (+) wealth (+) ethnicity*gender ethnicity*education village*gender village*education village*wealth $R^2 = 0.80$, $P = 0.001$	no significant model could be obtained
Model without aggregate variable "wealth"	village gender (men > women) ethnicity (Shuar > colonists) education (+) ethnicity*gender ethnicity*education village*gender village*education $R^2 = 0.46$, $P = 0.01$	village gender (men > women) ethnicity (Shuar > colonists) education (+) large animals ethnicity*gender ethnicity*education village*gender village*education village*large animals $R^2 = 0.76$, $P = 0.001$	village gender (men > women) ethnicity (Shuar > colonists) education (+) large animals crops (+) ethnicity*gender ethnicity*education village*gender village*education village*large animals village*crops $R^2 = 0.76$, $P = 0.02$

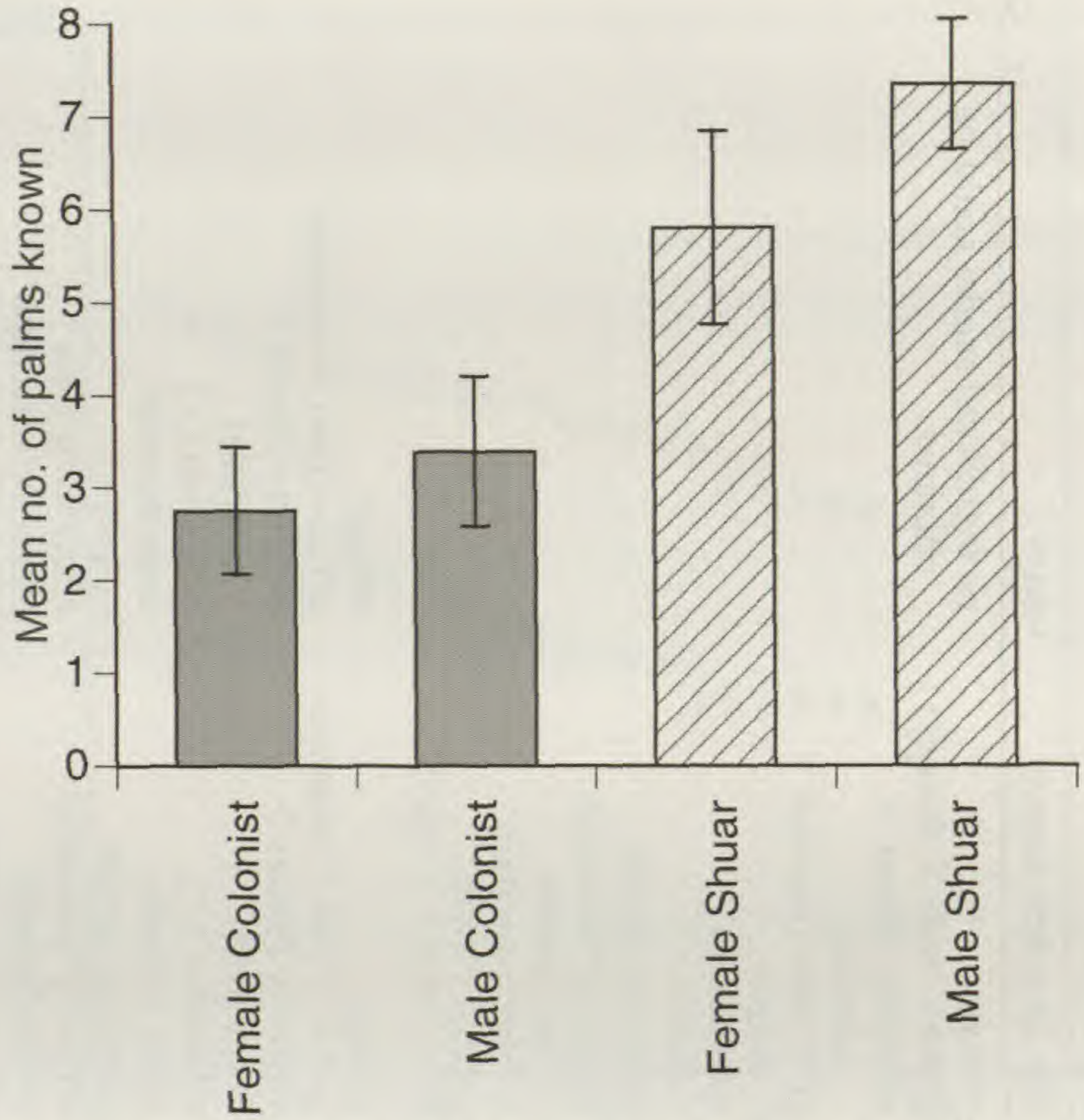

FIGURE 2.—Average palm knowledge for women and men in two different ethnic groups in the Nangaritza river valley in southeastern Ecuador. Error bars represent 95% confidence limits generated through permutation (without taking differences between villages into account).

DISCUSSION

Knowledge Loss and Acculturation.—The multiple regression analyses did not give any indications of knowledge loss among the Shuar: there were no clear tendencies for old people to know more about palms than young people. Neither did rank-abundance diagrams give indications of knowledge loss: the flat sigmoidal shape of the rank-abundance curve indicates that knowledge is approximately normally distributed and generally shared within the Shuar communities, with few people exhibiting either very highly or very low knowledge levels and the knowledge of the majority of people lying in between these two extremes. In the case of knowledge loss or expert knowledge, it would be expected that rank-abundance curves would be much steeper with few people (old ones or experts) having high knowledge levels and the majority having low knowledge levels.

Despite the lack of statistical and numerical support, we found anecdotal evidence of knowledge erosion in the form of people's own perceptions. Older people would complain about the younger generation's lack of knowledge. In addition, Shuar informants would often refer to a Shuar community living on the other side of the nearby border with Peru as leading more traditional life styles and using many more palm products. This impression seems to be reliable and not the result of mystification of the unknown other or "lost tribes" on the other

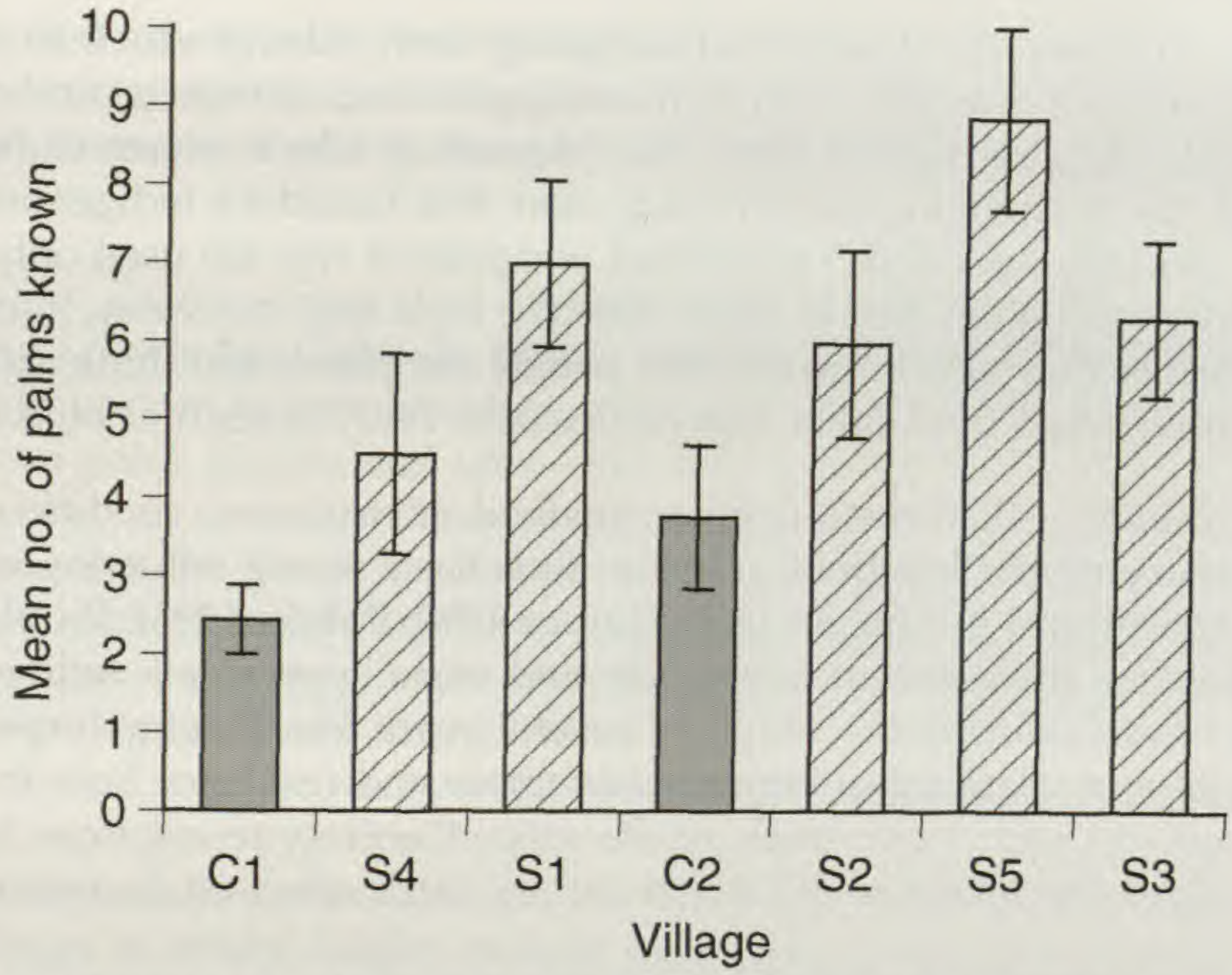

FIGURE 3.—Knowledge levels in seven villages in south-eastern Ecuador expressed as mean number of palms people knew. Hatched bars represent Shuar villages (S1–S5) and dark bars Colonist villages (C1–C2). Villages are arranged in order of approximate transportation time to nearest road with most accessible villages to the left. Error bars represent 95% confidence limits generated through permutation.

side of the border, since there were frequent visits between the two communities. The villages on the Peruvian side of the border are more marginal with regard to market access and transportation opportunities, which makes it plausible that they maintain traditions and practices which have been abandoned in the more accessible Ecuadorian villages.

In our study area, the Shuar village with highest average knowledge of palms (S5 in Figure 3) was one of the most remote, in the sense that it was situated along a tributary river, and people had to walk for two hours just to reach boat transport. Also, this village exhibited the more traditional low-density residence pattern rather than a centralized village pattern as in the other settlements. Houses were constructed over a broad area with a minimum walking distance of 10–15 minutes between neighbors. In contrast to the other villages, village S5 had not received much support from NGOs or the state for facilities such as health service, plumbing, or a school; in every sense of the word, it is more marginal than the other villages. In another physically remote village (S3 in Figure 3), more outside assistance had been offered (partly as a reaction to damages inflicted in this village by a severe flooding event in the area). Here, the village consisted of a core of government-built houses and a new school around a central square. Knowledge levels were much lower in this village than in village S5.

Marginality *vs.* availability of modern goods and services is decisive in determining the persistence of local knowledge and use of plant products (Begossi 1996; Benz et al. 2000; Gertsch et al. 2002; Ladio 2001). Replacement of palm products with modern goods seems also to have played an important role in the

Nangaritza area. Informants reported switching from palm products to manufactured alternatives if available, such as hunting gear (e.g., shotguns) and construction materials (e.g., corrugated iron). Use of some products seems to have been abandoned due to changing customs; e.g., now that Ecuador's indigenous groups have been officially "pacified," traditional weapons of war are used only for decoration. Overexploitation due to more effective tools and increasing human population densities may also influence how people use plants and think about them, as has been reported from other areas (Anyinam 1995; Gertsch et al. 2002).

Knowledge Transfer.—Birthplace (similar lowland environment *vs.* different highland environment) and length of residence time has a strong influence on people's choice of agricultural techniques (e.g., Dufour 1990; Pichón 1996). People settling in an unfamiliar environment adopt new and more appropriate techniques and knowledge slowly during the course of several years. We therefore expected that there would be a relationship between birthplace and residence time in the area on one hand and knowledge levels on the other. Contrary to our expectation, the multiple regression analyses did not show any such effect on knowledge about palms.

There were, however, indications of some knowledge transfer from Shuar to colonists. The same species were used for similar purposes both among colonists and Shuar (data not shown). Comparisons among different indigenous groups in the Amazon show that different uses for the same species and use of different species for the same purpose have evolved in the course of time in environments with overlapping species sets (Borchsenius et al. 1998; Gentry 1992; Kvist and Holm-Nielsen 1987). Therefore, it is highly unlikely that Shuar and colonists could have arrived at the same solutions as a result of parallel technical evolutionary processes. This hypothesis is supported by the fact that the colonist village, where people on average knew most about palms (C2 in Figure 3), was situated furthest from the road and closer to a Shuar village than any other colonist village. Both factors may promote knowledge accumulation among colonists. The long distance from roads and markets makes it difficult to sell agricultural products and to obtain external goods, promoting self-reliance and an incentive to use locally available products. At the same time, the proximity to the Shuar, who often came to this colonist village to obtain basic consumer goods from the small village shop, provided more opportunities to exchange knowledge and promote friendly relationships between members of the two communities. The importance of social contacts between ethnic (and other) groups in the promotion of knowledge transfer has been documented among different groups of colonists and indigenous people in one region in Guatemala (Atran et al. 2002). Further support for the importance of interethnic contact is provided by the fact that many of the non-indigenous colonists in village C2 provided Shuar names for palms rather than Spanish names.

Knowledge did not only seem to be transferred from Shuar to colonists, but also among Shuar themselves. For example, on several occasions we observed people bringing back "exotic" palms (i.e., not native to this area) from visits to relatives or friends in other parts of the Ecuadorian Amazon or people told us about palm species or uses they had observed in other places. This indicates that

also so-called "traditional" knowledge and practices are constantly undergoing changes and transformations as has also been shown elsewhere (Brodt 2002), adding more perspectives and challenges to the issue of knowledge loss and conservation.

Socioeconomic Factors.—Several of the factors we analyzed exhibited relationships with palm knowledge (Table 4). Ethnic identity and village location emerged as the most important factors. Members of the Shuar communities knew on average many more palm species and uses than did colonists (Figure 2), which is also illustrated by the rank-abundance diagram (Figure 1). This is hardly surprising, considering that the Shuar are native to the area and their collective knowledge system has evolved in this area over a long time span.

Differences between villages seemed partly to be related to remoteness or marginality (Figure 3) and thus to the availability of modern goods and services. Several studies have shown how the availability of modern goods and services influences traditional practices and knowledge (Benz et al. 2000; Figueiredo et al. 1993; Redford and Stearman 1993). Although there was a tendency for more remote villages to exhibit higher average knowledge levels, this did not hold true in all cases. Other factors, which may be responsible for differences between villages in the same area, may be differences in the environment, historical reasons and village age (Coomes 1996; Coomes and Barham 1997). We are conducting a follow-up study to investigate possible differences in environment and availability of palms in the area.

Apart from ethnic background and village location, palm knowledge was also related to gender, education, and indicators of wealth and agriculture practices. Men knew on average more palm uses than women (Figure 2), but the strength of the relationship varied between the two communities and between the different villages. Gender differences with regard to ethnobotanical knowledge have often been observed and are usually related to gender-related division of labor (Hanazaki et al. 2000; Luoga et al. 2000; Styger et al. 1999). Among the Shuar, traditional gender roles assign house and homegarden chores to women, while typical male tasks are hunting, clearing of forest for new fields, house construction, and fabrication of tools (Harner 1972). Although to some extent palms are grown and protected in homegardens and fields, typical male activities entail a higher probability of encountering palms in the forest. In addition, harvest of most palm products requires physical strength and is therefore usually performed by men. Processing is sometimes performed by men (e.g., house construction materials and hunting gear) and sometimes by women (e.g., fruits and palm hearts).

A weak positive correlation between marriage and knowledge level may be due to the fact that married people have more responsibility for satisying the household's subsistence and cash needs (Table 4). If this entails more frequent collection and use of wild plants, it might contribute to higher knowledge levels.

Our study demonstrated a positive relationship between formal education and palm knowledge (though the relationship was dependent on ethnic community and village location). This may be due to the fact that children in the Nangaritza area received their schooling in the villages, mostly by teachers recruited from their own community. Therefore, school attendance did not remove

them from the local cultural and natural environment for extended periods. Before and after school they were still expected to participate in household and farming chores, and it is in these contexts that traditional knowledge is typically passed on between the generations, by observation, imitation, and hands-on experience (e.g., Brodt 2002; Ruddle 1993; Zarger 2002). The positive relationship with length of formal education may indicate that individuals who are inclined towards acquiring formal knowledge also are the ones inclined towards or better at picking up traditional knowledge (Zent 1999). In addition, formal education may heighten people's awareness of different sources of knowledge and provide them with more tools to access knowledge (Godoy 1994). Introduction of "alien" knowledge does thus not necessarily lead to the loss of local traditional knowledge as long as it can be incorporated into the local context and people still have time and opportunity for, and interest in acquiring traditional knowledge and skills.

Another group of important factors related to people's palm knowledge were wealth-related variables (Table 4). In general, members of more well-to-do households knew more palms than members of poorer households. Wealth may affect people's use of wild plants by changing their dependence on forest products and also by determining which tools they have at their disposal for extracting and processing forest products (Takasaki et al. 2001). Previous studies have shown mixed tendencies, with both the poorest and the wealthiest people using most forest products while those with intermediate levels of wealth used least wild products (Barham et al. 1999). In the present study, wealth was mainly measured as agricultural assets, and therefore also reflects different agricultural practices. Extraction and management of natural resources such as plants is an integrated part of people's subsistence strategies, and decisions made with regard to agricultural practices, capital and labor investment will therefore also influence to what degree people extract natural plant products (Coomes 1996; Wiersum 1997). Household differences in agricultural practices may themselves be related to factors such as household history, labor and capital endowment, and past experiences (Coomes and Barham 1997; Scatena et al. 1996).

SUMMARY AND CONCLUSION

This case study, focused on knowledge of palms in southeastern Ecuador, investigated three different questions concerning knowledge loss, knowledge transfer, and the influence of socioeconomic characteristics on people's knowledge levels.

Knowledge loss among traditional people due to acculturation is often seen as one of the biggest threats to sustainable resource use. Indeed, loss of knowledge seemed to be taking place among the Shuar of the study area, although the statistical analyses (regression and rank-abundance curves) did not show age-related patterning. Rather, the Shuar informants reported their own perception that knowledge has been lost. One possible explanation for the lack of age-related patterns may be that the changes we would expect to find had already occurred during the previous generation, and could thus could no longer be detected among those presently living. The plausibility of such a scenario was supported

by people's references to the more traditional Shuar living about a day's walk away in Peru.

At the same time, knowledge transfer from Shuar to colonists of mixed origin seemed to be taking place. This process was not so much evidenced by any relationship to birthplace or residence time in the area as by location of residence at the time of the study. In addition, Shuar and colonists shared some palm uses and names, especially in the most remote of the two colonist villages. Both the process of knowledge loss and of knowledge transfer thus seemed to be associated with remoteness or marginality of villages, with increasing marginality favoring the preservation and transfer of knowledge. Similar results have been found in other studies and have been connected to the availability of modern goods and services and people's engagement in market economy. Geographic placement and village context seemed to be more important to both loss and transfer of knowledge than the time individuals had spent in the area.

Factors which have previously been used to explain knowledge loss or transfer (age, birth place, residence time) were found to be not significant in the present study. Nevertheless, processes of knowledge loss and transfer could partly be inferred from the geographic patterns revealed by the statistical analyses. The analyses showed that people's knowledge levels were related to their wealth, gender, marital status and education, but that these relationships to a large degree reflected ethnicity and residence. Generally, there were higher knowledge levels among Shuar than among colonists, and among men than among women. In addition, education, marriage, and wealth showed positive association with people's knowledge levels. It is, however, important to remember that statistical correlation does not imply a causal relation. As the present study also shows, the data must be examined carefully in the light of all available information lest important patterns be missed.

Heated debates about processes and importance of different factors in other academic disciplines such as ecology provide ample evidence for the impact of temporal and geographic scales of processes under investigation as well as of the research itself. Such effects of scale should also be taken into consideration in the case of both design and analyses of investigations of knowledge.

For understanding and predicting processes of knowledge loss and transfer, some factors are more important than others because they are variable. Marginality, remoteness and market integration are likely to change in the future; in southeastern Ecuador new roads are being built, giving easier access to markets. At the same time, populations continue to grow both by natural increase and inmigration, which will change agricultural practices and natural resource management; traditional knowledge will inevitably change, too. This particular study suggests that some traditional palm uses persist and are taken up by newcomers across ethnic boundaries, while others are likely to disappear due to the availability of alternatives or declines in the populations of the plants themselves.

NOTE

[1] Specimens deposited at the herbaria of the University of Loja, Ecuador (LOJA) and AAU.

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OF 'CLIMBING PEANUTS' AND 'DOG'S TESTICLES', MESTIZO AND SHUAR PLANT NOMENCLATURE IN ECUADOR

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ABSTRACT.—A total of 411 vernacular names were recorded for 354 edible non-crop plant species that are used by nonindigenous mestizo people and indigenous Shuar people in southern Ecuador. Mestizo plant names, predominantly Spanish, are often formed through transposition, borrowing from native languages, or neology. These are mechanisms typically used by immigrants to name unknown plants. Mestizo names show different degrees of regional variability, though many are shared throughout the region. Vegetation diversity of an area influences the diversity of local plant names. Indigenous Shuar people use only Shuar plant names, which show little variation within the area they inhabit. A comparison of mestizo and Shuar naming practices suggests that mestizo people are more likely to give the same name to different plant species and to use more binomial names than Shuar people do.

Key words: common name, edible plant, Ecuador, mestizo, Shuar.

RESUMEN.—Se recopilaron 411 nombres vernáculos correspondientes a 354 especies de plantas silvestres comestibles, utilizados por los mestizos y los indígenas Shuar del sur del Ecuador. Los nombres mestizos, la mayoría en español, se originan frecuentemente por transposición, neologismo o son nombres tomados de lenguas indígenas. Los inmigrantes suelen utilizar estos procesos para crear nombres de plantas desconocidas. Los nombres mestizos muestran diferentes grados de variación regional, aunque muchos son compartidos por toda la región. La composición florística de una zona influye sobre la diversidad de nombres comunes de plantas. Los indígenas Shuar utilizan únicamente los nombres de su lengua, que tienen poca variabilidad dentro de la pequeña región que habitan. La comparación de cómo denominan las plantas los mestizos y los pueblos Shuar, sugiere que los mestizos tienden a utilizar el mismo nombre común para especies diferentes y utilizan más nombres binomiales que los Shuar.

RÉSUMÉ.—Nous avons pu noter 411 noms vernaculaires pour les 354 plantes comestibles, non cultivées, utilisées par les Métis (peuple non autochtone) et les Shuars (peuple autochtone) du sud de l'Équateur. Les noms métis, surtout tirés de la langue espagnole, sont souvent créés par transposition, par emprunt aux langues indigènes ou par néologisme. Ce sont des procédés typiques des immi-

grants qui cherchent à nommer des plantes inconnues. Quoique les noms métis soient partagés par l'ensemble des Métis de la région, ils n'en montrent pas moins des différences régionales, plus ou moins importantes selon les noms. La diversité des noms de plantes suit celle de la flore locale. Le peuple autochtone Shuar utilise exclusivement des noms de plantes shuars. Ceux-ci montrent également peu de variabilité régionale. En comparant les pratiques des Métis et des Shuars, on remarque que les premiers sont appelés à utiliser le même nom pour des espèces différentes et à recourir davantage aux noms binomiaux.

INTRODUCTION

Local plant names can provide much information about how plants are viewed within a given culture. They allow people to communicate about and make sense of plants and the relationships that exist between them. A plant's name may be based on its cultural meaning or use, on its morphological characteristics, or on its habitat (Berlin 1992). It carries linguistic information of historical plant exchanges or the movement of people. A name can also indicate the plant's similarity to other plants. Thus, as people name plants, they classify them, knowingly or not.

The correspondence between scientific and folk plant nomenclature is often remarkable, but both systems use their own independent methods for naming and classifying plants. One-to-one relationships between common names and scientific names do not always exist. Sometimes one common name refers to various botanical species (i.e., it is under-differentiated) and sometimes one species is referred to by various common names, showing further subdivision (i.e., it is over-differentiated) (Berlin 1992).

Certain universal structures in the naming of plants can be found throughout all languages and societies (Berlin 1992). Two basic types of common plant names exist: primary and secondary names. Primary names are usually a one-word expression, but can occasionally be complex (binomial). Secondary names are complex (binomial) and occur in sets of contrasting names that indicate hierarchical relations among a group of plant taxa. The contrasting descriptors refer often to a plant's characteristics, distribution or use, and they usually serve to distinguish a plant from related similar plants. Folk genera usually have primary names, whereas subordinate folk specific taxa have secondary names. Sometimes folk species are referred to by primary names. This is usually occurs when the plant is culturally important—that is, it is cultivated or managed or has an important use or value within the culture.

At the same time, plant naming is both individual and culture-specific. Not only are regional differences in plant names very common, but also individual people within a limited area or group may not always agree on the names given to a particular plant (Sillitoe 1980). Different common names may be given to one plant or names of related plants may be intermingled.

During an ethnobotanical study of edible non-crop plants in southern Ecuador (provinces of El Oro, Loja and Zamora-Chinchipe) between 1994 and 1997 (Van den Eynden et al. 2003), common plant names were recorded for all edible plants. The term "non-crop plant" indicates plants that are neither crops nor

completely wild. When vegetation is cleared for new fields or pastures, for example, or when fields are weeded, certain useful wild plants are left or tolerated. Many plants are tolerated in hedges or along paths and roads. Farmers also deliberately transfer wild plants to their gardens, to fields, and to hedges. All these practices are classified as plant management (Van den Eynden n.d.).

The linguistic origins, meanings, structures and variations of plant names used by nonindigenous mestizo people and indigenous Shuar people in southern Ecuador will be discussed and compared. Although we only consider edible plants here, we believe this to be a sufficiently representative sample for all the useful plants of the area.

SETTING

The study area covers about 30,000 km^2 and is divided by the Andes mountains into three major natural regions: coast, Andes highlands and Amazon region. The irregular topography and climate result in a large range of different vegetation types (Van den Eynden et al. 2003) and high species diversity in a relatively small area. More than 6000 plant species are known to grow in southern Ecuador (Jørgensen and Léon-Yánez 1999) and ten vegetation types can be identified (Van den Eynden et al. 1999).

The majority of the population of southern Ecuador always lived in the Andean and dry coastal region, with indigenous peoples pushed towards marginal highland and Amazonian areas. Humid coastal and Amazonian regions were only colonized by nonindigenous peoples during the twentieth century, with a rapid increase in the latter half. Agricultural land reforms starting in the 1960s, severe droughts in southern Ecuador (especially in 1968), and major new road construction encouraged the exploitation of previously uncultivated areas. Especially in the coastal wetlands, large banana plantations and shrimp farms have been established in the last 50 years. Agriculture is the most important economic activity in southern Ecuador. In the coastal areas, agriculture is mainly large-scale and export-oriented; the main commodities are bananas, coffee, shrimp, and cattle. In the Andean highlands, small-scale traditional agropastoral farmers mainly practice subsistence agriculture; cash crops such as sugarcane, maize, peanuts, and coffee are also grown. In the Amazonian area, the indigenous Shuar combine traditional agriculture, hunting, fishing, and gathering, whereas colonizers log timber, raise cattle, and farm (Pietri-Levy 1993).

Southern Ecuador has a population of about one million and a low percentage of indigenous people compared to the rest of the country. More than 95% of the population is mestizo. In Latin America, the term mestizo refers to the population descended from Spanish colonizers and indigenous peoples. Quechua-speaking Saraguros (about 22,000 according to Chalán et al. 1994) live in the Saraguro area in Loja province and in the higher parts of Zamora-Chinchipe province. Indigenous Shuar communities (probably totaling about 20,000 people) inhabit the easternmost part of Zamora-Chinchipe province along the Río Zamora, Río Nangaritza, Río Numpatakaime, and their tributaries.

Various cultural and linguistic influences exist in the area due to historical conquests and immigration. The main linguistic influences that can be traced are

Spanish, Quechua, and Shuar. Spanish is the official language of Ecuador today and the dominant language in our study area. The Quechua linguistic influence dates to the Inca reign (A.D. 1463–1531) in the Andean part of southern Ecuador. The Inca displaced many people throughout the empire (Taylor 1991). Present-day Saraguros are thought to have been brought over from the Titicaca area in Bolivia. They maintained their cultural identity and language for more than 500 years. Today they are the only Quechua-speaking community in southern Ecuador.

The Shuar language belongs to the Jívaro linguistic group; it is spoken by Shuar, Achuar, Huambisa, Aguaruna, and Mayna peoples of southeast Ecuador and northern Peru (Harner 1984; Steel 1999). The Shuar people have lived in the eastern part of Zamora-Chinchipe province from before the arrival of the Incas, who never managed to conquer them. Until the beginning of the twentieth century, the Shuar were little influenced by any colonizers. Contact with the outside world gradually increased, mainly through trade and the influx of colonizers and missionaries. Their lifestyle has changed dramatically over the last 40 years, as they have come to rely more on agriculture and cattle-raising for cash income. Roads connecting the Andean and Amazonian areas, and national policies encouraging colonization of "virginal" lands, brought in ever more mestizo colonizers (Harner 1984). Other than Shuar, the pre-Inca languages of southern Ecuador (Cañari, Palta, and Malacatos) are poorly known (Harner 1984; Jaramillo 1991; Taylor 1991). The Andean indigenous people who spoke them have disappeared or have blended into the mestizo population (Pietry-Levy 1993).

METHODOLOGY

The ethnobotanical study was carried out in 42 field sites distributed throughout the different ecological zones (Van den Eynden et al. 2003). A field site usually corresponded to one village, sometimes to two or more. Selected field sites in El Oro province were: Isla Bellavista, Chacras, Arenillas, Piedras, Salatí, Casacay, Carabota, Cerro Azul, Zaruma, Sambotambo, Paccha-Daucay, and Chilla; in Loja province: Zapotillo, Puyango, Mangaurco, El Sauce, La Rusia, Sabanilla, Tambo Negro, El Limo, Casanga, Zambi, Catacocha, Amaluza, Celica, Orianga, Sozoranga, Lauro Guerrero, San Lucas, Santiago, Uritusinga, Gualel, Huachanamá, and Sevillán; and in Zamora-Chinchipe province: Timbara, Zumba, Palanda, Tutupali, Sabanilla, Quebrada Honda, El Padmi, and Upper Río Nangaritza. This last area is inhabited by Shuar people. Here fieldwork was done in the communities of Shayme, San Antonio, Yayu, Mariposa, and Nuevo Paraíso (mestizo community). El Padmi has a mixed Shuar-mestizo population. All other villages are mestizo communities.

Data were collected through semi-structured interviews with both male and female informants, including one expert informant in each village chosen based on recommendations by villagers. Interviews focused on the knowledge about and use of edible non-crop plants. People were asked to name the edible plants known to them in their area. Further questions were asked about use, harvesting, preparations, management and ecology of the plants. If the botanical identity of a plant was in doubt, interviewees were shown collected specimens of the plant.

Expert informants indicated all edible plants known to them during walks in the area (botanical specimens were collected at that time too). The walks often triggered their recognition of additional edible plants. Plant names were thus gathered during interviews and walks with 46 expert informants (extra Shuar experts were interviewed) and interviews with 123 nonexperts. Interviews were conducted in Spanish without the need for translators. All Shuar informants were bilingual (Shuar–Spanish). Besides interviews, edible plant use information (including plant names) was also collected simply by talking to any person met during field trips.

MESTIZO PLANT NAMES—OR HOW NONINDIGENOUS PEOPLE NAME PLANTS

All plant names used by the Spanish-speaking mestizo people have been grouped together and labeled "mestizo plant names." A total of 328 mestizo plant names of edible non-crop plants were recorded in southern Ecuador. They correspond to 304 botanical species. Because names were recorded in 41 villages with 149 informants, they represent the collective knowledge of many individuals living in a large area. Regardless of how often the plant names were mentioned, all were included in the list. Spanish dominates mestizo plant nomenclature; 41% of all plant names in the area are entirely or partly Spanish. Other linguistic influences easily identified are Shuar and Quechua. The linguistic origins or meaning of some mestizo plant names remain obscure.

Plant Naming Mechanisms.—Historical and recent population movements play an important role in the way plants in southern Ecuador are named. Spanish colonizers arriving in the area 500 years ago had to name plants that were unknown and unfamiliar to them, a process that continues to this day as mestizo farmers colonize new areas in the humid coastal and Amazonian regions.

Generally three mechanisms of naming plants exist among immigrants: transposition, borrowing, and neology (Grenand 1995). Transposition is the naming of new plants using names of plants already known that are similar in use or appearance. Plant names may also be borrowed from indigenous languages. Sometimes they are altered and adapted to fit the newcomers' own language and pronunciation. Neology is the coining of completely new names for plants. These neologisms are often very descriptive, referring to the appearance or use of a plant. All three naming mechanisms can be seen in the mestizo plant names recorded in southern Ecuador.

Transposition.—Many names of edible non-crop plants in the study area refer to a known plant (Table 1). This is either because the native plant or its fruit looks similar to the known plant, or because its use is similar. The two plants need not be botanically related. For example, various purple and black berries are called *uva* 'grape' or a derived name like *uva silvestre* 'wild grape', *uvilla* 'small grape', and *uva de montaña* 'mountain grape' or 'wild grape'. Various plants with edible seeds that are roasted and eaten like peanuts are called *maní* 'peanut'. Examples are *maní de árbol* 'tree peanut', *maní de bejuco* 'climbing peanut', and *maní del monte* 'wild peanut'. Almost all plants with edible leaves, regardless of their life form,

TABLE 1.—Mestizo names of edible plants in southern Ecuador formed through transposition.

Spanish name	Gloss	Scientific name
almendro, almendra[1]	almond	*Geoffroea spinosa* Jacq.; *Pentagonia* sp.
berenjena	eggplant	*Vasconcellea monoica*? (Desf.) DC.
cacao de monte	wild cocoa	*Pachira aquatica* Aubl.
cafecillo	small coffee	*Tabernaemontana columbiensis* (Allorge) Leeuwenberg
caña agria	bitter cane	*Costus scaber* Ruiz & Pavón
cerezo, cereza[1]	cherry	*Malpighia emarginata* DC.; *Muntingia calabura* L.
choclito	small corn cob	*Lantana* sp.
ciruela	plum	*Bunchosia deflexa* Triana & Planchon
ciruela de fraile	monk's plum	*Malpighia emarginata* DC.
ciruela de monte	wild plum	*Spondias mombin* L.
col de monte	wild cabbage	*Anthurium* spp.; *Vasconcellea microcarpa* (Jacq.) DC.
coquillo, coquito	small coconut	*Cyperus* sp.
granadilla de monte	wild granadilla[2]	*Clavija pungens* (Roem. & Schult.) Decne
higo	fig	*Jacaratia spinosa* (Aubl) DC.
higuerón	large fig	*Ficus* aff. *andicola* Standley
maní de árbol	tree peanut	*Caryodendron orinocense* Karsten
maní de bejuco	climbing peanut	*Cayaponia capitata* Cogn. ex Harms
maní del monte	wild peanut	*Caryodendron orinocense* Karsten
manzana	apple	*Pernettya prostrata* (Cav.) Sleumer; *Vaccinium floribundum* H.B.K.
manzana rastrera	creeping apple	*Vaccinium crenatum* (Don) Sleumer
manzana silvestre	wild apple	*Malpighia emarginata* DC.
manzanilla	small apple	*Vaccinium floribundum* H.B.K.
membrillo silvestre	wild quince	*Eugenia stipitata* McVaugh ssp. *sororia* McVaugh
mora	blackberry	*Clidemia hirta* (L.) Don var. *hirta*; *Clidemia* sp.
naranjilla del campo, naranjilla silvestre	wild naranjilla[3]	*Clavija euerganea* Macbr.
papayón	large pawpaw	*Grias peruviana* Miers
pepinillo	small pepino[4]	*Cyphomandra cajanumensis* (H.B.K.) Walpers
pepino de campo	wild pepino[4]	*Cyphomandra cajanumensis* (H.B.K.) Walpers
pepino de monte	wild pepino[4]	*Physalis peruviana* L.

TABLE 1.—Continued.

Spanish name	Gloss	Scientific name
romero	rosemary	*Cordia polyantha*? Benth.
sacha manzana	wild apple	*Bellucia pentamera* Naud.
uva	grape	*Chondrodendron tomentosum* R. & P.; *Cordia hebeclada* I.M. Johnston; *Cordia lutea* Lam.; *Pourouma bicolor* Mart.; *Pourouma cecropiifolia* Mart.; *Pourouma melinonii* Benoist
uva de montaña	wild grape	*Pourouma cecropiifolia* Mart.
uva pequeña	small grape	*Clidemia sericea* Don
uvilla, ovilla, juvilla	small grape	*Jaltomata* sp.; *Physalis peruviana* L.; *Physalis* sp.
yuca del campo	wild cassava	*Vasconcellea parviflora* DC.
yuquilla, yuquita	small cassava	*Oxalis latifolia* H.B.K.
zanahoria del campo	wild carrot	*Oxalis latifolia* H.B.K.
zapote de campo	wild zapote[5]	*Capparis scabrida* H.B.K.
zapote de monte	wild zapote[5]	*Quararibea* sp.
zapotillo	small zapote[5]	*Casearia* sp.

[1] The male form (ending in *-o*) refers to the tree, the female form (*-a*) to the fruit.
[2] *Granadilla* is the common name of various *Passiflora* species.
[3] *Naranjilla* is the common name of *Solanum quitoense*; this name is in itself transposed from *naranja* 'orange'.
[4] *Pepino* is the common name of *Solanum muricatum*.
[5] *Zapote* is the common name of various species of Sapotaceae.

TABLE 2.—Mestizo names of edible plants in southern Ecuador borrowed from Shuar language.

Mestizo name (synonym)	Original Shuar name	Scientific name
acho	***achu***	*Mauritia flexuosa* L.f.
apai	***apai***	*Grias peruviana* Miers
iñaco	***iniák***	*Gustavia macarenensis* Philipson
kumbía	***kumpía***	*Renealmia alpinia* (Rottb.) Maas
munche, munchi (*granadilla*)	***(washi) munchi***	*Passiflora pergrandis* Holm-Nielsen & Lawesson
pito	***pítiu***	*Trophis racemosa* (L.) Urban
santa maría	***nátsamar***	*Piper* sp.
shanguinia	***shankuinia***	*Pseudolmedia macrophylla* Trécul
shimbe	*	*Euterpe precatoria* Mart.
tinguiwí	***tinkimi***	*Prestoea schultzeana* (Burret) H. Moore
urutza	***uruts***	*Protium* sp.
yaraso, yarasu (*caimito*)	***yaás, yarasu***	*Pouteria caimito* (R. & P.) Radlk.

* Shuar people use ***shimpi*** for *Oenocarpus mapora* H. Karst, a different palm tree.

are called *col de monte* 'wild cabbage'. The only thing they have in common with cabbage is the fact that their leaves are eaten and prepared like cabbage.

Often a descriptor is added to the name, indicating that the plant is a wild form. This can be *silvestre* (wild), *del monte* (from shrubland, wasteland or forest, as opposed to from cropland), *del campo* (from the countryside, as opposed to from an agricultural area) or the Quechua word *sacha* (wild in a broad sense). A diminutive form (*cafecillo, uvilla*) or augmentative form (*papayón*) may be used, thus comparing the native plant's size to that of the known plant. Adjectives or descriptors describing the plant's appearance are also sometimes added, for example in *maní de bejuco* 'climbing peanut' and *manzana rastrera* 'creeping apple'. Forty-four recorded mestizo plant names (of 328) are formed through transposition (Table 1). Not all plant names that refer to another plant are formed by transposition, however. When both plants belong to the same genus, names are not considered to be cases of transposition. The name *granadilla de monte* 'wild passionfruit', given to *Clavija pungens*, is an example of transposition. The same name, however, given to *Passiflora punctata* L., is not, as most *Passiflora* species are named *granadilla*. Here *granadilla de monte* just specifies that particular species of passionfruit.

Borrowing.—Colonizers in the Amazonian part of southern Ecuador living amongst or near the Shuar people have borrowed certain Shuar plant names and now commonly use them (Table 2). Nuevo Paraíso is a fairly new colonizers' village along the Upper Río Nangaritza, in the Shuar territory. Of the 29 plant names recorded here, ten are borrowed Shuar names. Five of them are used unchanged (*apai, yarasu, achu, iniak, shankuinia*) and another five show linguistic adaptations to Spanish (*pito, tinguiwí, kumbía, urutza, santa maría*). Only one plant name has a locally used mestizo synonym: *yarasu* is also called *caimito*. The other nine plant names are unique and no mestizo synonyms are used to refer to these plants. Mestizo colonizers in the area around El Padmi, living amongst Shuar families, use five plant names borrowed from Shuar (of a total of 29 names). Only

TABLE 3.—Mestizo names of edible plants in southern Ecuador borrowed from Quechua.

Mestizo name	Scientific name
Quechua borrowed name	
aguarongo	*Puya* sp.
chawar	*Agave americana* L.
chine (*chini*)	Urticaceae gen. indet.
chulala	*Solanum* sp.
chulalay	*Salpichroa diffusa* Miers
chungay	*Vasconcellea candicans* (Gary) DC.
huicundo	Bromeliaceae gen. indet.
mishiyuyu	*Centropogon cornutus* (L.) Druce
mishki	*Agave americana* L.
*mote negro**	*Gaultheria erecta* Vent.
*motepela**	*Centropogon cornutus* (L.) Druce
*mote pelado**	*Gaultheria reticulata* H.B.K.
muyuyo	*Cordia lutea* Lam.
taxo (*taksu*)	*Passiflora cumbalensis* (Karst.) Harms
uchuchi	*Solanum brevifolium* Dunal
wile	*Freziera verrucosa* (Hieron.) Kobuski
yanamuro (*-u*)	*Myrcianthes* sp.
Name with Quechua descriptor	
sacha capulí	*Eugenia* sp.
sacha granadilla	*Granadilla foetida* L.
sacha manzana	*Bellucia pentamera* Naud.
sacha piña	*Ananas comosus* (L.) Merril
sacha sanguillo	*Anthurium* sp.

* *Mote* is a type of cooked maize.

one plant has a synonymous mestizo name: *munchi* is also called *granadilla*. In the other six Amazonian villages studied, the population consists entirely of mestizo people. Here fewer plant names borrowed from Shuar language are used: three were recorded in Timbara (*achu, iñaco, kumbía*) and Palanda (*munche, shimbe, yaraso*), two in Tutupali (*iñaco, yarasu*), and one in Zumba (*yarasu*, also called *caimito* here). The two villages where no plant names borrowed from Shuar were recorded (Quebrada Honda and Sabanilla) are both high up on the Andes slopes (above 1600 m), geographically far from the Shuar territory and with quite different edible species.

A total of twelve different plant names for edible non-crop plants, borrowed from the Shuar language, were thus recorded amongst mestizo colonizers in the Amazonian region of southern Ecuador. They correspond to twelve separate botanical species (Table 2). Only two of the plant names have a synonymous mestizo name. Ten plant names borrowed from Shuar are therefore the only names used by mestizo people to name these particular plant species. No plant names borrowed from Shuar language were recorded outside the Amazonian area (Zamora-Chinchipe province).

Some Quechua linguistic influence in local plant names is found, mainly in the western Andes region of southern Ecuador. A total of 22 recorded mestizo plant names (of 328) are borrowed from Quechua or have a descriptor borrowed from Quechua (Table 3). *Sacha* is regularly used as a descriptor preceding a mes-

tizo plant name to indicate that a plant is wild. Originally a general Quechua term meaning plant, forest, and shrubland, its meaning has changed to "wild."[1] A mapping of the occurrence of borrowed Quechua plant names and the use of *sacha* as a prefix in southern Ecuador shows the highest influence of Quechua in plant names is the area around Saraguro. This is the only area in southern Ecuador where Quechua is still spoken. The Quechua influence in plant names extends towards the Loja area, along the river Catamayo basin and also into the higher parts of the Amazonian region. Names borrowed from Quechua were recorded in 14 field sites (of the 42 studied). In each site, only one to four plant names borrowed from Quechua are used of a total of ten to sixty recorded plant names per site. In Gualel, four of nineteen plant names are borrowed from Quechua (*mishki, yanamuro, chulalay, uchuchi*). This is the highest occurrence of borrowed Quechua names encountered. Each name borrowed from Quechua is the only name used in that particular community to name a particular plant. No synonymous mestizo names are used in these villages for the same plants.

We can presume that other plant names would have been borrowed in the past from pre-Inca languages like Palta. Since these languages, or any written records about them, do not survive, we cannot say anything more about this possible linguistic influence.

Neology.—Twenty-two mestizo plant names that were recorded in this study can be considered as newly invented names (Table 4). The names refer to particular characteristics, uses or origins of the plants. Sometimes the reference is to the edible part of the plant, on other occasions it is to an obvious characteristic. Eleven plant names describe the shape or color of the edible fruit (*cucharilla, gañil, huevo de gallo, huevo de pava, huevo de perro, lagaña, negrito, nigua, niguito, perlilla, vainilla*). Two names refer to the fruit consistency (*babosa, moco*). One name refers to the color of the flower (*amarillo*). Six names refer to another plant characteristic (*palo blanco, pata blanca, sierra, sierilla, uña de gato, uña de pava*). The last two names refer to the shape of the plant's thorns. One name refers to the use of the plant (*flor de novia*) and one to the plant's geographical origin (*méjico*). In seven names reference is made to an animal. English translations of the names are given in Table 4.

Most of these new plant names are used very locally and were recorded only once. They may well be idiosyncratic names, although that is difficult to confirm. Many plant species only grow in one particular place, and thus only need to be named there. New names are generally used for edible fruits that are not very significant: the fruits are small and not tasty. Exceptions are *huevo de perro, amarillo,* and *palo blanco.* These new names are used throughout southern Ecuador and even beyond. *Huevo de perro* is the name most commonly used for wild plants of *Solanum quitoense,* a plant with large edible fruits that may be sold in markets. The cultivated form of this species is known as *naranjilla. Amarillo* and *palo blanco* are important timber trees, their edible fruits are only considered as snack foods. The common use of these new names throughout the area may be attributed to their economic importance.

Almost one-third of all mestizo plant names (102 of 328) are formed through one of these three mechanisms. Our study provides the opportunity to test the assumption that colonizers need to name unknown plants, by analyzing mestizo

TABLE 4.—Mestizo names of edible plants in southern Ecuador, formed through neology.

Spanish name	Gloss	Scientific name
amarillo	yellow	*Centrolobium ochroxylum* Tul.
babosa	slimy[1]	*Saurauia bullosa* Wawra
cucharilla	small spoon[2]	*Oreocallis grandiflora* (Lam.) R.Br.
flor de novia	bride's flower	*Yucca* sp.
gañil	gill[2]	*Oreocallis grandiflora* (Lam.) R.Br.
huevo del gallo	cock's testicle[2]	*Oreanthes fragilis* (A.C.Smith) Luteyn; *Gaultheria tomentosa* H.B.K.
huevo de pava	turkey's testicle[2]	*Celtis iguanaea* (Jacq.) Sarg.
huevo de perro	dog's testicle[2]	*Solanum quitoense* Lam.
lagaña	dirt[1]	*Cordia polyantha*? Benth.
méjico	Mexico	*Agave americana* L.
moco	slime[1]	*Saurauia* cf. *peruviana* Busc.
negrito	little black thing[2]	*Coccoloba ruiziana* Lindau
nigua	type of fly[2]	*Disterigma alaternoides* (Kunth) Niedenzu
niguito	small fly[2]	*Muntingia calabura* L.
palo blanco	white trunk	*Celtis* sp.
pata blanca	white leg[3]	Liliaceae gen. indet.
perlilla	small pearl[2]	*Arcyctophyllum thymifolium* (R. & P.) Standley
sierra	saw[4]	*Miconia* spp.
sierilla	little saw[4]	*Gaultheria tomentosa* H.B.K.
uña de gato	cat's nail[5]	*Celtis iguanaea* (Jacq.) Sarg.
uña de pava	turkey's nail[5]	*Celtis iguanaea* (Jacq.) Sarg.
vainilla	small pod[2]	*Caesalpinia spinosa* (Molina) O. Kuntze; *Vanilla* sp.

[1] Refers to the consistency of the fruit.
[2] Refers to the shape or color of the fruit.
[3] Refers to the white stem of the plant.
[4] Refers to the serrated leaf margin.
[5] Refers to the plant's thorns.

plant names created through transposition, borrowing, and neology in recently colonized areas, compared with those of older communities. In certain recently colonized coastal areas like Isla Bellavista, Cerro Azul and Arenillas, more than one third of all recorded plant names are formed through transposition and neology. There are no borrowed names here because there is no native population. In areas such as Sozoranga, Celica, Amaluza and Catacocha, which have been inhabited since pre-Inca times, fewer than 10% of all plant names are formed through these mechanisms. In the Amazonian region (Zamora-Chinchipe), where colonization by mestizo people is fairly recent, and where there is a native population of Shuar people, more than one quarter of all mestizo names of edible plants are formed through transposition and neology or are borrowed from Shuar language. Especially in El Padmi and Nuevo Paraíso, where mestizo people live within the Shuar territory, more than half of the plant names are formed through the three mechanisms.

The percentage of plant names used in a village that are formed through transposition, borrowing, and neology were compared for all mestizo communities (Table 5), distinguishing old and recent colonization (since the 1950s). No significant difference exists between recently colonized areas and areas with old colonization (one-way ANOVA test, $p = 0.25$). If one distinguishes the three categories of colonization separately—old colonization, recent colonization in coastal areas, and recent colonization in Amazonian areas (Table 5)—then a significant difference is found between the newly colonized Amazonian areas and areas with old colonization (one-way ANOVA test, $p = 0.0015$). No significant difference, however, exists between newly colonized coastal areas and areas with old colonization, in terms of mechanisms of plant naming.

Other Naming Patterns.—Many binomial mestizo plant names that do not follow any of the three naming mechanisms do have a salient descriptive Spanish (or occasionally Quechua) adjective or descriptor, alongside a seemingly meaningless (opaque) name. The descriptor usually refers to a particular plant characteristic (*cardo rastrero* 'creeping cardo') or indicates that the plant is wild (*papaya del campo* 'wild pawpaw'), which allows similar plants to be distinguished. Many examples can be seen among *Inga* species (generally named *guaba*), where descriptors specify the appearance of the pods of different species (Table 6). The incidence of such binomial plant names is high amongst mestizo names (121 of 328 names). Spanish descriptors always follow the main name, whereas the Quechua descriptor *sacha* precedes the plant name. Some plant names even have two descriptors indicating further specification or subdivision (*salapa blanca grande*).

It is especially common for farming communities to use "wild" as a descriptor to name plants in order to distinguish them from domesticated plants (comment of Ellen in Brown 1985:56). In our records, a total of 41 binomial mestizo plant names (13%) have a form of "wild" as a descriptor.

Meaning.—Since many of the edible plants recorded in this study are managed by farmers within the agricultural system as tolerated or cultivated plants, we would like to test Berlin's theory that semantic transparency of plant names is often inversely related to the cultural importance of the plant (Berlin 1992). Plant management indicates a certain level of cultural importance. According to this

TABLE 5.—Relation between percentage of mestizo plant names formed through neology, transposition and borrowing, and the colonization history of a village.

Village	Number of plant names	Naming[1]	Colonization history[2]	Colonization history[3]
Old colonization (mean 23.7; st. dev. 12.9)				
Sozoranga	16	6	0	0
Celica	13	7	0	0
Paccha-Daucay	10	8	0	0
Amaluza	23	8	0	0
Catacocha	29	11	0	0
Orianga	15	13	0	0
Lauro Guerrero	23	16	0	0
Uritusinga	12	17	0	0
Zambi	32	17	0	0
Chilla	16	18	0	0
Huachanamá	17	20	0	0
Santiago	19	20	0	0
Casanga	48	20	0	0
Gualel	17	21	0	0
Salatí	19	21	0	0
Tambo Negro	17	30	0	0
El Sauce	6	33	0	0
San Lucas	12	33	0	0
Mangaurco	7	38	0	0
Sabanilla	20	38	0	0
La Rusia	13	40	0	0
Sevillán	25	41	0	0
Zaruma	21	42	0	0
Zapotillo	9	50	0	0
Recent colonization (mean 29.2; st. dev. 17.9)				
Coastal (mean 18.8; st. dev. 4.4)				
Sambotambo	5	0	1	1
El Limo	14	0	1	1
Casacay	16	4	1	1
Piedras	14	14	1	1
Carabota	10	20	1	1
Chacras	11	23	1	1
Puyango	15	24	1	1
Arenillas	9	33	1	1
Cerro Azul	19	34	1	1
Isla Bellavista	10	36	1	1
Amazonian (mean 42.1; st. dev. 4.9)				
Palanda	27	26	1	2
Zumba	13	29	1	2
Timbara	22	41	1	2
Tutupali	22	36	1	2
Nuevo Paraiso[4]	29	65	1	2
Quebrada Honda	14	36	1	2
El Padmi	32	60	1	2
Sabanilla Zamora	19	44	1	2
ANOVA-test			p = 0.25	p = 0.0015

[1] Percentage of plants names that are formed through transposition, borrowing and neology.
[2] 0 = old colonization; 1 = recent colonization (less than 50 years).
[3] 0 = old colonization; 1 = recent coastal colonization (<50 years); 2 = recent Amazonian colonization (<50 years).
[4] The only mestizo community in the Upper Río Nangaritza area.

TABLE 6.—Spanish descriptors used to specify different *Inga* species in southern Ecuador.

Common name	Descriptor's meaning	Scientific name
guaba cajetilla	square	*I. sapindoides* Willd.
guaba de bejuco	liana-like	*I. edulis* Mart.
guaba de cajón	square	*I. feuillii* DC.
guaba de mono	monkey[1]	*I. striata* Benth.
guaba de monte	wild	*I. silanchensis* T.D. Penn.
guaba de oso	bear[1]	*I. fendleriana* Benth.
guaba de perico	sloth[1]	*I. oerstediana* Benth.
guaba de zorro	fox[2]	*I. fendleriana* Benth.; *I. insignis* Kunth; *I. oerstediana* Benth.
guaba lanuda	hairy, woolly	*I. fendleriana* Benth.; *I. insignis* Kunth
guaba machetona	machete-shaped	*I. spectabilis* (Vahl) Willd.
guaba musga	hairy, mossy	*I. fendleriana* Benth; *I. oerstediana* Benth.; *I. striata* Benth.
guaba natural	natural	*I. striata* Benth.
guaba negra	black hairy	*I. nobilis* Willd. ssp. *quaternata* (P. & E.) T.D. Penn.
guaba poroto	bean-like	*I. silanchensis* T.D. Penn.
guaba rabo de mono	monkey-tail	*I. oerstediana* Benth.
guaba vainilla	small bean-like	*I. laurina* (Sw.) Willd.
guaba verde	green[3]	*I. striata* Benth.

[1] Refers to brown hairs on pod.
[2] Refers to red hairs on pod.
[3] Refers to the smooth, hairless pod.

theory, managed species would have more opaque (nondescriptive) names and nonmanaged plants would have more semantically transparent or descriptive names. Berlin argues that this is because everyone knows a culturally important plant, even when the common name gives no clues about its appearance, characteristics or use. On the other hand, culturally less important plants need a more descriptive name for people to be able to remember the plant.

In our study, Spanish plant names, such as *maní de árbol* 'tree peanut', are the most transparent and non-Spanish plant names, such as *vichayo,* are the most opaque. Plant names with some degree of Spanish influence are between the two extremes and considered as semitransparent (for example, names with a Spanish descriptor, like *guaba de mono* 'monkey *guaba*'). Organizing all plant species according to their degree of management (distinguishing the categories wild, tolerated, and cultivated) and the transparency of their common names (distinguishing the categories transparent, semitransparent, and opaque), and testing for independence of the variables, we can show statistically that there is no relation between the semantic transparency of a mestizo plant name and the cultural status of the plant (Table 7).

Nomenclature Structures.—Mestizo plant names can be classified as primary and secondary. Primary names are either simple expressions (e.g., *shora*) or complex, binomial expressions (e.g., *guanábana silvestre*). Secondary names are complex and occur in sets of contrasting names (e.g., *granadilla amarilla* and *granadilla negra*). However, these contrasting sets are often used in only a single community. They

TABLE 7.—Relation between management of edible plants and semantic transparency of their names.

Plant management	Opaque plant names	Semitransparent plant names	Transparent plant names
Wild	78	37	49
Tolerated	46	20	20
Cultivated	21	19	14

$\chi^2 = 5.17$; d.f. = 4; p = 0.05; H_0 accepted.

depend on which plant resources grow locally. Since the mestizo plant names were collected in a large geographical area and represent the plant knowledge of many individuals in many communities, it is not possible to clearly distinguish primary complex names from secondary names.

Most mestizo plant names have a one-to-one correspondence with a botanical species. Forty-seven names, however, are under-differentiated and correspond with 2 to 14 botanical species. *Guaba* is used for 14 different species of *Inga* and *mora* is used for 13 different botanical species belonging to several genera. There are, however, strong regional differences that depend strongly on the number of different species that grow in any one area. In some communities various *Inga* species have their own binomial names, whereas in other areas the primary name *guaba* is used for all *Inga* species. Also, some informants are more inclined to lump different taxa under one name, whereas others use distinct names.

Some common names are over-differentiated and refer to varietal subdivisions within a botanical species. Two different varieties of *Macleania rupestris* (H.B.K.) A.C.Smith are recognized in Sevillán: *joyapa blanca* and *joyapa chaucha*. In the area of Zambi, *M. salapa* (Benth.) Hook F. ex Hoerold is subdivided into *joyapa blanca* and *joyapa morada*. Two varieties of *Myrcia fallax* (Rich.) DC., *saca blanca* and *saca colorada*, are distinguished in Sozoranga. In Santiago, *Rubus floribundus* Kunth is divided into *mora pequeña, mora grande,* and *mora grande de jugo. Vasconcellea × heilbornii* (Badillo) Badillo is an important economic species with an enormous range of fruit types and shapes, developed over centuries of management and cultivation. Often these crosses are all called *toronche,* but in some areas local varieties like *chamburo, siglo,* and *babaco* are recognized.

VARIATIONS IN MESTIZO PLANT NAMES

The area where mestizo plant names were collected is so large and diverse that it is important to analyze regional variations in names. Because the vegetation in different areas is often distinctive, the botanical species of edible plants may be very different. It is therefore not always straightforward to compare plant naming variations between communities.

Ninety-nine edible plant species were, however, recorded in at least two communities. Two-thirds of these (65 plants) have only one common name throughout southern Ecuador; for some plants the same unique name was recorded in up to 10 different communities (Table 8). Sometimes slight variations of the same name are used. These can be phonological (spoken) or lexical (written) variations, or binomial names derived from one and the same primary name. *Pouteria lucuma*

TABLE 8.—Unique mestizo names of edible plants used throughout southern Ecuador and the number of communities where the name was recorded (minimum 5 of a total of 42 communities).

Common name	Number of communities	Scientific name
algarrobo	5	*Prosopis juliflora* (Sw.) DC.
caimito	5	*Pouteria caimito* (R.&P.) Radlk.
chirimoya	9	*Annona cherimola* Mill.
chivila	5	*Attalea colenda* (O.F.Cook) Balslev & Andr. Hend.
chonta	5	*Bactris gasipaes* H.B.K.
chonta	7	*Bactris macana* (Mart.) Pittier
guanábana	10	*Annona muricata* L.
guásimo	6	*Guazuma ulmifolia* Lam.
guayabilla	5	*Psidium guineense* Sw.
lusumbe	7	*Pradosia montana* T.D.Penn.
mortiño	8	*Solanum americanum* Mill.
pechiche	5	*Vitex gigantea* H.B.K.
pitaya	11	*Hylocereus polyrrhizus* (Weber) Britton & Rose
quique	7	*Hesperomeles ferruginea* (Pers.) Benth.
sota	5	*Maclura tinctoria* (L.) Steudel ssp. *tinctoria*
verdolago	9	*Portulaca oleracea* L.

(R.& P.) Kuntze is usually called *luma* (the fruit) or *lumo* (the tree), but can also be called *lucumo. Cyperus* sp. is called *coquillo* or *coquito,* both meaning "small coconut," describing the edible roots. *Hylocereus polyrhizus* (Weber) Britton & Rose is generally called *pitaya,* but some people say *pitahaya. Clavija euerganea* is called *naranjilla del campo* or *naranjilla silvestre,* according to the area; both names indicate the "wildness" of the plant. *Lycopersicon pimpinellifolium* (Jusl.) Mill. can be called *tomatillo, tomate del campo, tomatillo de gallinaso* or *tomate wishco,* according to the area. Various species of *Inga* are called *guaba,* or may have a binomial name derived from *guaba* (Table 6).

A second group of ten plants are known with one common name throughout southern Ecuador, but one or two different names are used in particular areas or by some informants. *Acnistus arborescens* (L.) Schlecht. is generally called *pico pico* (in 14 communities of 42), only in two places is it called *sabaluco. Erythrina edulis* Triana ex M. Micheli is called *guato* in the western part of southern Ecuador, but *pashul* or *cañari* in some areas in the east. *Prestoea acuminata* Willd. is generally known as *palmito,* in some areas distinct names like *tinguiso* and *caño* are used. Only in Amaluza is *Allophylus mollis* (Kunth) Radlk. known as *clambo,* in all other areas it is called *shiringo. Inga marginata* Willd. is always called *guabilla,* except in Zambi, where it is called *porotillo. Cordia lutea* is called *uva* or *overal* and *Passiflora foetida* L. is *(sacha) granadilla* throughout southern Ecuador, except on Isla Bellavista where these are known as *muyuyo* and *bedoca* respectively. *Physalis peruviana* is named *uvilla, ovilla,* or *juvilla,* but known in Cerro Azul as *pepino de monte. Inga spectabilis* is generally called *guaba machetona,* but in some areas *panaco.* Likewise, *Inga oerstediana* generally has a binomial name derived from *guaba* (Table 6), but is sometimes called *laricaro.*

A third group are plants that are known throughout southern Ecuador by completely different names. Only 24 plants that were recorded in at least two

TABLE 9.—Relation between management of edible plants and variation of their names.

Plant management	Unique name	Name variants*	Various regional names
Wild	133	6	23
Tolerated	65	6	15
Cultivated	29	10	14

$\chi^2 = 20.0$; d.f. = 4; $p < 0.001$; H_0 rejected.
* Lexical or phonological name variants, or various binomial names derived from the same primary name.

villages belong to this group. *Celtis iguanaea* is called *cacumba, uña de gato, uña de pava, huevo de pava, mogroño, uva* or *uva de pava* in different communities. *Agave americana* can be called *méjico* (after its region of origin), *mishki* (the Quechua name of its juice), *penco* (the name of its leaves) or *chawar. Coccoloba ruiziana* is known as *añalque, añalque pampero, añalque chiquito, indindo,* or *negrito.*

Why do certain plants have a single name throughout southern Ecuador, whilst others have various names? Often, culturally important plants have fewer name variants than less important ones (Berlin 1992). We can test this proposition for all name variants, in southern Ecuador: phonological and lexical variants, binomial name variants and regional variants. Plant management is one way to measure cultural importance. Organizing all recorded plant species according to their degree of management (distinguishing the categories wild, tolerated, and cultivated plants) and the presence or absence of name variation (distinguishing plants with unique names, name variants, and various names), we can test for independence between both factors using a χ^2-test. There is a significant link between the cultural importance of a plant and the variation in its name in southern Ecuador (Table 9). It is, however, opposite to the relation found by Berlin (1992): wild plants in southern Ecuador have fewer name variants than managed plants.

Most wild plants, however, were recorded only in one field site, with one name. This may give a false picture of name variation structures, as such local names would necessarily count as unique. We therefore limited the test to the 99 species of edible plants that were recorded in at least two different field sites. Although tolerated and cultivated plants seem to have more unique names than wild plants, a χ^2-test shows that there is no significant link between the management of a plant and its name variations (Table 10a).

A disproportionate number of trees and plants with economically valued fruits have a unique or at least generally recognized common name. Marketed fruits can be considered as culturally more important than fruits that are gathered occasionally as snack foods. Trees often have multiple uses (timber, fuel) and may be more visible in the landscape, giving them more cultural importance than herbs and shrubs. The test for independence between name variation and whether or not a plant is marketed found no significant relation between the two criteria (Table 10b). Similarly, the test for independence between name variation and the life form of a plant (tree, shrub, herb) found no significant relation (Table 10c).

Finally, we noticed that unique plant names in southern Ecuador are more likely to be opaque and plants whose names vary throughout the study area are more likely to have transparent names that describe salient characteristics. A χ^2-

TABLE 10.—Relation between name variation of edible plants (mentioned in at least two villages) and various factors expressing their cultural importance.

	Unique name	Name variants	Various regional names
a. Plant management			
Wild	15	1	10
Tolerated	33	4	8
Cultivated	17	5	6
$\chi^2 = 6.5$; d.f. = 4; $p < 0.2$; H_0 accepted			
b. Fruit			
Economic fruit	14	2	4
Non-economic fruit	51	8	20
$\chi^2 = 0.26$; d.f. = 2; $p < 0.2$; H_0 accepted			
c. Life form			
Tree	40	6	8
Shrub	12	2	10
Herb	13	2	6
$\chi^2 = 6.8$; d.f. = 4; $p < 1$; H_0 accepted			
d. Name			
Transparent name	10	1.7*	11.3*
Opaque name	55	8.3*	12.7*
$\chi^2 = 10.1$; d.f. = 2; $p < 0.01$; H_0 rejected			

* Decimal values because all common names for each species are given a total value of 1 per plant species.

test of this hypothesis found a significant relationship (Table 10d). Opaque plant names are therefore less likely to vary throughout southern Ecuador.

An important factor in the naming of plants within any one community is the number of similar plants occurring in the area. For example, if only one type of palm tree is found in a village, it is likely to be simply called *palma*; if only one species of *Inga* is found in an area it will most likely be called *guaba*. If more species of the same genus or family occur in the area, distinctive names are usually given to each one. All *Rubus* species in southern Ecuador are called *mora*. Only in Santiago, where five *Rubus* species occur together, are they given distinct secondary names like *mora grande, mora pequeña, mora grande de jugo* (three different types of *R. floribundus* Kunth), *mora de pepa* (*R. bogotensis* H.B.K.), *mora de los pajones* (*R. loxensis* Benth.), *mora de piña grande* (*R. nubigenus* Kunth), and *mora piña* (*R. roseus* Poir.). The names given may have a very restricted use because they are needed only to distinguish locally available species. *Inga striata* for example is called *guaba verde* in most places because its pods are typically hairless and green whereas most other *Inga* species have brownish hairy pods. In Sabanilla and Palanda, however, it is called *guabilla*, because it is the *Inga* with the smallest pods (compared to *I. extra-nodis* T.D.Penn. and *I. densiflora* Benth.).

SHUAR PLANT NAMES

Shuar people use exclusively Shuar names for the plants they know and use, although they often know the equivalent mestizo or Spanish names. A total of 83

TABLE 11.—Primary and derived secondary Shuar names of edible non-crop plants.

Primary Shuar names with corresponding scientific names	Secondary Shuar names with corresponding scientific names
chimi—*Pseudolmedia laevigata* Trécul	***kawachimi***—*Cordia nodosa* Lam.
éep—*Anthurium* generic	***katshiniak éep***—*Anthurium breviscapum* Kunth
but; ***shiniumas***—*A. rubrinervium* (Link) Don, ***wankat***—*A. triplyllum* Brogn. ex Schott	***natsa éep***—*Anthurium* sp.
	wee éep—*A.* sect. *Xialophyllium*
iniák—*Gustavia macarenensis* Philipson	***tsantsaniak***—*Gustavia* sp.
kukúch'—*Solanum* generic	***shuankukúck'***—*Solanum* sp.
	ya kukúch'—*S. stramoniifolium*? Lam.
munchi—*Passiflora* generic; *P. pergrandis* Holm-Nielsen & Lawesson	***patúkmai munchi***—*Passiflora foetida* L.
	tsere munchi—*Passiflora* sp.
	washi munchi—*P. pergrandis* Holm-Nielsen & Lawesson
sámpi—*Inga* generic; *I. acreana* Harms but: ***napúrak***—*I. thibaudiana* DC., ***wámpa***—*I. edulis* Mart., ***wampukish***—*I. nobilis* Willd. ssp. *nobilis*	***imik sámpi***—*Inga microcoma*? Harms, *I. nobilis* Willd. ssp. *quaternata* (P. & E.) T.D. Penn., *I. punctata* Willd.
	kunkuin sámpi—*I. nobilis* ssp. *quaternata*
	main sámpi—*I. leiocalycina* Benth.
	yakum sámpi—*I. capitata* Desv.
shuinia—*Pourouma* generic	***mutuch' shuinia***—*Pourouma bicolor* Mart., *P. guianensis* Aublet, *P. melinonii* Benoist
	nakantar shuinia—*P. bicolor* Mart.
	pau shuinia—*P.* aff. *cecropiifolia* Mart.
	washi shuinia—*P. cecropiifolia* Mart., *P. guianensis* Aublet

Shuar names of edible non-crop plants was recorded from 20 informants in the Shuar communities along the Upper Río Nangaritza and in El Padmi (Appendix 1). They correspond to 72 botanical species. We are not familiar enough with the Shuar language to be able to analyze the meaning and origin of these names.

Nomenclature Structures.—The Shuar plant names were collected in a relatively small area with uniform vegetation. The structure of the names can therefore be studied in detail. Of the 83 recorded names listed in Appendix 1, 65 (78%) are simple primary names and 16 (19%) are secondary (binomial) names; we have been unable to analyze the structure of two names. Table 11 shows examples of groups of primary names (folk genera) and sets of contrasting secondary names (folk species) derived from each primary name. Shuar descriptors are always placed before the primary names. These primary names correspond to folk generic taxa, with further division into folk specific taxa by their secondary names. A folk genus can correspond to a botanical one, but does not necessarily include all the speices that grow in the study area (Berlin 1992). In the case of ***sámpi***, for example, five *Inga* species have a secondary name derived from the primary name ***sámpi***, but three other *Inga* species have different primary names (***wámpa***, ***napúrak***, ***wampukish***). The name ***sámpi*** is also used to name one particular species, *Inga acreana* Harms. Similarly, ***munchi*** indicates both passionfruit in general and one particular species, *Passiflora pergrandis*, which is the most common and largest

edible passionfruit in the area. The fact that a primary name is used for one particular botanical species may indicate the cultural importance of that species. All 12 different edible palm species used by the Shuar have their own primary name, which probably reflects their cultural importance. This is in stark contrast to the generalized naming of palms by mestizo people (Table 12).

The relationship between common name and botanical name is in most cases one-to-one. Exceptions include: ***shiniumas, najaraip, chimi,*** and ***kushikiam,*** which are each used for two different species of the same botanical genus; these names are therefore under-differentiated (Berlin 1992). Some secondary names in the ***shuinia*** and ***sámpi*** group are used for different botanical species by some informants. ***Mutuch' shuinia*** is the common name for *Pourouma bicolor, P. guianensis,* and *P. melinonii,* but some informants use ***nakantar shuinia*** for *P. bicolor* and ***washi shuinia*** for *P. guianensis* and also for *P. cecropiifolia*. ***Imik sámpi*** is the local name for three *Inga* species, *I. microcoma, I. nobilis* and *I. punctata.* But *I. nobilis* is by some informants called ***kunkuin sámpi***. This may either indicate that the different plant species are not considered as separate taxa, or that there exists variability in plant naming between informants.

Regional Variation of Shuar Names.—Few naming variations exist amongst informants and between communities in the study area, even though El Padmi and the Upper Río Nangaritza are more than 100 km apart. Only four cases of lexical variation were recorded: ***tinkimi–tinkibi; kúnakip–kúnapi; nátsamar–nátsatsam; yáas–yarasu***. Some informants are inclined to use more detailed secondary names, whereas others use the general corresponding primary names (***kathsiniap éep–éep; washi munchi–munchi***). For only two botanical species were two completely different Shuar names recorded from different informants: ***wankat*** and ***éep*** for *Anthurium triphyllum*; ***imik sámpi, kunkuin sámpi*** and ***wampukish*** for *Inga nobilis* ssp. *quaternata.*

In order to analyze possible regional variations of Shuar plant names even further, we compared the names we recorded with Shuar plant names elicited during two ethnobotanical studies carried out in neighboring Morona-Santiago province, approximately 250 km northeast of the Upper Nangaritza area (Bennett et al. 2002; Borgtoft et al. 1998). Thirty-four botanical species were recorded in all three studies. Seven plant names were the same in all three studies (***achu, apai, kumpia, kunchai, kunkuk', uwi,*** and ***yaas***). Most of these are economically important fruits. Another fifteen names were the same in our study and in one of the other two studies. For two of them a different name was recorded in the third study, for the remaining thirteen no name had been recorded. Five names had a different descriptor, but the same generic name and five names showed lexical variations. For only two botanical species were the names recorded in the three studies completely unrelated. Shuar plant names used by different Shuar communities show therefore little variation.

COMPARING MESTIZO AND SHUAR PLANT NOMENCLATURE

It is difficult to directly compare mestizo and Shuar nomenclature. Mestizo plant names were recorded in a large area with a high diversity of vegetation

TABLE 12.—Comparing Shuar and mestizo names given to palm trees.

Scientific name	Shuar name	Mestizo name
Aiphanes grandis Borchs. & Balslev	—	*chonta*
Aiphanes verrucosa Borchs. & Balslev	—	*chonta*
Astrocaryum urostachys Burret	***awant'***	—
Attalea colenda (O.F. Cook) Balslev & Andr. Hend.	—	*chivila*
Bactris gasipaes H.B.K.	***uwí***	*chonta*
Bactris macana (Mart.) Pittier	—	*chonta*
Bactris setulosa H. Karst.	—	*chontilla, chonta*
Ceroxylon amazonicum? Galeano	***paik'***	*palma de ramas*
Ceroxylon echinulatum Galeano	—	*palma*
Ceroxylon vogelianum (Engel) H. Wendl.	—	*coco*
Ceroxylon sp.	—	*palma*
Dictyocaryum lamarckianum (Mart.) H. Wendl.	—	*palma*
Euterpe precatoria Mart.	—	*shimbe, palma*
Euterpe precatoria var. *longevaginata* (Mart) Andre. Hend.	—	*palmo real*[1]
Euterpe ?	***yayu***	—
Iriartea deltoidea R. & P.	***ampakaí***	*pambil, palmito*
Iriatea sp.	—	*palma, palmita*
Mauritia flexuosa L.f.	***achu***	*acho*
Oenocarpus bataua Mart.	***kunkuk'***	*palma real*
Oenocarpus mapora H. Karst.	***shímpi***	—
Pholidostachys synanthera (Mart.) H. Moore	—	*palma paja cambana*
Phytelephas aequatorialis Spruce	—	*tagua, trapa, tapra, cade*
Prestoea acuminata Willd.	***saké***	*palma, palmito,*[1] *caño, tinguiso*
Prestoea ensiformis (R. & P.) H. Moore	—	*caño*
Prestoea schultzeana (Burret) H. Moore	***tinkibi, tinkimi***	—
Socratea exorrhiza (Mart.) H. Wendl.	***kúpat***	—
Wettinia kalbreyeri (Burret) R. Bernal	—	*bambil, pambil*
Wettinia maynensis Burret	***terén***	—
Wettinia cf. *maynensis* Burret	—	*palma*

[1] The male variant *palmo* or *palmito* refers to the tree being tall, stout or single-stemmed.

types, plant species, and communities. Various ethnic and linguistic factors have influenced the creation and evolution of mestizo plant names. Shuar plant names, on the other hand, were recorded in a relatively small area with a uniform vegetation and population. There are, however, some interesting points of comparison.

Mestizo people tend to use a high percentage of binomial plant names. Thirty-six percent of mestizo plant names are binomial, compared to 25% of Shuar plant names. Mestizo plant names are more likely to be under-differentiated (14% compared to 5% for Shuar names).

Different patterns emerge in mestizo and Shuar naming when comparing how two culturally important groups of plants (palm trees and *Inga* species) are named. Mestizo people often simply call a palm tree a palm (*palma*), whereas Shuar people give each palm tree a distinctive and unique name, which probably indicates the cultural importance of palm trees for Shuar people (Table 12). Shuar people use 12 species of palm trees with edible parts that belong to 10 botanical genera; they refer to each of them with a different primary name. Mestizo people use 23 different species of palm trees, belonging to 13 genera, for which 18 common names exist. Thirteen of them are primary names (72%) and 5 are binomials (28%). The five palm species with spiny trunks are called *chonta* or the derived name *chontilla*; 11 species are called *palma* or a derived binomial name such as *palma de ramas, palma real, palmita,* or *palma paja cambana.*

There is some ambiguity in this analysis because mestizo names are recorded over a large area; for any one mestizo community, there are usually only one or two palm species, each of which typically has its own name. Mestizo plant names given to palm trees are indeed very generalized, but then there is probably no need to give separate names if the variety of palm species in the area is low.

Another interesting group of plants is the genus *Inga*, represented by 33 species in southern Ecuador. These multipurpose trees are often used as shade trees in traditional coffee groves. They provide good fuelwood and the fruits have an edible aril. Shuar people use eight species (and two subspecies), for which they have four primary and four secondary names (Table 11). Mestizo people use 23 *Inga* species. Twenty-three binomial mestizo names were recorded, 22 of which are derived from *guaba* (examples in Table 6) and one from *laricaro.* (The primary names *laricaro* and *panaco* are sometimes used as synonyms alongside *guaba.*) This again illustrates the more generalized way of naming plants by mestizo people. Even though various *Inga* species often grow in an area, informants are likely to refer to all of them as *guaba*; some use descriptors to create unique binomial names that distinguish each species.

CONCLUSIONS AND DISCUSSION

The basic data of this study come from an ethnobotanical inventory of edible non-crop plants of southern Ecuador. We do, however, believe that the large number of plant names (411 names for 354 species) that was recorded throughout southern Ecuador, combined with information on where they were recorded and how often, provide a unique opportunity to analyze how indigenous and non-

indigenous people in the area name plants. We also believe these findings to be representative for the naming of useful plants in general.

'Climbing peanuts' (*maní de bejuco*) and 'dog's testicles' (*huevo de perro*) are typical examples of how certain mestizo plant names in southern Ecuador are formed. 'Climbing peanuts' is the name of a vine, *Cayaponia capitata,* whose seeds resemble peanuts. This is a good example of transposition as a way of naming plants. 'Dog's testicles' is the name given to the hairy, oval, orange fruits of *Solanum quitoense.* This name, formed through neology, refers to the shape, size and appearance of the fruits. Transposition, neology and borrowing from indigenous languages (Shuar and Quechua) are mechanisms through which almost one-third of all mestizo plant names in southern Ecuador are formed. Another third are binomial names, one part of which is a Spanish adjective or descriptor. Descriptors are used to differentiate between similar plants or to describe a plant in more detail. They often refer to the plant being wild or highlight some other characteristic.

These observed mechanisms are typical for the naming of plants by immigrants. In the case of southern Ecuador, the immigrants creating new names were the Spanish colonizers, but also more recently Spanish-speaking mestizo colonizers migrating to new coastal and Amazonian areas. Unknown plants have to be named and this can be done by reference to known plants, by making up new names or by borrowing indigenous plant names. In recently colonized Amazonian villages, significantly more plant names are formed through these mechanisms than in villages that have been inhabited for a long time. This is, however, not the case for recently colonized coastal areas.

Forty-one percent of all mestizo names are (at least partly) Spanish. The indigenous languages Shuar and Quechua, although still spoken today by ethnic minorities in southern Ecuador, have not had an important influence on the naming of plants by mestizo people, though they may have a local influence in the area where they are spoken. Names borrowed from Shuar are rarely used by mestizo people, even when they live in the Shuar territory, which suggests that cultural exchanges between Shuar and non-Shuar people are limited.

Besides the names whose meaning or origin can be analyzed, by recognizing the mechanism that created the name, many mestizo plant names can not be analyzed in any way. For many binomial names the meaning of the Spanish or Quechua descriptor can be understood, but the rest of the name has no apparent meaning. Some names may go back to local pre-Inca languages. Many plant names are, however, simply names whose origins cannot be traced.

Such nondescriptive, opaque names show the least variation and are used to refer to the same plant taxa throughout southern Ecuador. Transparent, descriptive names, on the other hand, created through transposition or neology, or binomial names with Spanish descriptors, are most likely to vary from one area to another. Two-thirds of all edible plant species that grow throughout southern Ecuador and were recorded in at least two distinct field sites, have the same unique name in the whole region. For some plants local names exist in addition to a generally known name. A small number of plants are known by a series of different common names throughout the region. Most recorded plants, however, grow in a narrow geographical area and are known there by one name. Their

name variation can therefore not be analyzed. Economic or cultural importance of a plant has no apparent influence on the uniqueness or variability of mestizo names throughout southern Ecuador.

The naming of plants in a locality is influenced by the species composition of the area. The presence of many related plant taxa may lead to more explicit plant naming, but that is not always the case. In some areas detailed names are used to distinguish between related plants, whereas in other areas similar plants are given the same name. Knowledge and use of plant names also varies among people living in the same area. In the study area, growth of many of the edible non-crop plants is managed, which suggests they have some cultural importance. There is, however, no significant relation between the management status of a plant and the transparency or linguistic variation of its name. This is a typical phenomenon in the naming of plants in various languages throughout the world (Berlin 1992). The fact that this does not apply to our recorded plant names is probably due to the ethnically mixed situation in southern Ecuador.

Shuar plant names show little variation among villages or informants. Shuar people usually use one distinctive primary or secondary name for each botanical species. Mestizo people tend to use more binomial plant names than Shuar people do, and the names are more underdifferentiated (i.e., the same name is given to various botanical taxa). This is the case for two groups of culturally important plants, palms and *Inga* species. Mestizo names vary more from one area to another. The apparently greater variability in mestizo plant names compared to Shuar ones may simply reflect our interview sample, which included more mestizo people living in a larger and more biologically diverse area.

Could the differences in plant naming partly be explained by the different lifestyles of mestizo and Shuar people? According to Brown (1985), farming people use significantly more secondary plant names (binomials) than hunter-gatherers do, probably because of their more extensive plant knowledge. Possible explanations for this are the fact that agriculture creates a diversity of ecosystems which contain more plants, and the fact that farmers, who usually live at higher population densities, need to know more wild plants in case their crops fail. Could this in part explain a difference in use of binomial names between Shuar and mestizo people? Mestizo people are primarily farmers, whereas Shuar people incorporate more hunting and gathering practices in their farming subsistence.

Another potential explanation is suggested by Lewis et al. (1988), who report a high occurrence of primary plant names used by Jívaro people in Peru and attribute this to an "economy of words" in an oral culture. Using primary names (one word only) means communication can be more rapid. This, however, seems implausible. Why would mestizo people not want to economize on words?

The plant names included in this article were recorded in various communities spread over a large and highly varied geographical area. They therefore represent the collective knowledge of many individuals, living in many different communities and often using different plant species. It would be a mistake to make too many generalizations, since it is difficult to distinguish idiosyncratically assigned descriptive names from names shared by the population of southern Ecuador. More detailed studies would be necessary to fully understand the logic behind the naming of plants in southern Ecuador by indigenous and nonindige-

nous people. A complete list of all 411 plant names has not been added here, due to its length, but can be obtained from the authors.

NOTES

[1] Jacobs, P. n.d. *Runasimi Vocabulary* [online] Available at: http://www.philip-jacobs.de/runasimi/runasimi.txt (verified February 24, 2004).

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APPENDIX 1.—Shuar plant names of edible non-crop plants recorded in southern Ecuador.

Shuar name	Scientific name
achu	*Mauritia flexuosa* L.f.
ampakaí	*Iriartea deltoidea* Ruiz & Pavón
apai	*Grias peruviana* Miers
awant'	*Astrocaryum urostachys* Burret
chimi	*Pseudolmedia laevigata* Trécul; *Pseudolmedia* sp.
chúrunch'	*Arthrostema ciliatum* Ruiz & Pavón
eép	*Anthurium breviscapum* Kunth; *Anthurium triphyllum* Brogn. ex Schott; *Anthurium* sp.
imik sámpi	*Inga microcoma*? Harms.; *Inga nobilis* Willd. ssp. *quaternata* (P. & E.) T.D. Penn.; *Inga punctata* Willd.
iniák	*Gustavia macarenensis* Philipson ssp. *macarenensis*
jímia	*Solanum* sp.
katírpas	*Rhodospatha latifolia* Poeppig
katshiniak eép	*Anthurium breviscapum* Kunth
kawachimí	*Cordia nodosa* Lam.
kukúch'	*Solanum* sp.
kumpía	*Renealmia alpinia* (Rottb.) Maas
kúnakip	*Tabernaemontana sananho* Ruiz & Pavón
kúnapi	*Tabernaemontana sananho* Ruiz & Pavón
kunchái	*Dacryodes peruviana* (Loes.) J.F. Macbr.
kunkuin sámpi	*Inga nobilis* Willd. ssp. *quaternata*
kunkuk'	*Oenocarpus bataua* Mart.
kúpat	*Socratea exorrhiza* (Mart.) H. Wendl.
kushíkiam	*Herrania mariae* var. *putumayonis* R.E. Schultes; *Herrania* sp.
main sámpi	*Inga leiocalycina* Benth.
mirikú	Moraceae gen. indet.
moras	*Rubus urticifolius* Poir.
mukunanch'	*Rhodospatha moritziana* Schott
munchi	*Passiflora pergrandis* Holm-Nielsen & Lawesson; *Passiflora* cf. *pergrandis*
mutuch' shuinia	*Pourouma bicolor* Mart; *Pourouma guianensis* Aublet ssp. *guianensis*; *Pourouma melinonii* Benoist ssp. *melinonii*
naámpi	*Caryodendron orinocense* Karsten
najaraip	*Casearia* spp.
nakantar shuinia	*Pourouma bicolor* Mart.
napúrak	*Inga thibaudiana* DC. ssp. *thibaudiana*
nara	Urticaceae gen. indet.
nátsapai	*Grias* cf. *peruviana* Miers
natsa eép	*Anthurium* sp.
natsa unkuch'	*Piper* sp.
nátsamar	*Piper* sp.
nátsatsam	*Piper* sp.
numbi	*Jacaratia digitata* (Poepp. & Endl.) Solms
paik'	*Ceroxylon amazonicum*? Galeano
patúkmai munchi	*Passiflora foetida* L.
pau shuinia	*Pourouma* aff. *cecropiifolia* Mart.
pítiu	*Trophis racemosa* (L.) Urban; *Trophis* sp.
pumpuná	*Carludovica palmata* Ruiz & Pavón
saké	*Prestoea acuminata* Willd.
sámpi	*Inga acreana* Harms
shankuinia	*Pseudolmedia macrophylla* Trécul
sharimiat	*Mouriri grandiflora* A. DC.

APPENDIX 1.—Continued

Shuar name	Scientific name
shímpi	*Oenocarpus mapora* H. Karst.
shímpiship	*Solanum americanum* Mill.
shiniumas	*Anthurium rubrinervium* (Link) G. Don; *Anthurium* sp.
shuankukúch'	*Solanum* sp.
supínim	*Coussarea brevicaulis* Krause
terén	*Wettinia maynensis* Burret
tinkibi	*Prestoea schultzeana* (Burret) H. Moore
tinkimi	*Prestoea schultzeana* (Burret) H. Moore
tsachík	*Celtis iguanaea* (Jacq.) Sarg.
tsamba	*Vasconcellea microcarpa* (Jacq.) A. DC.
tsambúnumi	*Vasconcellea microcarpa* (Jacq.) A. DC.
tsantsaniak	*Gustavia* sp.
tsere munchi	*Passiflora* sp.
tserempach'	*Inga marginata* Willd.
tunchinchi	*Piper* sp.
túnkia	*Bellucia pentamera* Naud.
unkuch'	*Piper* sp.
untuntup'	*Piper* sp.
uruts	*Protium* sp.
uwí	*Bactris gasipaes* H.B.K
wakam	*Theobroma bicolor* L.
wámpa	*Inga edulis* Mart.
wampukish	*Inga nobilis* Willd. ssp. *nobilis; Inga nobilis* Willd. ssp. *quaternata*
wánkat	*Anthurium triphyllum* Brogn. ex Schott
washi munchi	*Passiflora pergrandis* Holm-Nielsen & Lawesson
washi shuinia	*Pourouma cecropiifolia* Mart.; *Pourouma guianensis* Aublet ssp. *guianensis*
wayákish	Lauraceae gen. indet.
wee eép	*Anthurium* sect. *Xialophyllium*
wuak	*Cayaponia capitata* Cogn. ex Harms
ya kukúch'	*Solanum stramoniifolium*? Lam.
yaás	*Pouteria caimito* (R. & P.) Radlk.
yakum sámpi	*Inga capitata* Desvaux
yarasu	*Pouteria caimito* (R. & P.) Radlk.
yayu	*Euterpe*?
yuránmis	*Physalis peruviana* L.

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LOCAL USE OF CLIMBING PLANTS OF BUDONGO FOREST RESERVE, WESTERN UGANDA

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ABSTRACT.—We investigated the use of climbing plants in and around Budongo Forest Reserve (BFR) in terms of their abundance in the forest and the cultural preferences and socioeconomic characteristics of the local population. We randomly issued questionnaires to 127 respondents in nine villages. From each of 18 ethnic groups, one respondent who was most knowledgeable about climbers was selected and asked to identify species in three 1-ha forest plots. Of the 142 species of climbers known to occur in mature forest of BFR, the local people use 63 species (44%) from 52 genera and 36 families. After trees/poles, the greatest number of respondents rank climbers as the most used plant growth form. The most frequent uses of climbers, in order, are medicine, construction materials, and food. Use patterns are related to socioeconomic characteristics. The species of climbers used most occur at low densities. To conserve rare taxa, people should be encouraged to use alternative closely related species that occur at higher densities.

Key words: Budongo Forest Reserve, ethnobotany, traditional use, lianas, climbers.

RESUMEN.—Se ha investigado el uso de plantas trepadoras en la Reserva Forestal Budongo (RFB) y en sus alrededores, atendiendo a su abundancia en el bosque, a las preferencias culturales y a las características socioeconómicas de la población local. Se realizaron aleatoriamente 127 cuestionarios a personas de nueve pueblos. Además se seleccionó a la persona de cada una de los 18 etnias que tenía más conocimientos sobre plantas trepadoras y se le pidió que identificara las especies de tres parcelas de bosque de 1 ha. De las 142 especies de trepadoras que aparecen en un bosque maduro de RFB, la población local utiliza 63 especies (44%), pertenecientes a 52 géneros y 36 familias. Según la mayoría de los encuestados la forma de crecimiento más utilizada son los árboles y después las trepadoras. Los usos más frecuentes de las trepadoras son, en orden de importancia, como medicina, material de construcción y alimento. Los patrones de uso se relacionan con las condiciones socioeconómicas. La mayoría de las especies trepadoras que se utilizan solo aparecen en el bosque en bajas densidades. Para la conservación de táxones raros, se debería animar a la gente a que utilice especies similares que aparecen en densidades mayores.

RÉSUMÉ.—Dans les alentours immédiats et au sein du réserve forestière du Budongo (RFB), nous avons étudié l'utilisation des plantes grimpantes en tenant compte de leur abondance en milieu forestier ainsi que des préférences culturelles et des caractéristiques socioéconomiques de la population locale. Nous avons distribué des questionnaires de façon aléatoire à 127 répondants situés dans neuf villages. Pour chacun des 18 groupes ethniques, un répondant était sélectionné,

soit celui qui possédait le plus de connaissances quant aux plantes grimpantes. Ceux-ci devaient identifier les espèces sur trois parcelles de forêt ayant une superficie d'un hectare. Parmi les 142 espèces de plantes grimpantes présentes dans les forêts matures du RFB, 63 espèces (44%) réparties dans 52 genres et 36 familles sont utilisées par la population locale. La majeure partie des répondants placent les plantes grimpantes au second rang après les arbres ou plantes à port arborescent en ce qui a trait au plus grand nombre d'utilisations parmi les différents habitus. Les plantes grimpantes sont surtout utilisées comme plantes médicinales, puis comme matériaux de construction et, finalement, comme aliments. Les différents types d'utilisations sont structurés selon les caractéristiques socioéconomiques. La densité des plantes grimpantes les plus utilisées demeure faible. Aussi, afin de conserver les taxons rares, la population devrait être sensibilisée à choisir davantage des espèces qui leur sont proches parentes et dont la densité est élevée.

INTRODUCTION

In Uganda, assessments of plants used by local people often lump together various growth forms and fail to highlight the contribution of climbing plants. Yet each growth form requires specific management strategies. Climbers are considered a nuisance by professional foresters and are commonly cut in forests managed for timber production. Studies focusing on the use of climbers in Uganda in recent years (e.g., Muhweezi 1999; Obua et al. 2000) were carried out around Bwindi Impenetrable National Park. The study of climbers in Budongo Forest Reserve (BFR) (e.g., Babweteera et al. 2000; Eilu 1999, 2000) has focused on ecology and taxonomy. Recent studies of community use of wild natural resources in BFR addressed general aspects on use of forest products without considering their impact on plant life forms (Johnson 1993; Lauridsen 1999; Ndemere 1997).

In this paper, we report ethnobotanical information collected on climbing plants in and around BFR. The aims of this study were: to investigate the patterns of forest resource use in relation to socioeconomic factors such as age, gender, education level, ethnic group, economic status, and distance of residence from the forest; to relate the patterns of use of climbers to quantitative plot data of climbers from BFR; to investigate whether there is preferential use of plant life forms such as climbers; and to assess the reasons favoring or discouraging the use of particular plant growth forms. The growth form of climbers has implications for management that have been neglected in the past.

BFR is a tropical rainforest in Uganda surrounded by settlements of local people involved in small-scale subsistence cultivation. Local communities obtain wild natural resources from forests in Uganda in spite of regulations restricting access to such resources. Currently, the National Forest Authority is exploring the best ways to involve communities in forest use and management, inspired in part by arrangements developed by the Uganda Wildlife Authority in Bwindi Impenetrable National Park (Cunningham 1996; Wild and Mutebi 1996).

THE STUDY AREA

Budongo Forest Reserve (BFR) is located in western Uganda between lat. 1°37′–2°03′N and long. 31°22′–31°46′E (Figure 1). It is a medium-altitude moist

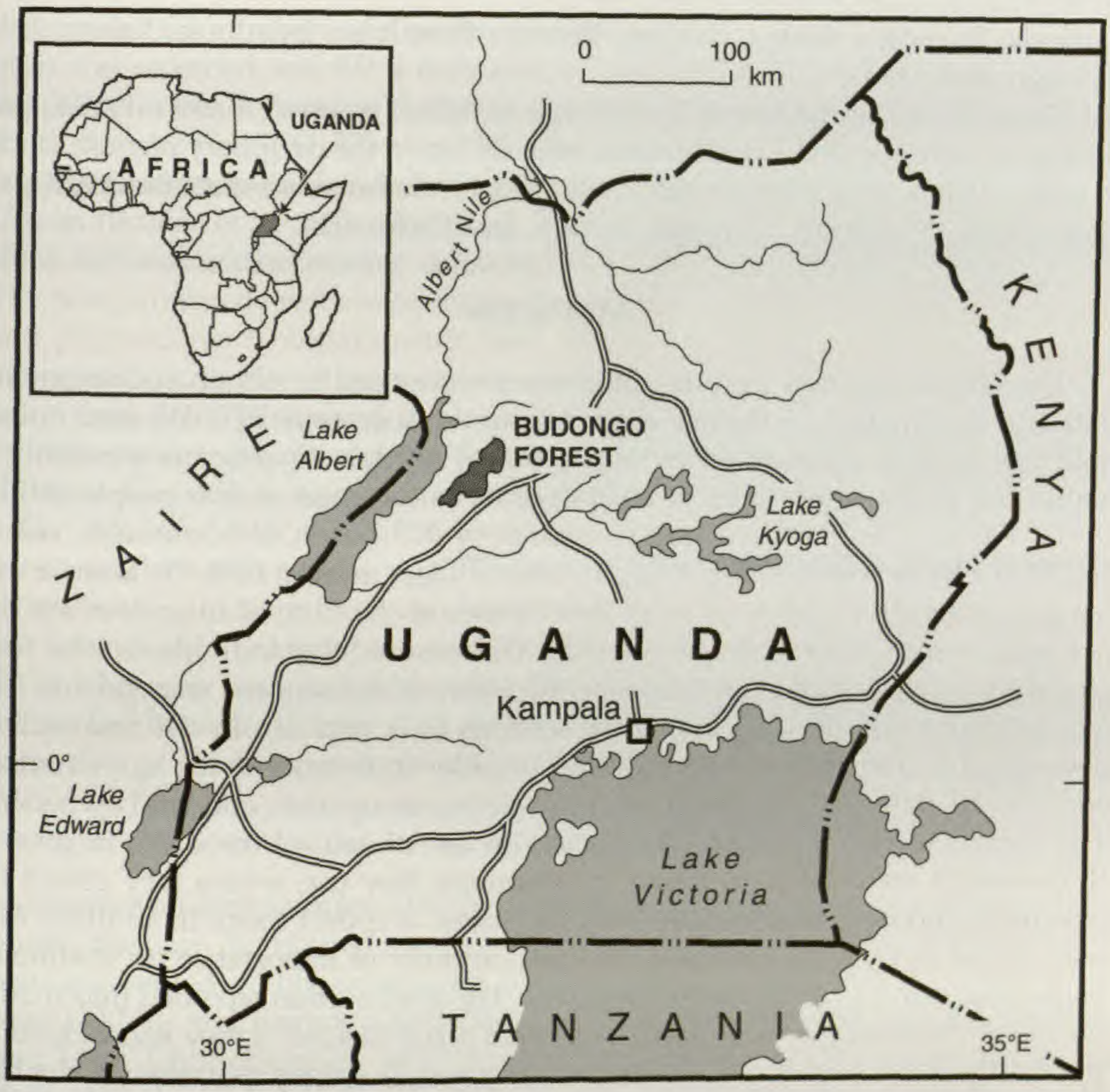

FIGURE 1.—Location of Budongo Forest Reserve.

semideciduous forest (Langdale-Brown et al. 1964) covering 793 km^2. It is dominated by *Cynometra* and *Celtis* spp. at elevations between 700 and 1000 m. The reserve is the largest block of this type of forest remaining in Uganda, but it is now degraded by timber harvesting. Intact forest constitutes only about 4% of the reserve. The forest is important for conservation of biodiversity and provides both timber and non-timber forest products to local communities. A total of 465 taxa of trees and shrubs occur in the forest (Howard et al. 1996), including *Entandrophragma* spp. and *Khaya* spp. that are on the world list of threatened species (IUCN 2003). In addition, the forest supports about 500 endangered chimpanzees (*Pan troglodytes*), 359 species of birds, and 289 species of butterflies (Howard et al. 1996). The main ethnic groups around BFR are the Banyoro, Lugbara, Alur, Lendu, and Okebo. The Banyoro are the indigenous inhabitants of the Kingdom of Bunyoro, where BFR is located (Johnson 1993). The Lugbara, Alur, Lendu, and Okebo immigrated to the Budongo area from the West Nile region in northwest Uganda and from the east to northeast of the Democratic Republic of Congo (Southall 1956). Other ethnic groups encountered in this study include Acholi,

Baganda, Bagungu, Bakiga, Bakonjo, Batooro, Bare, Iteso, Jopadhola, Kakwa, Langi, Logo, and Madi.

Three blocks of the forest Nyakafunjo (a nature reserve), Kaniyo-Pabidi, and Busingiro were studied. Local communities living on the periphery of these blocks in nine villages were interviewed (Busingiro, Nyakafunjo, Kasenyi-Bokwe, Kigaragara, Siiba, Nyantonzi, Kanyege, Kituka, and Kadukuru).

METHODS

Questionnaires and in-forest interviews were used to obtain socioeconomic data and information on the use of wild natural resources in BFR. We used household census lists maintained by local council officials to select respondents; a household in the study area is comprised of an average of five people (MFEP 1991). We randomly issued questionnaires to 127 heads of households out of 11,373 (1.1%) in communities living in nine villages around BFR. We interviewed household heads found at or near their homes at the time of interview. We did not make return visits to the households. This ensured that individuals who were already interviewed did not influence the views of subsequent respondents. The questionnaire was divided into three sections (i, ii, and iii). In the first section, demographic information was collected in order to determine the age structure, educational status, ethnic group, financial status, occupation, and land ownership. The second section recorded information on use of natural resources in general. Respondents were asked to name the resources they use, where they collect the resources, and how far they travel into the forest to collect them. In addition, they were asked to rank the resources they use in order of importance (to livelihood) beginning with "1" as the most important. The third section recorded information on use of climbing plants. Respondents were asked to state: if they know climbing plants; the local names of climbers (as opposed to epiphytes); uses of climbers (categorized as food, medicine, firewood, construction, craft, cultural use—i.e., use in traditional ceremonies—or others), reasons for using climbers, and availability. Respondents were asked to assign ranks to the seven use categories of climbers based on importance they attached to each, with "1" as the most important and "7" the least.

Of the total 127 respondents, one respondent was selected from each of the 18 ethnic groups to help identify climbers in the forest. For each ethnic group, we selected a respondent who could identify climbers and was knowledgeable on local uses of climbers. The 18 knowledgeable people identified climbers in three study plots (each 20 × 500 m), or from specimens collected in the sample plots and brought back to the camps outside the forest. The flora of climbers in the plots and surrounding areas had been assessed in earlier botanical studies (Eilu 1999, 2000). The plots were located in sites of relatively intact forest. They represented a full range of topographical variation and habitats, from valley bottom to ridge top. The data for climbing plants of diameter ≥1 cm (measured at breast height or 130 cm from the base at ground level) and rooted in the 20 × 500 m plots were recorded. From the plot data, relative density (*RD*) was determined using the formula: *RD* = Number of individuals of a species per ha/total number of individuals in the 1-ha (20 × 500 m) plot × 100. Relative density was not

determined for climbers of diameter less than 1 cm. Presence only of these in the plots was recorded and *RD* is indicated as "not determined" (ND). Vouchers were deposited in the herbaria at the Botanical Museum University of Copenhagen (C), Royal Botanic Gardens, Kew, and Makerere University (MHU).

The Spearman Rank Correlation, the Kruskal-Wallis *K* and the Mann-Whitney *U* tests (Fowler et al. 1998; Höft et al. 1999) were used to investigate the relationships between socioeconomic characteristics of respondents and use of climbers. The non-parametric tests were chosen because the data were comprised of counts and proportions. Non-parametric tests do not require the data to be normally distributed or to have homogeneous variance. Bivariate Spearman Rank Correlation tests were performed to assess the relationships between the respondents in different age groups and the way they used climbers. To compare the use of climbers for various purposes by respondents of different marital status, occupation, income levels, education levels and ownership of different sizes of land, the Kruskal-Wallis test was used. The test is appropriate if a socioeconomic characteristic (e.g., income level) can have three or more values. The Mann-Whitney test was used to compare the use of climbers for different purposes by respondents who own land and those who do not. The test compared two unmatched categories. Because sample sizes of some ethnic groups are very small, groups with <3% of total respondents are grouped together as "others."

RESULTS

Socioeconomic Characteristics.—Of the 127 respondents, 80% are male and 20% are female; they are distributed among nine villages and eighteen ethnic groups. The best-represented ethnic groups are Banyoro (27%), Lugbara (23%), Alur (15%), Lendu (12%), and Bagungu and Okebo (3% each). Other ethnic groups are Bakonjo, Logo, Langi, Baganda, and Batooro (2% each) and Acholi, Bare, Iteso, Kakwa, Madi, Adhola, and Bakiga (1% each). These are referred to as "others" in subsequent analyses.

The 127 respondents were grouped by age: 15–25 years (9%), 26–35 years (23%), 36–45 years (34%), and over 45 years (34%). About 79% are married, 9% are divorced or separated, 6% are widowed, and 6% are not married. About 57% of the respondents have been to primary school. Relatively few (20%) have been to secondary school and even fewer have attained advanced level secondary school education (2%). None of the respondents have diplomas or university degrees, and 21% have never been to school. Most respondents (94%) earn the equivalent of less than US $30 per month. A small fraction (5%) earn $30–60 and only 1% earned $61–90. About 85% of respondents own land. A large proportion of the landowners (43%) possess more than 4 ha, 28% possess 1–2 ha, 15% possess 3–4 ha, and 14% possess 2–3 ha. About 79% are subsistence farmers, and 1% of these are also traditional herbalists or tradespeople (1%). Other respondents are involved in timber extraction (5%), carpentry (4%), employees of government or nongovernmental organizations (NGOs) (4%), mechanics, clergy, and students (3%), artisans (2%), and traditional herbalists (2%). No hunters were reported.

Patterns of Use of Forest Resources.—The wild natural resources used by the highest proportion of respondents are trees/poles (44%), climbers (30%), and herbs (14%).

Only 1% said they use wild animals. Up to 8% of the people use "other" wild natural resources such as water and honey from the forest, and 3% collect mushrooms from the forest. About 80% of the respondents collect wild natural resources from the forest, 2% from outside the forest, and 18% from both inside and outside the forest, mainly from savanna. To collect wild natural resources from the forest, most respondents (63%) travel 1–5 km into the forest. Only 2% of respondents move over distances longer than 6 km to collect resources. Up to 35% of the respondents move within 1 km of the forest edge.

Use of Climbers.—A total of 63 climber species (Table 1) representing 44% of the 142 climber species recorded from BFR (Eilu 1999) are used. The species belong to 52 genera and 36 families. The respondents use the climbers mainly for medicine (19 genera), construction (11 genera), cultural use (9 genera), craft (15 genera), food (11 genera), other uses (4 genera) and firewood (1 genus). No respondent reported the use of climbers as ornamentals, although this was observed in some homesteads and the species noted. Seventy-nine species are not used. Species such as *Calamus deeratus* Mann & H. Wendl. and *Pyrenacantha* spp. are frequently used by respondents but occur at lower relative densities (< 4.5 individuals/ha) than the less used species (e.g., *Pristimera plumbea* (Blakelock & R. Wilczek) N. Hallé), which had a density of >10 individuals/ha.

Reasons Favoring or Discouraging the Use of Climbers.—Respondents gave various reasons for using climbing plants, including medicine, food, construction, and crafts. Climbers are used for medicine because respondents are unable to purchase modern medicine, they are effective against a particular ailment, they are sometimes more readily available than modern medicine, they have a long history of traditional use, and as alternatives to modern medicine. Non-climber alternatives are not used for traditional medicine because they are scarce, rare, or difficult to collect.

People say they eat fruits, leaves, or tubers of climbers during times of shortage, because they are delicious and nutritious, when a person cannot afford to buy food, because of scarcity of alternatives, for a change of diet, and as part of traditional practice. Climbers are sometimes preferred because the non-climber alternative foods are scarce, require longer preparation time, are difficult to collect, or do not taste as good.

Climbers are used for house construction because they are strong and resist insect (termite) attack. Although some other construction materials share these traits, some non-climbers are not used for house construction because they are easily damaged by insects or break easily.

Climbers for crafts are used because they make durable crafts (Figure 2), generate income (Figure 3), and are relatively more available. Non-climber alternatives are not used for craft because their collection involves travel over long distances, they are difficult to work with, and children find them difficult to collect.

Climbers are used for cultural purposes (i.e., in practices specific to the culture of an ethnic group) because they have been traditionally used, are effective against evil spirits, and have neither known nor available alternatives. They are used for firewood because they burn more slowly and are good fuels. Alternative

fuel-wood (trees/poles) were at times not used because some respondents are too old to cut the trees/poles or because it takes more time to cut, split and dry firewood.

Problems encountered in collection of some climbers include dangerous wild animals and insects, injurious/harmful plant parts, persecution by the authorities managing the forests, scarcity, and discomfort from rain or dew considered unpleasant by some respondents. Problems encountered in use of some climbers included injury from thorns/hooks of some species, harmful insects nesting in some species, long cooking time for the edible species, and pretreatment required before use. Herbalists cited lack of standard dosages as a major problem. Storage was considered a problem mainly in the case of climbers used for medicine when fresh. Lack of information sharing between the traditional herbalists was also noted as a problem.

Preference of the Use of Climbers.—Of the wild natural resources used, in terms of importance to local livelihood, the most highly ranked (Rank 1) are trees and poles (Figure 4). Most respondents ranked the climbers second. Some respondents of all ethnic groups knew general terms for "climber," but a few from two ethnic groups (Table 2) knew no word for "epiphyte." A total of 99% of the respondents did not know of any "undesirable effects" of climbers on the forest and 96% knew of uses for climbers and had actually used them.

Bivariate correlation of number of respondents in four age groups (15–25, 26–35, 36–45, and over 45 years) that use climbers for medicine, house construction, cultural purposes, craft, food, firewood and other uses showed that the older people mainly use climbers for medicine (1.00, $P < 0.001$, Spearman Rank Correlation) and house construction (0.400, $P < 0.60$). Younger people use them for "other uses" (1.00, $P < 0.001$), crafts/fibers (0.800, $P < 0.20$), firewood (0.800 $P < 0.20$), food (0.800, $P < 0.20$) and cultural/spiritual purposes (0.400 $P < 0.60$).

Proportionately more females than males collect edible parts of climbers from the forest for food (Table 3) and there was no significant difference in the use of climbers by respondents of the four marital categories ($K = 0.008$, df = 3, $P > 0.05$; Kruskal-Wallis test). Respondents of the nine occupations use climbers for different purposes ($K = 14.697$, df = 8, $P < 0.065$). The carpenters use climbers mainly for house construction and for food, while the craftspeople, as would be expected, use climbers mainly for their craft products. Traditional herbalists use climbers mainly for medicine and for cultural purposes, while government or NGO employees use them mainly for house construction. Tradespeople mainly use climbers for food. The rest of the respondents were grouped together as "others" and collectively use climbers mainly for house construction.

Respondents with different income levels use climbers for different purposes ($K = 16.650$, df = 4, $P < 0.05$). Respondents with low incomes use climbers mainly for food and for house construction (Table 3). Respondents with comparatively higher incomes (US $61–90) recorded relatively higher proportions of use of climbers for crafts. Respondents in the "high" income group never used climbers for medicine, firewood, cultural purposes and "other" uses. Respondents of different education levels used climbers for different purposes ($K = 24.613$, df = 6, $P < 0.002$). The least educated people use the climbers for cultural purposes

TABLE 1.—List of climbers recorded from Budongo Forest and some uses. Abbreviations of ethnic groups were Alu: Alur; Lan: Langi; Len: Lendu; Lug: Lugbara; Nyo: Runyoro. Rel. D: Relative density; ND: not determined.

Taxon	Voucher	Local name	Uses	Rel. D
ACANTHACEAE				
Barleria brownii S. Moore	Eilu 6-490	—	Ornamental	0.4
Pseuderanthemum ludovicianum (Buettn.) Lindau	Eilu 096	—	Ornamental	ND
Thunbergia alata Boj. ex Sims	—	*lolobi, putepute* (Lug), *nyawankura* (Nyo)	Medicine: leaves treat stomach- and backache	ND
T. vogeliana Benth.	Eilu 145	—	Ornamental	ND
Whitfieldia elongata C.B Clarke	Eilu 452	—	Ornamental	0.2
ANNONACEAE				
Artabotrys velutinus S. Elliot	Eilu 263	*ombeni* (Lug)	Construction	1.4
Monanthotaxis ferruginea (Oliv.) Verdc.	Eilu 169	*geumbwe* (Len), *achebi* (Lug), *ntera ye nkwiri* (Nyo)	Other: catch ants for food	ND
M. littoralis (Bagshawe & Bak. f.) Verdc.	Eilu 168	*ombe* (Lug)	Craft	1.0
APOCYNACEAE				
Landolphia landolphioides (Hall. f.) Chev.	Eilu 305	—	Food (fruits)	2.3
Motandra guineensis (Thonn.) A. DC.	Eilu 115	*eyi* (Len)	Medicine: treat scabies and stop diarrhea	0.9
Oncinotis glabrata (Baill.) Stapf ex Hiern	Eilu 020	*mindre mindre* (Len/Lug)	Medicine: Dried bark relieves pain of bones	ND
Saba comorensis (Boj.) Pichon	Eilu 43, 46, 421	*ndrigada* (Len)	Food (fruits)	0.1
ARACEAE				
Culcasia falcifolia Engl.	Eilu 034	*elulu* (Lug)	Construction	ND

TABLE 1.—Continued.

Taxon	Voucher	Local name	Uses	Rel. D
ARECACEAE				
Calamus deeratus Mann & H. Wendl.	Eilu 147	*kerekere* (Alu), *ngei* (Len), *ngei, kazarani* (Lug), *rugayi* (Nyo)	Craft. Other: cane used as whip	4.4
ASCLEPIADACEAE				
Mondia whytei (Hook.f.) Skeels.	—	*morundu* (Len), *gatinwa* (Lug), *omurondwa* (Nyo)	Medicine: aphrodisiac and appetizer	ND
Periploca linearifolia Dillon & A. Rich.	Eilu 212	*ma* (Len), *eji* (Lug)	Medicine: prevents growth of 'false teeth'	ND
Secamone africana (Oliv.) Bullock.	Eilu 195	*akanyamata* (Nyo)	Construction. Cultural: treats circumcision wounds	ND
ASTERACEAE				
Gynura scandens O. Hoffm.	Eilu 130	—	Medicine: leaves used to treat fever	ND
BASELLACEAE				
Basella alba L.	Eilu 136, 297	*kurekure, ndera* (Alu), *enderema* (Nyo), ndoge (Len)	Food (leaves). Medicine: induces childbirth	ND
CAPPARACEAE				
Capparis erythrocarpos Isert.	Eilu 429	—	Food (fruits)	0.2
CELASTRACEAE				
Pristimera andongensis (Oliv.) N. Hallé	Eilu 158	*kasingi* (Len), *runyangaro* (Nyo)	Construction. Firewood. Craft	1.1
P. graciliflora (Welw. Ex Oliv.) N. Hallé	Eilu 6-267	*kasingi* (Len), *runyangaro* (Nyo)	Construction. Firewood. Craft	2.7
P. plumbea (Blakelock & R. Wilczek) N. Hallé	Eilu 160	*kasingi* (Len), *runyangaro* (Nyo)	Construction. Firewood. Craft	10.1
P. polyantha (Loes.) N. Hallé.	Eilu 12-464	*kasingi* (Len), *runyangaro* (Nyo)	Construction. Firewood. Craft	ND
Salacia cerasifera Welw. ex Oliv.	Eilu 4-203	—	Food (fruits). Craft	3.7

TABLE 1.—Continued.

Taxon	Voucher	Local name	Uses	Rel. D
S. elegans Oliv.	Eilu 079	—	Food. Craft. Construction	1.7
Simicratea welwitschii (Oliv.) N. Hallé	Eilu 268	—	Construction	0.1
Simirestis dewildemaniana N. Hallé	Eilu 075	*zombinga* (Len)	Craft	ND
COMBRETACEAE				
Combretum cinereopetalum Engl. & Diels.	Eilu 274	*ayi* (Len), *eyara kombe* (Lug), *oruko-raigo, kibambanjobe* (Nyo)	Medicine. Craft	0.1
CONNARACEAE				
Agelaea pentagyna (Lam.) Baill.	Eilu 295	*rikba* (Len)	Medicine: leaves used to treat mental disorder or fever	0.3
Connarus longistipitatus Gilg.	Eilu 279, 433	—	Craft	0.2
CUCURBITACEAE				
Momordica foetida Schumach.	Eilu 039	*jorro ngwa-kwa ngwa* (Len)	Medicine: treat cough, fever and stomachache; induce abortion. Cultural: celebrate childbirth	ND
DILLENIACEAE				
Tetracera potatoria Afzel. ex G. Don.	Eilu 317	*njaa* (Len)	Medicine: roots used to treat body pain. Other: cut stems provide drinking water	4.4
DIOSCOREACEAE				
Dioscorea cayenensis Lam.	Eilu 078	*mulugu* (Alu), *luliga, ndoo, ayu* (Len), *endale* (Nyo)	Food (root tubers)	ND
D. odoratissima Pax.	Eilu 199, 201, 233, 328	*mulugu* (Alu), *luliga, ndoo, ayu* (Len), *endale* (Nyo)	Food (root tubers)	ND

TABLE 1.—Continued.

Taxon	Voucher	Local name	Uses	Rel. D
EUPHORBIACEAE				
Tragia brevipes Pax.	Eilu 338	*ewu, nyai nyai* (Len), *haka-haka* (Lug), *rugenyi* (Nyo), *ayila-yila* (Lan)	Medicine: leaves used to treat stomachache or boils and wounds, and settle domestic disputes; roots used to induce childbirth. Cultural	ND
FABACEAE				
Entada rheedei Spreng.	Eilu 051	*imira* (Nyo)	Cultural	ND
HERNANDIACEAE				
Illigera pentaphylla Welw.	Eilu 106, 185	*tago chinge* (Alu)	Cultural: to win cases in court	0.9
ICACINACEAE				
Iodes sp.	Eilu 007	*zukwa* (Len), *baabi* (Lug), *bebwa, nyinabarongo, banda barogo* (Nyo)	Cultural: repulse evil spirits and enemies; win cases in court. Construction	0.8
Pyrenacantha sylvestris S. Moore	Eilu 001, 017	*kateganende, haulambwe* (Len)	Construction. Craft: traps	ND
Pyrenacantha sp. 1, sp. 2	Eilu 095, 006	*kateganende, haulambwe* (Len)	Construction. Craft: traps	0.2
LILIACEAE				
Gloriosa superba L.	Eilu 066	—	Ornamental	ND
LINACEAE				
Hugonia platysepala Oliv.	Eilu 428	—	Ornamental	0.3
LOGANIACEAE				
Strychnos congolana Gilg	Eilu 7-096	*tha* (Len)	Firewood	0.2

TABLE 1.—Continued.

Taxon	Voucher	Local name	Uses	Rel. D
MALVACEAE				
Hibiscus calyphyllus Cav.	Eilu 430	—	Food (leaves)	ND
MENISPERMACEAE				
Triclisia sacleuxii (Pierre) Diels	Eilu 008, 041, & 148	*jor* (Len)	Cultural: chase evil spirits during burial	0.1
MORACEAE				
Ficus asperifolia Miq.	Eilu 070	*ka* (Len, *eka* (Lug), *munyamata* (Nyo)	Food (fruits)	0.1
NYCTAGINACEAE				
Pisonia aculeata L.	Eilu 173	—	Construction. Cultural: chase predators from domestic animals and birds	0.2
PASSIFLORACEAE				
Adenia tricostata de Wilde	Eilu 440	*esuale* (Lug)	Construction: termite control	0.2
PIPERACEAE				
Piper guineense Thonn.	Eilu 142	*rukokota* (Nyo)	Medicine: seeds used to treat hypertension and stomach-ache. Other: spice (seeds)	1.1
ROSACEAE				
Rubus apetalus Poir.	—	*kaa* (Len), *ewandwandwa* (Lug), *amakerre* (Nyo)	Food (fruits). Cultural	ND
RUBIACEAE				
Chassalia cristata (Hiern.) Bremek.	Eilu 128	*elelu* (Lug)	Craft	0.2
Keetia gueinzii (Sond.) Bridson.	Eilu 363	—	Food (fruits)	0.3

TABLE 1.—Continued.

Taxon	Voucher	Local name	Uses	Rel. D
RUTACEAE				
Toddalia asiatica (L.) Lam.		*oriro* (Len)	Craft. Medicine: fruits used to treat cough	0.4
SAPINDACEAE				
Cardiospermum grandiflorum Sw.	Eilu 144	*ozozua* (Lug)	Medicine: leaves used to treat boils, ringworm or fever	ND
Paullinia pinnata L.	—	*choko choko* (Len), *kabugu, omunyampatwe* (Nyo)	Craft. Medicine: treat diarrhea	0.1
SMILACACEAE				
Smilax anceps Willd.	Eilu 124	*boo, buu* (Len), *eya* (Lug)	Craft	0.2
URTICACEAE				
Urera hypselodendron (A. Rich.) Wedd.	Eilu 319	*oii* (Len), *nyakatoma* (Nyo), *odiki* (Lug)	Construction. Craft	ND
Urera trinervis (Hochst.) Friis & Immelman	Eilu 111	*oii* (Len), *nyakatoma* (Nyo), *odiki* (Lug)	Construction. Craft. Medicine: aphrodisiac	0.8
VERBENACEAE				
Clerodendrum formicarum Guerke	Eilu 189, 257, 383	*ruseke* (Alu), *luseke* (Len, Lug), *lusekeseke* (Nyo)	Craft: drinking straws	ND
C. schweinfurthii Guerke	Eilu 242	—	Medicine: relieves hypertension	ND
VITACEAE				
Cissus producta Afzel.	Eilu 6-224	*ladoro, ororo* (Lug), *tundenge* (Len), *kinya* (Nyo)	Medicine: treat diarrhea and boils. Construction	1.2

FIGURE 2.—Granary made using strong ropes of *Pyrenacantha* sp. to tie the sticks together.

as well as for medicine. Indeed the largest proportion of use for cultural purposes, in relation to education level, was among the group that had never been to school (Table 3). In addition, the largest proportion who use climbers for house construction belong to the group that has never been to school.

All ethnic groups collect and use some forest climbers (Figure 5) for medicine and for construction. Only the Bagungu, the Alur, the Lugbara and the Banyoro use the forest for cultural purposes. Respondents who own land use climbers more than those who do not ($U = 6.5$; $P < 0.05$, n_1 and $n_2 = 7$, Mann-Whitney

FIGURE 3.—Stools made from rattan canes (*Calamus deeratus*) on sale at the roadside to generate household income.

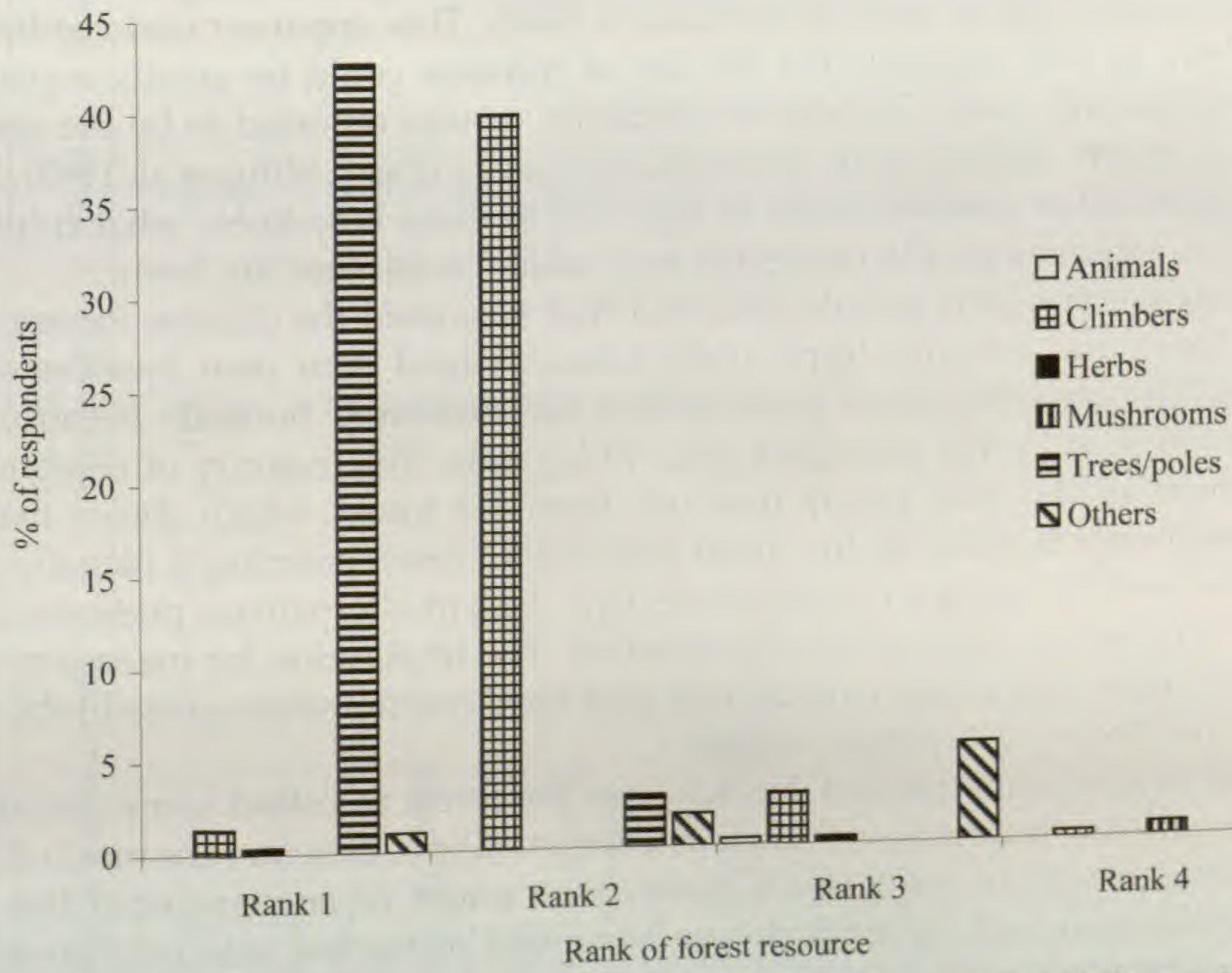

FIGURE 4.—Wild natural resources used by the communities around Budongo Forest Reserve. Rank 1 represents the resource perceived by respondents to be most important to household livelihood and rank 4 the least important.

TABLE 2.—Local terms for "climber" and "epiphyte" according to the different ethnic groups.

Ethnic group	% respondents (n = 127)	Climber	Epiphyte
Alur	15	*tol*	*aturubombo, obendoyaii*
Bagungu	3	*bihururwa, bikosi*	none
Banyoro	27	*bihururwa, ebiguha, ebigoye*	*ebitaama, engurukii, engurukizi*
Lendu	12	*baa, jorro, mbicha, mbii, mbui, ngai*	*banju, gwi, mbutekutha, satha*
Lugbara	23	*baka, bakaraza, kalia, patiraza*	*ebikobi, lari, laro, laru, patiabi*
Okebo	3	*baabu, kaba, onvu*	none
Others	17	—	—

test). However, there was no significant difference in use of climbers by respondents who own different amounts of land ($K = 0.020$, df = 3, $P > 0.05$; Kruskal-Wallis test).

DISCUSSION

Climbing plants have an extraordinary range of uses (Phillips 1991). Among the natural resources desired by the communities from BFR, most respondents ranked climbers second only to "trees and poles." The 63 species of climbers used represent only a small proportion of the climber species recorded from BFR (Eilu 1999) compared for example to 80% use of the climber flora by Ecuadorian lowland peoples (Kvist and Holm-Nielsen 1987). This apparent underutilization of climbers in BFR suggests that the use of climbers could be greatly expanded. Most respondents used climbers for medicine, as was reported to be the case for the Siona-Secoya Indians from Amazonian Ecuador (Paz y Miño et al. 1995). More people knew what climbers were, as opposed to those who knew what epiphytes were. This suggests people recognize and value the climber life form.

Whereas some respondents indicated that they used the climber *Pyrenacantha* sp. for ropes and to make traps, none acknowledged their own involvement in hunting. The question about hunting was not answered honestly because it is illegal in BFR and other protected areas in Uganda. The majority of respondents obtain most of the wild plants they use from the forest, which shows that the local people rely heavily on the forest and cannot resist entering it illegally. Reasons advanced for using climbing plants (e.g., lack of alternatives, preference, and traditional practice) support this observation. The implication for management of protected areas is that mechanisms that give local communities access to the most desired products are urgently needed.

Most respondents traveled 1–5 km into the forest to collect some natural resources; very few traveled over 5 km. The forest edge is therefore the most utilized and degraded part of the forest. Conservation might be encouraged if this area were demarcated and the local people permitted to harvest selected non-timber resources from it in a regulated manner.

Older people mainly use the climbers for traditional medicine. Only rarely do they use them for food, crafts, or firewood. Young people, some of whom

TABLE 3.—Socioeconomic characteristics of respondents who reported climber use. Values indicate the number of times each category of climber use was reported by respondents.

Socioeconoimic characteristic	Number of respondents	Food	Medicine	Firewood	Construction	Craft	Cultural	Other[2]
Sex								
Male	102	80	43	33	82	59	10	4
Female	25	24	8	3	13	9	2	0
Marital status								
Unmarried	8	4	3	3	7	5	12	3
Married	100	84	41	28	76	55	12	3
Divorced/separated	11	8	4	3	9	4	0	0
Widowed	8	6	3	2	5	4	0	1
Occupation								
Subsistence farmers	100	79	36	24	70	52	8	3
Timber extractors	6	6	6	5	4	2	0	0
Carpenters	5	5	4	2	5	3	2	0
Artisans	3	1	0	1	2	3	0	0
Traditional herbalists	3	2	3	0	2	1	3	0
Government/NGO[1] employees	5	3	2	1	5	3	0	1
Tradespeople	1	1	0	0	0	0	0	0
Other	4	2	2	1	4	2	1	0
Income (monthly; US$)								
<30	120	95	47	34	87	65	12	4
30–60	6	5	3	1	4	1	0	0
61–90	1	1	0	0	1	1	0	0
Education								
Secondary, advanced level	3	2	0	1	2	2	0	1
Secondary, ordinary level	25	19	7	7	18	14	0	0
Primary level	72	62	11	20	8	40	2	2
Never been to school	27	5	23	2	58	4	7	0

[1] NGO: Nongovernmental organization.
[2] Other: Water, honey, and mushrooms.

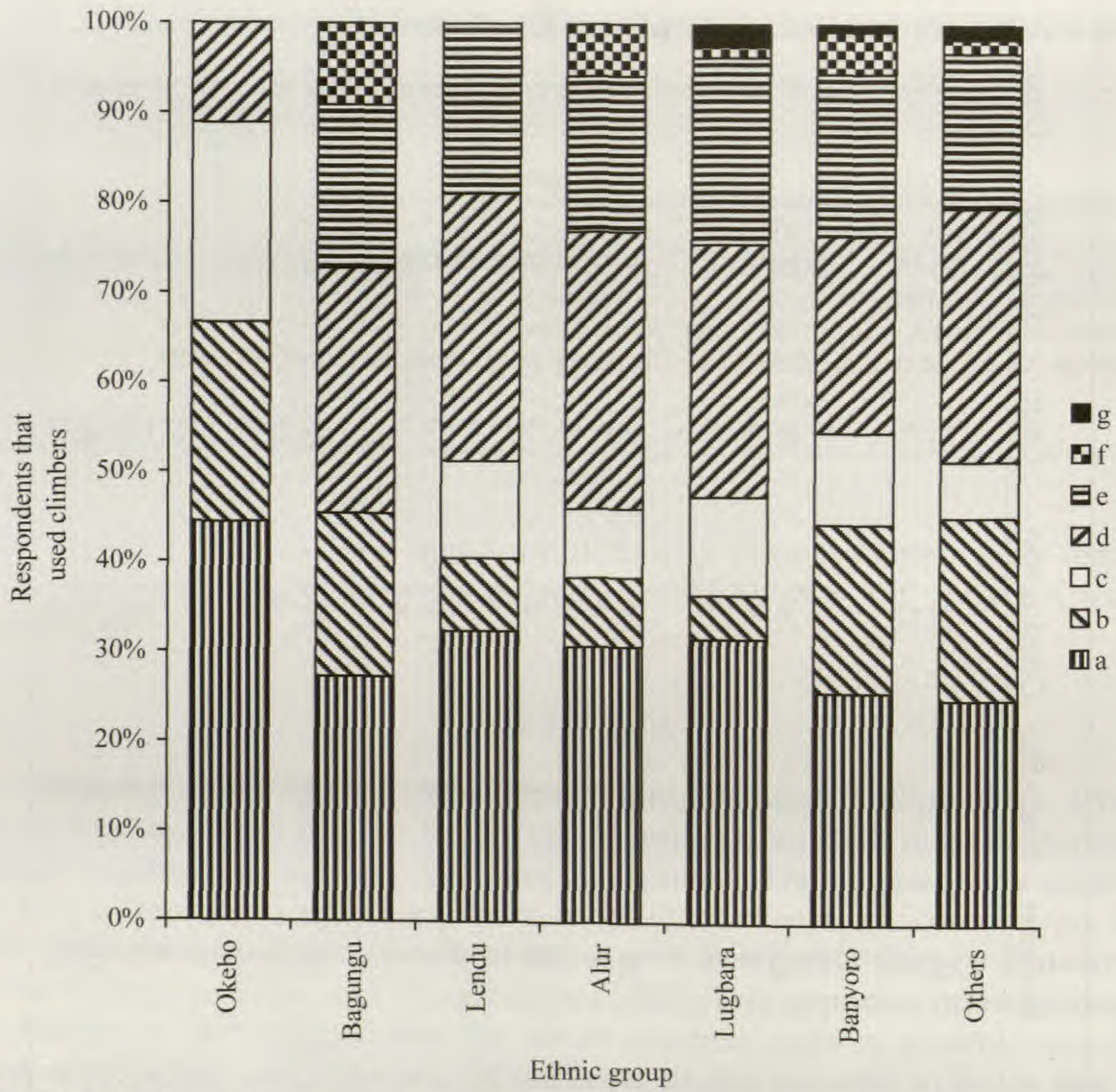

FIGURE 5.—Relationship between ethnic group and main categories of climbers used. The categories are represented as: a (food); b (medicine); c (firewood); d (construction); e (craft); f (cultural purposes); and g (others). Ethnic groups used climbers for more than one purpose.

engage in hunting, consume wild edible species casually as they pursue other activities (see also Johns et al. 1996). Those who have been to school consider the use of medicinal plants a primitive practice, but they turn to cultural uses of climbers in an attempt to solve social and economic problems. Young people have more energy and therefore spend more time collecting firewood and materials for crafts from the forest. More females collected climbers from the forest for food than did the males because their traditional role includes preparing food for their families; when they go to the forest for firewood and materials for crafts, they are more likely to collect some fruits, too.

Phillips et al. (1994) have shown that the notion of what plants are useful varies from culture to culture. However, the different ethnic groups live together around BFR and a number of plant uses are common to all the groups, which indicates knowledge is exchanged between groups. Concerning occupation and climber use, the carpenters ate some fruits from climbers as they went about collecting timber and construction materials, and probably pitsawing. Traditional

herbalists made most use of climbers for cultural purposes, because herbal medicine is often administered along with spiritual and mystical powers that do not directly treat ailments but create faith in the treatment.

Poor people generally used climbers to supplement their diet and as an alternative to spending cash on food items (similarly, Somnasang and Moreno-Black (2000) found that in Thailand, one of the reasons that wild food was preferred over cultivated food was to save money). The poor use climbers for house construction whereas the relatively higher income earners use the more expensive bricks and iron sheets. Respondents with relatively high income use the climbers mainly for handicrafts/fibers, which suggests that sale of crafts raises income. One of the climbers (*Calamus deeratus*) is used to make stools and chairs sold on a commercial scale and could indeed make a major contribution to income (Stockdale and Power 1994).

Respondents with relatively higher incomes can afford alternatives, and therefore none use climbers for medicine, cultural purposes or firewood. Only the least educated people use the climbers for medicine and for cultural purposes, indicating that the uneducated continue to follow traditional practices more than educated people do.

Most of the problems encountered in collecting and using climbers relate to injury sustained from thorns (in the forest) and hooks (on some climber species, such as *Calamus deeratus*), wild animals, and injurious insects. These, together with the fear of park and forest officers, serve as deterrents and may partly help protect the forest until proper measures are put in place to regulate harvesting.

Some climbers used for cultural purposes (e.g., *Entada rheedei* Spreng. and *Iodes* spp.) have no known alternatives and illegal use is likely to continue. Others are threatened by uncontrolled commercial use (e.g., *Calamus deeratus,* which is used by most respondents). Some plants may be amenable to cultivation. For example, respondents tolds us that *Pyrenacantha* spp. are becoming difficult to find, so planting *Pyrenacantha* spp. (and other scarce species) by the local people should be investigated and encouraged outside the forest. Similarly, improved cultivars of edible climbers such as *Dioscorea* spp. might be developed; cooking time of wild *Dioscorea* spp. was reported to be longer than for other foodstuffs (mainly potatoes and cassava). Studies to propagate these species and improve the varieties to shorten cooking time should be pursued. This would be a step towards addressing the food security situation, since it was indicated these species are eaten mainly during times of drought and food scarcity. Ultimately, however, if preferred, but stressed climber species are to be protected, the major reasons against using alternatives need to be addressed.

Inability to standardize dosages of herbal medicine, and lack of proper storage facilities or preservatives (particularly for medicinal plants used fresh), are major problems that require attention. The challenges, when addressed will ease pressure on some of the affected plants. The best immediate option is to design strategies for controlled use. Information sharing among the traditional herbalists is proposed as one of the initial steps towards addressing problems in plant use in relation to dosage, intellectual property rights and conservation measures. The various practitioners who worked together during the present study acknowledged having learnt from each other and wish to collaborate in the future.

CONCLUSION

This study showed that most of the local people around BFR are familiar with the climber growth form and use climbers. The local people did not use 56% of the climber species recorded from BFR. The unused species are potential alternatives to some closely related preferred species. Regulating the use of plant resources based on growth forms is encouraged as a means of conserving rare species. The formation of local plant user groups should take into account aspects such as age, sex, and occupation because these social variables have a bearing on how people harvest and use plants. Most respondents had positive views about climbers as a growth form, and this attitude should be exploited to encourage planting of useful climbers on privately owned land. In addition availability of climbers outside the forest requires investigation and increased use of such climbers could ease pressure on forest climbers.

Medicinal plants constitute the major non-timber resource that people around BFR obtain from the forest. Only very few people (traditional herbalists and birth attendants) collect them. The medicinal plants may withstand the pressure of this extraction for some time, but the status of the individual species needs to be assessed. For each plant resource, there is a need to study in detail the methods of harvesting to identify which methods are sustainable. Related to this is the need to determine the quantities (and parts) harvested for each climber on a daily, monthly or yearly basis for purposes of economically valuing the resource. Establishment of use zones in BFR permitting collection of the most highly ranked resources within 5 km of the forest edge might provide economic benefits to the local population without disturbing the inner forest. These are some of the important issues that need to be addressed before policies are formulated on the use of climbers from the forest.

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SAMPLING TO REDUNDANCY IN ZOOARCHAEOLOGY: LESSONS FROM THE PORTLAND BASIN, NORTHWESTERN OREGON AND SOUTHWESTERN WASHINGTON

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ABSTRACT.—A method for determining whether a group of samples is adequate to address a research question is presented. As each sample is analyzed the average value of a variable is recalculated and a cumulative graph is produced. When the value of the average stabilizes, one has empirical evidence that analysis of additional samples is not necessary—one has sampled to redundancy—and the collection is adequate for its intended analytical purpose. Analysis of two zooarchaeological collections of mammalian remains recovered from the Portland Basin of northwestern Oregon and southwestern Washington illustrates this point. Despite the spatial and temporal propinquity of the two sites, one assemblage is adequate for estimating taxonomic richness and diversity whereas the other, larger collection, is adequate for estimating richness but not diversity. Combined, the two collections are adequate for estimating taxonomic richness but do not provide an accurate measure of taxonomic diversity. Graphing procedures for monitoring sample adequacy, if implemented in the field, could help preserve finite archaeological resources.

Key words: mammalian zooarchaeology, sample adequacy, sampling to redundancy, taxonomic diversity, taxonomic richness.

RESUMEN.—Se presenta un método para determinar si un grupo de muestras es adecuado para abordar una investigación concreta. Al analizar cada muestra se vuelve a calcular el valor medio de la variable y se produce un gráfico acumulativo. Cuando se estabiliza el valor de la media se concluye empíricamente que no es necesario analizar muestras adicionales pues se ha muestreado de manera redundante y la recogida de datos es suficiente para el pretendido análisis. Este hecho se ilustra con el análisis de dos colecciones de restos de mamíferos recogidos en la cuenca del río Portland en el noroeste de Oregón y en el suroeste de Washington. A pesar de la proximidad espacial y temporal de ambos yacimientos, una de las colecciones es adecuada para estimar la riqueza taxonómica y la diversidad, mientras que con la otra colección que es mayor, se puede estimar la riqueza, pero no la diversidad. La combinación de ambas colecciones es adecuada para estimar la riqueza taxonómica pero no proporciona una medida exacta de la diversidad taxonómica. La realización en el campo de métodos gráficos que representan la idoneidad de la muestra, podrían ayudar a conservar recursos arqueológicos escasos.

RÉSUMÉ.—Nous présentons une méthode permettant de déterminer si un ensemble d'échantillons est suffisant pour répondre à une problématique de recherche.

Pour chacun des échantillons analysés, la valeur moyenne d'une variable est recalculée et un graphique cumulatif est créé. Lorsque la valeur de la moyenne devient stable, l'on obtient une donnée empirique indiquant que l'analyse des autres échantillons n'est pas nécessaire—et que les échantillons deviennent redondants; la récolte de données est alors jugée suffisante pour les besoins des analyses prévues. Des analyses de deux collections zooarchéologiques de restes de mammifères découverts dans le bassin de Portland, au nord-est de l'Oregon et au sud-ouest de Washington mettent en lumière ce point. Malgré la proximité temporelle et spatiale des deux sites, un seul assemblage est adéquat afin d'évaluer la richesse et la diversité taxonomique alors que l'autre collection plus importante est suffisante pour évaluer la richesse, mais non la diversité. Si l'on combine les deux collections, on peut évaluer adéquatement la richesse taxonomique, mais on ne peut obtenir une mesure précise de la diversité taxonomique. Les méthodes graphiques qui assurent le suivi d'un échantillonnage précis peuvent aider à conserver les ressources archéologiques limitées; il faut cependant les mettre en place sur le terrain.

INTRODUCTION

One of the hallmarks of the so-called "new" or "processual" archaeology of the 1960s and 1970s was a call to utilize probability sampling to guide the collection of archaeological materials (Binford 1964; Redman 1974; Rootenberg 1964; Vescelius 1960). This call was echoed in paleontology (Krumbein 1965) and ethnography (Honigmann 1970) at about the same time. In archaeology the call was accompanied by a concern over how large samples had to be in order to be "representative" (Cowgill 1964), and various researchers worked toward empirically deriving a universal sample size that was in some sense representative (Mueller 1974; various chapters in Mueller 1975). Most soon realized that the more diverse the population in terms of the variable of interest, the greater the sample size necessary to be representative. It was also recognized that accurate estimates of different population parameters sometimes require samples of different sizes (Hole 1980). In other words, a sample of some size that is representative in terms of estimating one parameter will not necessarily be adequate or representative in terms of estimating other parameters. There is no sample size (ignoring that of 100%) that will allow all parameters of a diverse population to be accurately estimated statistically. Assuming that a representative sample could be generated and also be shown empirically to be representative, the pressing question thus became: How is sample adequacy to be determined in any particular case?

Dunnell (1984:72) suggested that "it should be possible to determine sample adequacy empirically by following an incremental program in which the significance of the effect of adding additional sampling units is measured directly." Leonard (1987) expanded on this suggestion and argued that one should sample incrementally "to redundancy." He indicated that the way to do this was to "plot the information gained against the number of samples taken and determine if the curve is becoming asymptotic. It may then be reasonable to assume that the sample is sufficiently representative with regard to that particular information" (Leonard 1987:499). This exact procedure had been used twelve years earlier by a paleontologist who sought to determine if his collection of late Quaternary mam-

malian remains was representative in terms of genera identified (Wolff 1975). He plotted the cumulative number of genera on the vertical axis and the incremental samples on the horizontal axis; when the curve defined by the plotted points leveled off across multiple samples, he argued that he had sampled sufficiently to have collected remains of all genera. We emphasize that empirical demonstration of sample representativeness by the procedure of sampling to redundancy demands a total sample that is in fact larger than a merely representative sample.

To our knowledge, the sampling-to-redundancy procedure outlined by Dunnell (1984), described by Leonard (1987), and used by Wolff (1975) has seldom been used in archaeology and only once, so far as we know, in zooarchaeology (Butler 1990). Instead, many have followed Grayson's (1984) recommendation and determined if a correlation existed between the values taken by the variable of interest and sample size. Following this procedure, if the values of the variable covary significantly with sample size, then typically it is concluded that the value of the variable might be a function of the sample size rather than a function of the character of the population. Others have attempted to develop procedures much like a paleontologist's rarefaction technique (Tipper 1979) to circumvent sample-size effects on various analyses (Kintigh 1984). Archaeologists have used this procedure (e.g., McCartney and Glass 1990; selected chapters in Leonard and Jones 1989), though it has also been noted that this approach presumes much is already known about the structure of the archaeological record (Rhode 1988). In this paper we illustrate the incremental sampling-to-redundancy procedure. We use zooarchaeological materials from sites we have studied, plus zooarchaeological data generated by others, to explore the utility of the procedure. To be successful, explicit definition of variables is critical.

METHODS AND MATERIALS

The terms of probabilistic sampling and studies of diversity, particularly the latter, are not always consistently defined. It is thus critical to provide explicit definitions of the terms that we use in our discussion. A *population* is some set of phenomena about which we wish to know one or more characteristics. A *sample* is some subset of the phenomena making up a population. A *parameter* is a measurable property of a population; parameters are estimated by characteristics of samples. The *richness* of a population concerns the number of kinds or classes of phenomena comprising that population. The *evenness* of a population concerns the distribution of individual phenomena across classes of phenomena; high evenness occurs when each class has the same number of individuals as every other class. In both the ecological (Spellerberg and Fedor 2003) and zooarchaeological (Byrd 1997) literature, "diversity" sometimes refers to richness and sometimes to how we have defined the term. For us, *diversity* refers to a combined measure of richness and evenness; if richness, evenness, or both increase, then so too will diversity. A simple way to conceive of diversity is this: the lower the probability that the taxonomic identity of an individual randomly chosen from a population can be predicted, the more taxonomically diverse the population. Diversity may appear to stabilize when the effect of increased richness on the diversity index is offset by change in evenness. In the following, we presume that one is interested

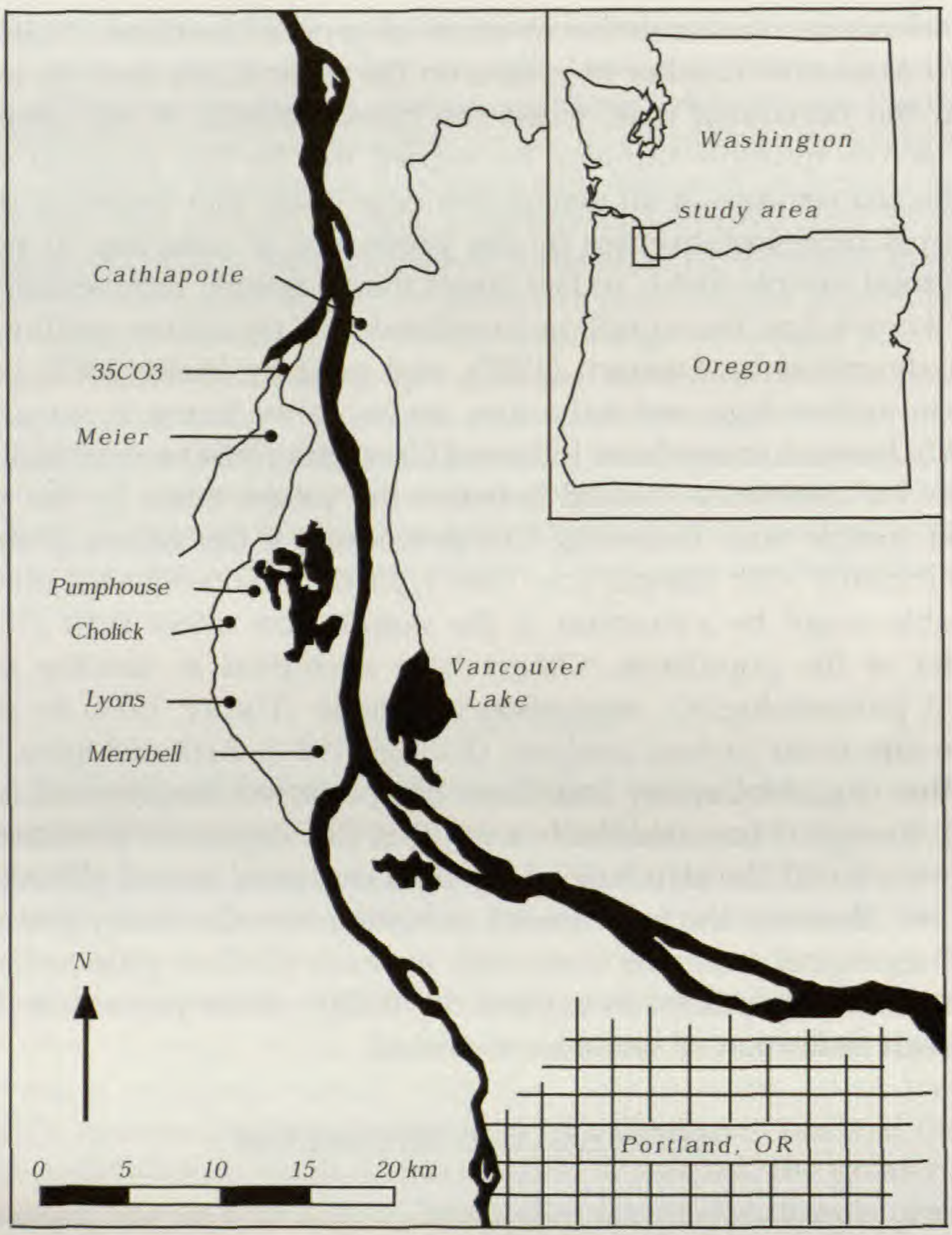

FIGURE 1.—Map of Portland Basin showing locations of sites mentioned in text.

in the quantitative property of diversity rather than the separate influences of richness and evenness on it.

Zooarchaeological collections of mammal remains recovered from two late prehistoric sites within 10 km of one another provide the data. Both are found in what is locally known as the Portland Basin or the Wapato Valley of northwestern Oregon and southwestern Washington (Figure 1). All mammalian remains from both sites discussed here were recovered from one-quarter inch mesh screens in the field. The Meier site (35CO5) is located downstream (north) of modern Portland, Oregon, on the floodplain of the Columbia River, on the Oregon side. The Meier site comprises a single large cedar-plank house, which was occupied more or less continuously between approximately A.D. 1400 and A.D. 1800, and associated midden deposits (Ames 1996; Ames et al. 1992). The site was tested in 1973 (Pettigrew 1981) and 1984 (Ellis n.d.). It underwent extensive excavations every year from 1987 through 1991. The 1973 collection was made by Pettigrew (1981) and studied by Saleeby (1983). The 1984 tests were directed by Ellis (n.d.); any

recovered fauna remains from those tests have not been analyzed. Lyman studied all mammalian remains collected by Ames in later years. The six assemblages resulting from the annual field seasons are each treated as one incremental sample.

The other site, Cathlapotle (45CL1), is located northeast of Meier, on the Washington side of the Columbia River, on a series of levee-like scroll bars next to a distributary of the river (see the map in Ames and Maschner 1999:110). The site was visited by Lewis and Clark in March of 1806, at which time it comprised several large cedar-plank houses and associated midden deposits (Ames et al. 1999). Radiocarbon dates indicate the main occupation began about A.D. 1450. Seriation of ceramic trade goods indicates abandonment circa A.D. 1834 (Kaehler 2002). Auger sampling of the Cathlapotle sediments took place in 1992–93, and excavations took place each year from 1993 through 1996; both augering and excavation were under the direction of Ames. Faunal remains from the augering are here treated analytically as one incremental sample, and each assemblage resulting from an annual excavation season is treated as a distinct annual sample, for a total of five incremental samples. Lyman identified all mammalian remains recovered from this site.

With the probable exception of the auger samples from Cathlapotle, the assemblages of mammalian remains from the two sites were recovered from similar contexts. At both sites, the deposits are classified into analytical units (AU) defined on the basis of their age, their depositional origin, and their position in relation to the house structures that dominate the deposits. Deposits are first designated as exterior or interior deposits (outside or inside of a house, respectively). Exterior deposits are designated as "midden" deposits and "yard" deposits. The former have very high organic contact, lenses of freshwater mussel shells, and other indications that they formed as primary or secondary dumps (Ames et al. 1999). Yard deposits are generally broad sheet-like deposits that contain intact hearths, activity areas, pits, evidence of small structures, and so forth. They usually lack the very high organic content of middens though they can have some organic remains. Interior deposits are separated according to the structure facility in which they occur. We assign these deposits to walls, benches (deposits below the 2-m wide sleeping platforms that ran along the interior side of the house walls), storage pits, and hearth areas.

The houses at Meier and Cathlapotle had extensive subfloor storage features that, at Meier at least, formed a cellar almost 2 m deep that extended under the house floor between the sleeping platforms and the row of hearths in the house's center. The Cathlapotle features are less extensive, but are about 2 m wide by 2 m deep. They are below the sleeping platforms rather than next to them as at Meier. The mammalian remains from both sites were derived primarily from these storage pits and exterior areas.

All frequencies of mammalian taxa are given as number of identified specimens (NISP). Because taxonomic abundance data based on NISP values are typically at best ordinal scale (Grayson 1984), we use ordinal scale statistics in our analyses. We examine the influence of sample size on two parameters typically estimated in zooarchaeology—taxonomic richness and taxonomic diversity. We use the taxonomic level of genus when considering these parameters because some

genera in the collections are polytypic but the species represented by zooarchaeological specimens could not always be determined. We include what are likely to be remains of intrusive rodents (*Scapanus, Sorex, Peromyscus, Microtus, Eutamias, Tamiasciurus, Thomomys*) that lived in the area at the time of site occupation, but we exclude the few remains of historically introduced domestic taxa in the collections from our analyses (NISP < 10 at both sites). Richness is here measured as the number of identified genera. To measure diversity we follow zooarchaeological tradition and use the Shannon index, $-\Sigma\ p_i \ln p$, in which p is the proportion of the total NISP in a sample identified as taxon i, and ln is the natural log. Evenness is generally measured as the Shannon index divided by the ln of richness. We do not include evenness in our analyses here except to note how it influences values of diversity.

Throughout the discussion the terms cumulative graph and cumulative curve are used as convenient shorthand for illustrations and descriptions of the relationship between the variable of interest and how it changes relative to cumulative incremental samples. Given how richness and diversity are calculated, it is important to make clear what the curves on cumulative graphs will look like. In a graph in which incremental samples are added on the X-axis and cumulative taxonomic richness is plotted on the Y-axis, the curve will become progressively less steep as fewer new taxa are added with new samples and will level off once all taxa have been encountered. The curve on a graph with incremental samples added on the X-axis and diversity on the Y-axis will increase as taxa are added, as evenness increases, or both. Unlike a cumulative richness curve, a cumulative diversity curve can decrease or have a negative slope. This is so because evenness can decrease as samples are added (there is no reason to expect every sample to have the same evenness). Thus cumulative curves, especially for diversity, may tell us something about the underlying structure of the cumulative samples with respect to richness and evenness that is not otherwise apparent in long tables of NISP values.

Cumulative graphs are used here to illustrate how measures of richness and diversity change with the addition of each incremental sample. The graphs grant insight to the influences of sample size on the taxonomic richness and diversity at each site. At neither site were excavation units chosen probabilistically. Rather, both were excavated with similar research goals in mind and using similar clues based on surface features and previous testing and excavation. If the mammalian populations differ between the two sites, then cumulative curves should level off at different positions in terms of incremental samples and perhaps at different total NISP values. As Meltzer et al. (1992) indicate, the slope and shape of the curve describing the relationship between cumulative sample size and cumulative richness depend on the underlying structure of the population—its richness, evenness, and diversity (see also Byrd 1997). Assemblages with low richness and high evenness will produce curves with short, steep slopes that level off quickly. If richness is high, evenness is low, or both, the curve will level off more gradually.

Meltzer et al. (1992) follow Grayson (1984) and state that if a correlation is found between sample size and richness or between sample size and diversity, then the latter values are likely reflecting sampling and collection activities of the archaeologist rather than the parameter of the population. We agree, and note that

the editors of *Science* recently saw fit to publish a case study from paleontology exemplifying the relationship between sample size and sampling intensity, and taxonomic richness and diversity (Crampton et al. 2003). They did so because many paleontologists assume that their samples are representative of the variable(s) of interest, rather than test the assumption (Smith 2003). It seems to us that many zooarchaeologists behave similarly (as do archaeologists studying lithics, ceramics, and virtually all other kinds of archaeological materials). The graphic technique described here is simple conceptually and quickly used as a test of sample adequacy. Although we focus on just this test here, we attempt to go a bit beyond exemplification of it by considering a little-used method that could have some analytical utility beyond its efficiency as a method to test for sample-size effects.

We refer to the entire set of identified remains from a site as a *collection* because entire sites were not excavated but rather only a portion of each site was excavated. Each collection is, then, actually a sample of what is present in site deposits. We refer to each annually recovered set of remains as a *sample.* Basic descriptive data for all 11 samples and both collections are presented in Tables 1 and 2. To illustrate how the definition of a population can influence whether a sample is representative or not, we identify two kinds of populations. The first is the typical site-specific population. That is, we are concerned with estimating taxonomic richness and diversity of the population of mammalian remains at each individual site. The second population we define is the suite of mammalian genera represented in archaeological deposits of the Portland Basin. The population characteristics of interest at this more inclusive geographic scale are again taxonomic richness and diversity.

RESULTS

The Individual Sites.—The Cathlapotle collection (NISP = 6920) is a bit larger than the Meier collection (NISP = 6420), yet the former site has only 22 genera whereas the latter has 25 genera represented. Plotting cumulative taxonomic richness against the cumulative incremental samples indicates that richness levels off subsequent to addition of the fourth sample (cumulative NISP = 4079) from Meier whereas the number of genera increases with the addition of each sample, including the fifth and final sample (cumulative NISP = 6920), from Cathlapotle (Figure 2). This indicates that despite the larger sample size measured as total NISP at Cathlapotle, we have not yet sampled to redundancy in terms of taxonomic richness—in this case, in terms of mammalian genera—at this site. The fact that nearly 2400 NISP are added by the last two incremental samples at Meier—a 59% increase to the cumulative NISP of 4079 after the first four annual samples—yet no additional mammalian genera were identified suggests that we have sampled to redundancy in terms of taxonomic richness at this site.

For each site, the NISP of each individual incremental sample is not correlated with the number of genera represented in the sample. At Meier, Spearman's rho = 0.77 ($P = 0.1$); at Cathlapotle, rho = 0.9 ($P > 0.08$). In other words, if one were to calculate this statistic to determine if taxonomic richness was a function of sample size at either of these sites, the site-specific coefficient would not reveal

TABLE 1.—Number of identified specimens (NISP) of mammalian taxa from each field season at the Meier site (35CO5).

Taxon	1973	1987	1988	1989	1990	1991	Total
Scapanus	4	4	3	4	1	2	18
Sylvilagus	2	3	1	1	10	1	18
Aplodontia	2	1	—	1	—	3	7
Eutamias	—	—	—	1	—	—	1
Tamiasciurus	—	—	2	—	—	—	2
Thomomys	—	2	—	1	5	1	9
Castor	13	100	65	52	41	71	342
Peromyscus	—	4	12	12	4	3	35
Neotoma	—	—	1	—	—	—	1
Microtus	—	15	25	34	15	11	100
Ondatra	37	97	55	59	74	52	374
Erethizon	—	—	—	1	—	—	1
Canis	21	25	13	16	11	25	111
Vulpes	3	1	1	—	—	—	5
Ursus	20	16	20	7	13	26	102
Procyon	15	79	51	35	43	64	287
Martes	1	6	1	—	1	11	20
Mustela	4	35	17	19	38	21	134
Mephitis	—	1	1	—	—	2	4
Lutra	6	12	6	2	11	14	51
Felis	—	4	1	—	3	1	9
Lynx	9	5	4	1	4	8	31
Phoca	3	6	5	10	6	13	43
Cervus	103	165	191	152	106	218	935
Odocoileus	276	788	756	562	570	838	3780
Annual sample totals							
NISP	519	1359	1231	970	956	1385	6420
Richness	16	21	21	19	18	20	25
Diversity	1.606	1.618	1.440	1.547	1.593	1.489	1.555
Cumulative totals							
NISP	519	1878	3109	4079	5035	6420	
Richness	16	21	23	25	25	25	
Diversity	1.606	1.623	1.558	1.559	1.568	1.555	

TABLE 2.—Number of identified specimens (NISP) of mammalian taxa from each field season at Cathlapotle (45CL1).

Taxon	Augering	1993	1994	1995	1996	Total
Scapanus	—	—	—	—	3	3
Sorex	—	—	4	—	—	4
Lepus	—	—	12	20	18	50
Aplodontia	2	18	41	42	33	136
Castor	1	32	123	185	51	392
Peromyscus	—	—	4	1	—	5
Microtus	1	—	12	16	39	68
Ondatra	—	19	34	32	21	106
Canis	—	4	27	5	3	39
Vulpes	—	1	3	1	—	5
Ursus	1	23	29	31	18	102
Procyon	1	57	59	70	20	207
Martes	—	—	—	2	—	2
Mustela	—	3	14	7	5	29
Mephitis	—	—	—	—	3	3
Lutra	—	14	19	13	19	65
Felis	—	5	3	3	1	12
Lynx	—	2	6	12	6	26
Phoca	—	1	19	41	4	65
Ovis	—	—	1	—	—	1
Cervus	16	462	879	1184	683	3224
Odocoileus	18	332	797	821	408	2376
Annual sample totals						
NISP	40	973	2086	2486	1335	6920
Richness	7	14	19	18	17	22
Diversity	1.244	1.395	1.503	1.434	1.438	1.472
Cumulative totals						
NISP	40	1013	3099	5585	6920	
Richness	7	15	19	20	22	
Diversity	1.244	1.395	1.479	1.469	1.472	

any such correlation. One could, of course, argue that with only five samples from Cathlapotle and six from Meier, we would be hard pressed to find a statistically significant correlation. Cumulative incremental samples can not be used in such correlations because of the interdependence of the cumulative samples. The graph in Figure 2 reveals the relationship between sample size and taxonomic richness in clear, unambiguous, and readily interpreted form, given the size and scale of the Y-axis and knowing the richness values.

Taxonomic diversity at both sites stabilizes after the addition of the third incremental sample (Figure 3; Meier cumulative NISP = 3109; Cathlapotle cumulative NISP = 3099). This suggests that both collections are statistically representative in terms of the diversity of mammalian genera, at least as measured by the Shannon index. It may be significant for assessing mammalian exploitation patterns in the Wapato Valley in general that diversity is accurately estimated at both sites when NISP is about 3100. We cannot as yet test this observation with other collections because none in the area have sufficiently large NISP values. Interestingly, there is no significant correlation for either site between the annual

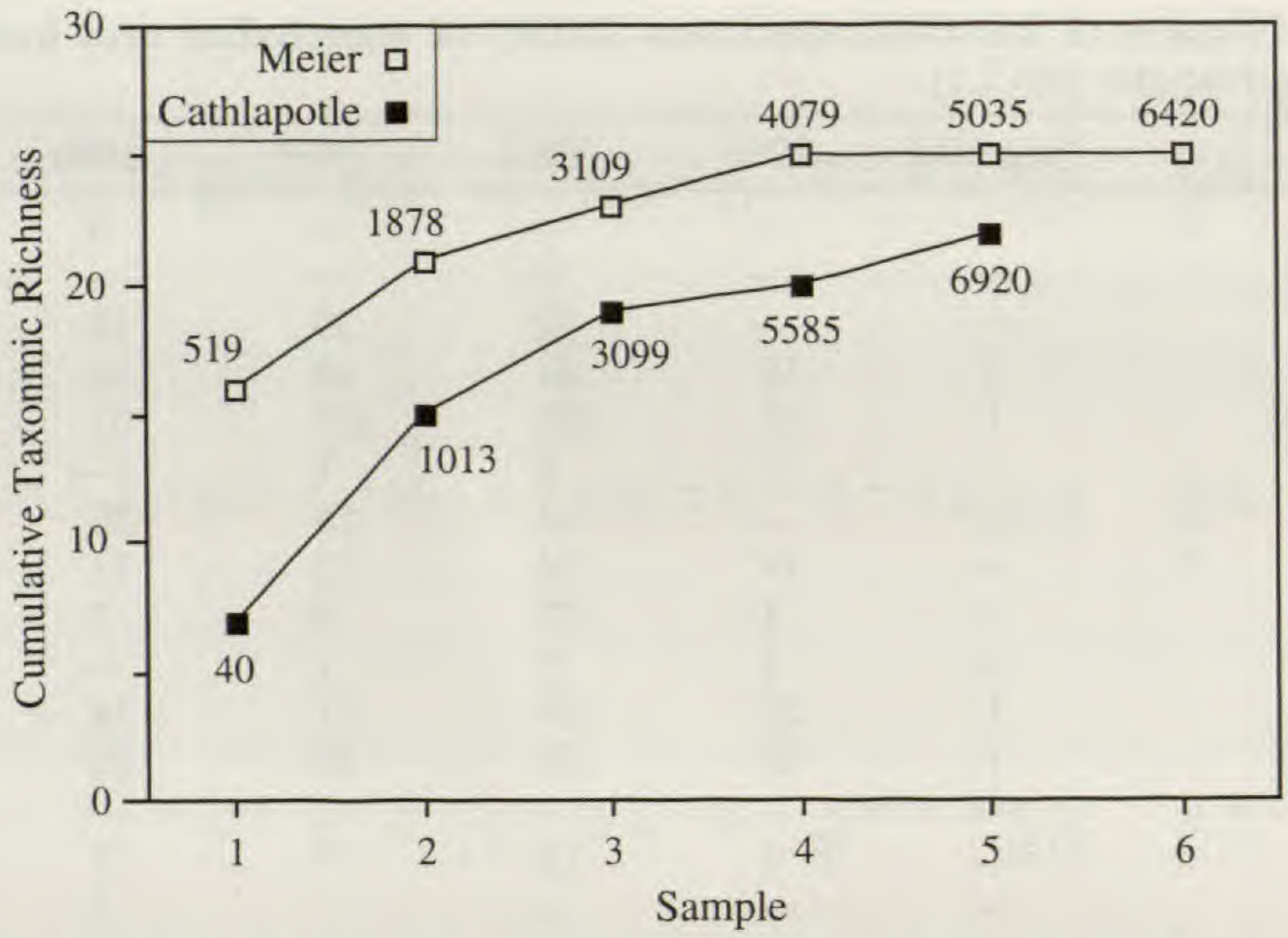

FIGURE 2.—Cumulative richness of mammalian genera across cumulative incremental samples from the Meier site and Cathlapotle. Numbers adjacent to plotted points are cumulative NISP.

incremental sample NISP and the annual Shannon index ($P > 0.2$). This result corroborates our interpretation of Figure 3, but again one might argue that it is difficult to find a correlation when $N = 5$ or 6. As with sample size and richness (Figure 2), the graph in Figure 3 reveals the relation between cumulative sample size and cumulative taxonomic diversity in clear, unambiguous, and readily interpreted form, again allowing for the size and scale of the Y-axis or knowing the

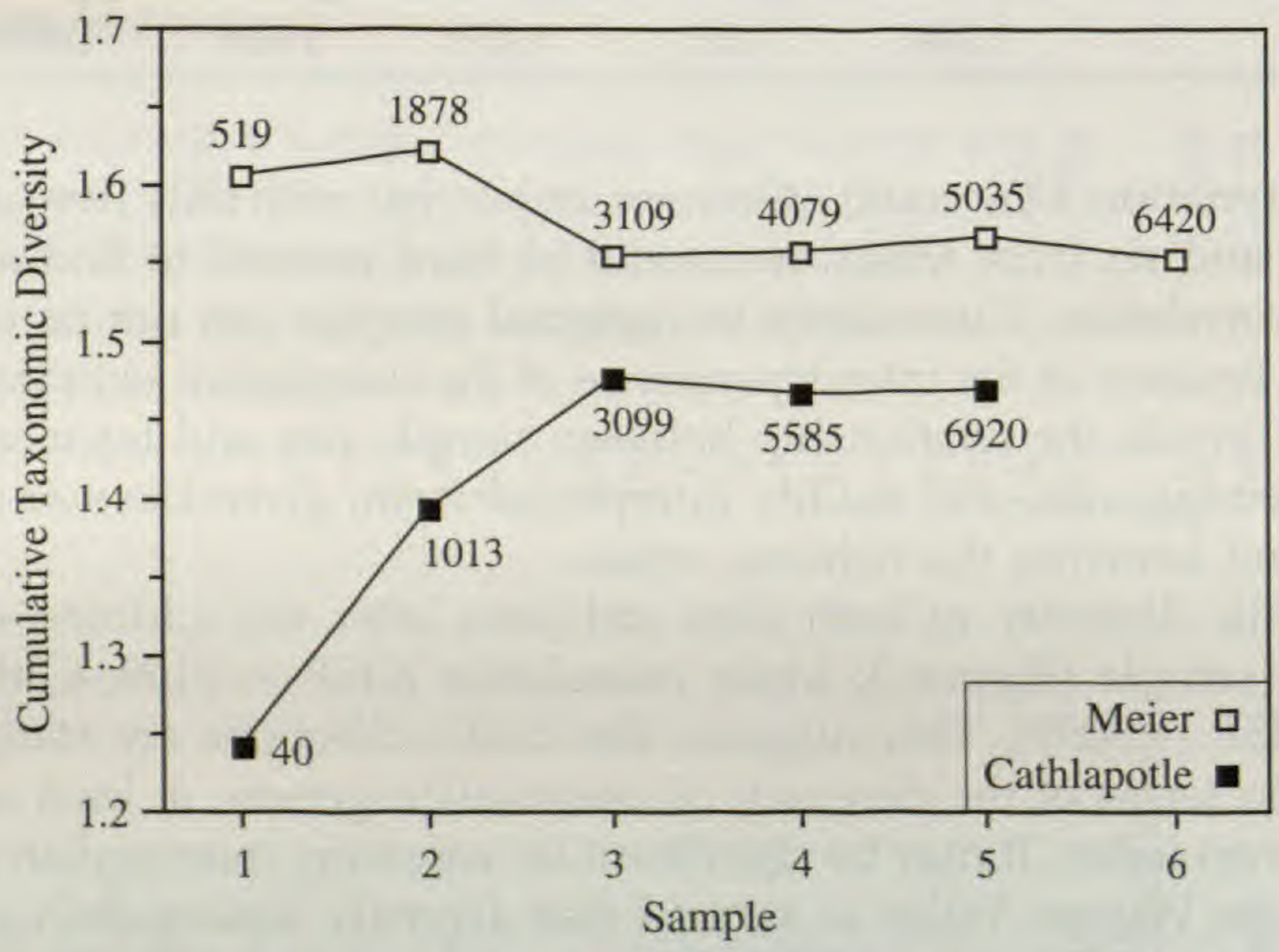

FIGURE 3.—Cumulative diversity of mammalian genera across cumulative incremental samples from the Meier site and Cathlapotle. Numbers adjacent to plotted points are cumulative NISP.

diversity values. We see in that graph when we have reached a representative sample and when we have not.

The Portland Basin.—Given growing interests in regional-scale questions such as those involving land use, settlement patterns, and subsistence systems, it might be the case that researchers have cause to somehow lump zooarchaeological data from multiple sites (Lyman 2003 and references therein). In such cases the geographic scale shifts from a site to an area containing multiple sites. It is a well-known principle of biogeography that an increase in the size of the geographic area sampled will typically concomitantly increase the number of taxa included in the area (Brown and Lomolino 1998). This is precisely what happens when the lists of mammalian genera represented at the Meier and Cathlapotle sites are examined. Note, for example, that *Sylvilagus* is the genus of leporid represented at Meier whereas *Lepus* is the genus of leporid represented at Cathlapotle. This is a reflection of the biogeography of local mammals (Johnson and Cassidy 1997; Verts and Carraway 1998). We believe a similar explanation accounts for the single *Ovis* specimen recovered from Cathlapotle (Johnson 1983). The Meier site collection includes four genera (excluding *Lepus*) not found in the Cathlapotle collection, and the Cathlapotle collection includes two genera (excluding *Sylvilagus*) not found in the Meier collection. Several hundred bulk samples were collected from each site, and these are still being processed. We think it likely that once the faunal remains from these samples are analyzed, the genera unique to each site will be added to the other site's list. But do these two sites represent the full suite of mammalian genera in Portland Basin archaeological sites?

Additional late Holocene sites in the Portland Basin were sampled in the 1970s (Pettigrew 1981; Saleeby 1983). Each collection of mammalian faunal remains from these additional sites are summarized in Table 3, along with the collections from Meier and Cathlapotle. The additional collections add two new genera (*Enhydra* and *Spermophilus*) to the Portland Basin mammalian zooarchaeological record. Superficially, this is not surprising given that these collections also increase the total NISP for the areal record. The summed collections from the two sites that produced these two new genera (NISP = 1 for each) comprise 171 NISP, a mere 1.2% of the total 13,887 mammalian NISP from the Portland Basin. There are four variables that could account for the fact that an increase in the all-sites-summed sample size by 1.2% also increases the all-sites-summed taxonomic richness from 27 to 29, or by 7.4%. First and most obvious is the fact that the two new taxa are exceptionally rare locally and thus it is not unusual at all that they would appear only when sample sizes are exceptionally large. This readily accounts for *Enhydra* (monotypic species *lutris*)—the sea otter—which is a saltwater obligate virtually never found in rivers (Kenyon 1969), even those influenced by oceanic tides, such as the Columbia River in the Portland Basin (Richardson and Allen 2000). Perhaps the single specimen identified as this species was procured on the coast and transported by prehistoric people inland to the Portland Basin.

Another, perhaps less obvious reason the new taxa may have been added is that a different person made the identifications. Contrary to what some might think, making taxonomic identifications of faunal remains comprising broken bones and tooth fragments is neither simple nor straightforward (Lyman 2002

TABLE 3.—Number of identified specimens (NISP) of mammalian taxa from Portland Basin archaeological sites.

Taxon	Meier	Cathlapotle	Cholick	Pumphouse	35CO3	Lyons	Merrybell
Scapanus	18	3	—	—	1	—	—
Sorex	—	4	—	—	—	—	—
Sylvilagus/Lepus	18	50	—	—	—	—	1
Aplodontia	7	136	—	—	—	—	—
Eutamias	1	—	2	—	—	—	—
Tamiasciurus	2	—	—	—	—	—	—
Spermophilus	—	—	—	1	—	—	—
Thomomys	9	—	—	—	—	—	—
Castor	342	392	10	8	4	—	—
Peromyscus	35	5	7	—	—	—	—
Neotoma	1	—	—	—	—	—	—
Microtus	100	68	30	3	—	—	—
Ondatra	374	106	5	2	—	—	1
Erethizon	1	—	—	1	—	—	—
Canis	111	39	36	3	4	—	1
Vulpes	5	5	—	—	—	—	—
Ursus	102	102	3	3	1	—	1
Procyon	287	207	32	6	6	1	—
Martes	20	2	—	—	—	—	—
Mustela	134	29	3	—	—	—	—
Mephitis	4	3	—	—	—	—	—
Lutra	51	65	—	—	—	—	—
Enhydra	—	—	—	—	1	—	—
Felis	9	12	—	—	—	—	—
Lynx	31	26	2	1	—	—	—
Phoca	43	65	—	—	—	—	—
Ovis	—	1	—	—	—	—	—
Cervus	935	3224	40	7	10	17	—
Odocoileus	3780	2376	160	74	35	22	2
Site-specific totals							
Total NISP	6420	6920	330	109	62	40	6
Richness	25	22	12	11	8	3	5
Diversity	1.570	1.472	1.692	1.290	1.398	0.785	1.562
Cumulative totals							
Richness	25	27	27	28	29	29	29
Diversity	1.570	1.593	1.604	1.606	1.604	1.604	1.605

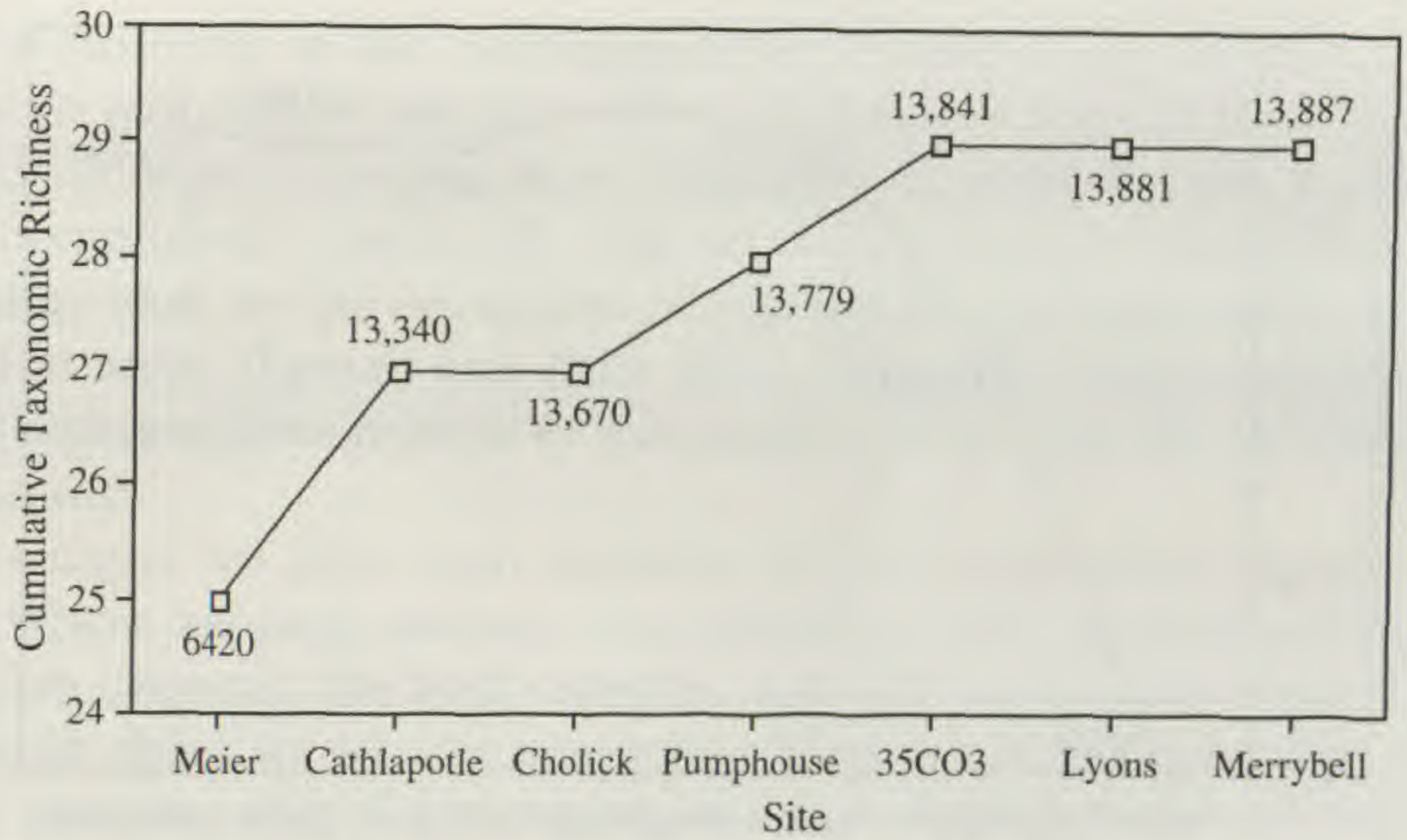

FIGURE 4.—Cumulative richness of mammalian genera across cumulative site collections from the Portland Basin. Numbers adjacent to plotted points are cumulative NISP.

and references therein). Another reason the additional taxa may have been added was mentioned earlier and comprises the fact that new geographic areas were sampled by the new sites. Human occupants of each site likely exploited different catchment areas, which could mean different habitats and thus different animal taxa. The fourth and final possible cause of an addition to taxonomic richness resides in the fact that the time and duration of site occupation varies. Even given the limited resolution of archaeological dating techniques it is clear that these seven sites were not all occupied simultaneously or for similar spans of time. For example, the Lyons site was occupied very late in time for about 100 years whereas the Merrybell site was occupied about 2000 years ago for about 800 years (Pettigrew 1981; Saleeby 1983). If local faunas changed over time for any of myriad reasons, then different taxa are to be expected in the zooarchaeological record. Even if there was no local faunal turnover during the late Holocene, we suspect a site occupied for a longer period of time would produce remains of more taxa than a site occupied for a shorter period of time (all else being equal, of course).

It is at present unclear which of the four variables, or combination of them, accounts for the two additional taxa that appear when the sites excavated in the 1970s are included. But knowing which of those variables is responsible is less important than our main point. Adding the collection from each site in a cumulative fashion indicates that the total collection from the Portland Basin is representative of the areal mammalian fauna. This is so because, as Figure 4 makes clear, the addition of the site samples to the two largest and richest—Meier and Cathlapotle—in descending order of size produces a cumulative richness graph that levels off after the addition of the fifth sample. The two smallest samples provide a mere 46 NISP, and thus perhaps not surprisingly do not provide additional taxa. Also not surprising is the fact that taxonomic richness per site is correlated with site collection NISP (rho = 0.93, P = 0.007). What is disconcerting is that for a relatively small physiographic area, nearly 14,000 specimens had to be identified in order to have evidence of the 29 mammalian genera that comprise the archaeofauna.

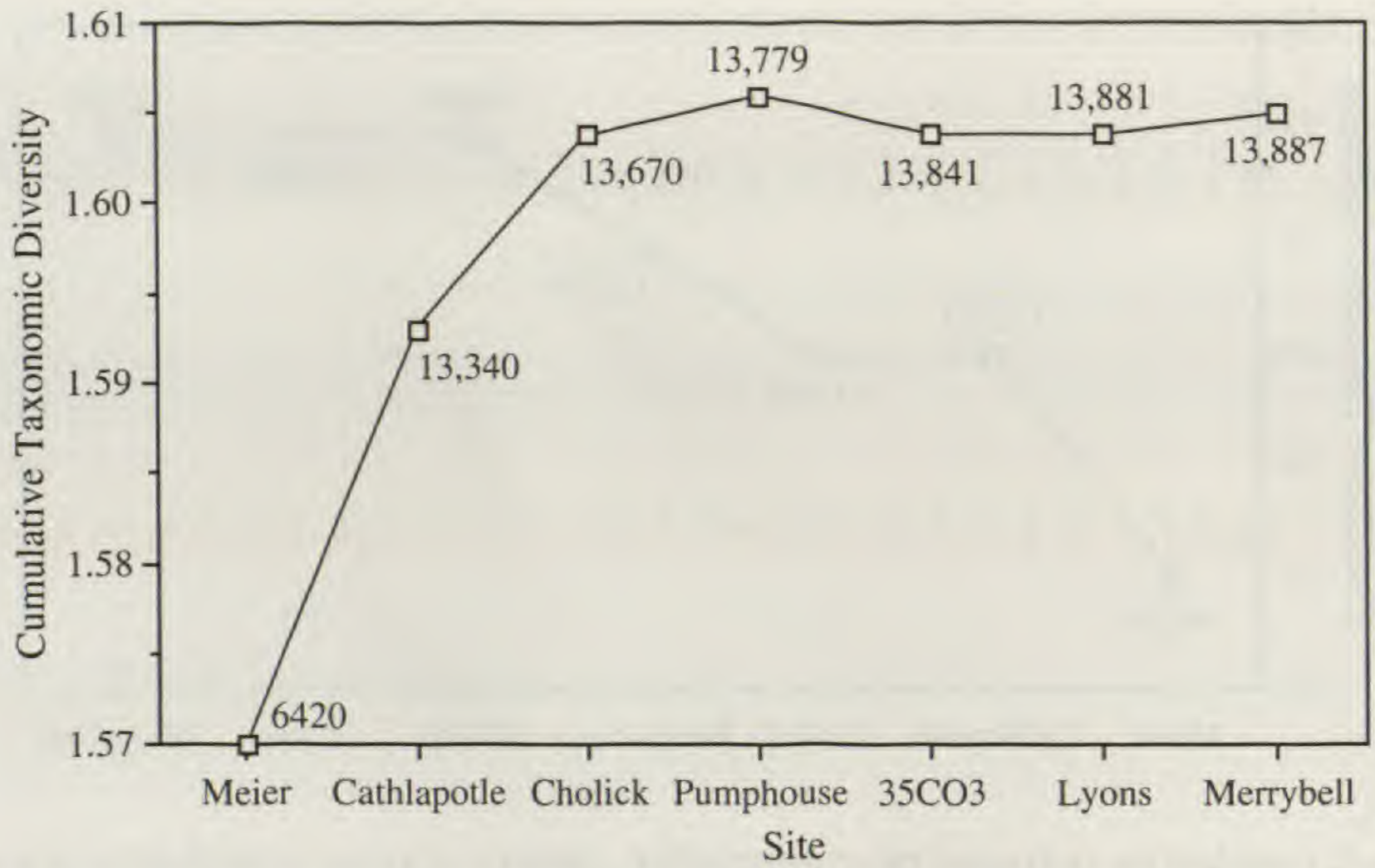

FIGURE 5.—Cumulative diversity of mammalian genera across cumulative site collections from the Portland Basin. Numbers adjacent to plotted points are cumulative NISP.

Cumulative diversity across these seven sites, if added in the same order as for richness, stabilizes with the addition of the third sample and hardly fluctuates with the subsequent addition of site samples (Figure 5). Interestingly, the addition of the several small site collections to the summed Meier and Cathlapotle collections causes the Shannon index to increase slightly, no doubt in part because of the addition of new taxa. Taxonomic diversity per site is not correlated with site collection NISP (rho = 0.39, P = 0.39).

CONCLUSION

Anyone who has done any amount of archaeological research knows that archaeologists seldom have sufficient time and money to accomplish all of the goals set by a project. For this reason alone one might adopt a sample-to-redundancy protocol during field work such that it will be known when a sample is sufficient to estimate some parameter of interest. It seems to us that the most difficult aspect of implementing this sort of protocol will involve the rate of identification of materials keeping pace with the rate at which they come out of the field. If it could be done, say, on a year-to-year basis, it could result in the *in situ* preservation of scarce archaeological resources, because it could be demonstrated that additional excavation was unnecessary with respect to the variable(s) of interest. For example, it is clear that the first annual incremental sample from Meier correctly indicated that deer remains outnumber those of elk at this site. Similarly, one would know by the time the third incremental sample from Cathlapotle had been analyzed that elk outnumber deer at this site. If the parameter of interest was merely the relative abundance of deer and elk, then we could have stopped excavating at both sites after a few years. This would not only have saved archaeological resources, but it would have saved the cost of collecting and curating the recovered materials as well. Yet another example concerns the relatively rare remains of *Phoca,* the harbor seal. We were able to demonstrate this taxon was

found prehistorically in the Columbia River (Lyman et al. 2002), and we could have done so without the last year or two of samples from both sites. In contrast, we needed all annual samples from both sites in order to have sufficient specimens to demonstrate statistically that mountain beaver (*Aplodontia*) mandibles were used as tools by the occupants of Cathlapotle but apparently not by those who lived at Meier (Lyman and Zehr 2003). The point, then, is that a sample is (or is not) representative relative to the question asked and the variables pertinent to that question.

In this paper we focus our attention on the mammalian remains from the two sites where we have worked. Our intention is to perform similar analyses with the fish remains, the bird remains, and the artifact and feature classes at these sites. In doing so, we can assess the adequacy of these samples in terms of numerous variables that are central to the research questions we have. Further, the graphic technique may reveal similarities and differences between the two sites in terms of richness, evenness, and diversity that would not otherwise be apparent in columns of numbers.

We perceive several other lessons from the results presented above. First, what comprises a representative sample at one site need not comprise a representative sample at a nearby site of approximately the same age. The collection from Meier is smaller than that from Cathlapotle, but the Meier collection seems to be sufficient to give a good estimate of taxonomic richness and also of taxonomic diversity. Collection uniqueness is no doubt a result of the historical contingencies of its formation. Thus even though the Meier and Cathlapotle sites are within 10 km of each other and overlap considerably in terms of age and apparent site function, the size of the sample that must be analyzed to provide a fair representation of the assemblage at one site does not necessarily provide a good indication of a representative sample size at the other site. This adds empirical support to Rhode's (1988) contention that to use rarefaction techniques based on summed collections from multiple sites such as are suggested by Kintigh (1984) is ill advised because it presumes that we know much more about the quantitative properties of the record than we perhaps actually do.

A second lesson is that we must be explicitly clear about the scale of the parameter we seek to measure. Although it seems that we have a representative sample in terms of taxonomic richness at Meier, the collection from that site does not comprise a representative sample in terms of taxonomic richness for the Portland Basin. Even more than doubling the size of the total collection by adding the Cathlapotle collection to the Meier collection does not produce a complete list of all mammalian genera represented in the areal zooarchaeological record. And third, some of these lessons and some of our insights to the structure of the Portland Basin mammalian faunal collections we describe here would not be evident if all we had done was to correlate taxonomic richness or diversity with sample size. The sampling-to-redundancy procedure is simple and straightforward, and the graphs produced are readily interpreted. In terms of the Meier and Cathlapotle collections, we now know that we should not compare the two in terms of taxonomic richness (the latter is not a representative sample), though we might compare their respective diversities.

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BOOK REVIEWS

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Bird Traditions of the Lime Village Area Dena'ina: Upper Stony River Ethno-ornithology. Priscilla N. Russell and George C. West, with editorial and linguistic commentary by James Kari; illustrations by George C. West. 2003. Alaska Native Knowledge Network, Center for Cross-Cultural Studies, University of Alaska, Fairbanks. Pp. xx + 206. $10.00 (paper). ISBN 1-877962-38-4.

Russell and West have compiled a sensitive and detailed account of the ornithological knowledge of the people of Lime Village, Native Alaskans who speak a dialect of Dena'ina Athabaskan. Though Lime Village is tiny—population 42 according to the 1990 census—the elders who provided the bulk of the information for this ethno-ornithology participate in a cultural and linguistic tradition that nearly spans the continent. The authors are careful to note that the knowledge in this local community is distinctive in many ways in that it reflects the particular experiences of Lime Villagers with the birds of their traditional homelands. On the other hand, James Kari's wide-ranging linguistic comparisons (Appendix B) hint at broader patterns, as for example, that the Lime Village name for the Sandhill Crane is cognate of the Navajo term for the same bird (p. 204).

Priscilla Russell has lived and worked with local Dena'ina peoples for over thirty years and has earned their trust. Her ethnographic summary covers the seasonal cycle, how children learn to identify and to hunt birds, harvest strategies, useful products of birds, birds as pets, and a brief account of Lime Villagers' beliefs about birds, with particular emphasis on attitudes of respect that inform people's interactions with birds. Sacred stories and details of local beliefs with respect to specific birds are treated in a later section devoted to individual species accounts. This section is largely the work of George West, an expert on Alaskan bird life with forty years' experience in that field. He is also an accomplished artist. His accurate pen-and-ink drawings illustrate every species known to occur in the immediate region.

West's species accounts reflect the latest word in scientific bird classification and nomenclature. He is careful to note which species are of regular occurrence in the Upper Stony River area and which are rare stragglers. This proves critical, as nearly all regularly occurring species have widely recognized Dena'ina names, while most rarities, while recognized, are not named. Though hardly surprising, this fact is important if we are to judge the accuracy of the local knowledge system. As Kari notes in his appendix (p. 203), Lime Villagers name 111 kinds of birds, representing 127 well-known species. They recognize but do not name an additional 18 rarities. This compares very favorably with the classic account by Jared Diamond (1966) of the ornithological nomenclature of the Fore people of the Papua New Guinea highlands. The "discrepancy" is due to the "lumping" of

closely related species, such as the scaups, goldeneyes, golden-plovers, yellowlegs, peeps, dowitchers, glaucous-winged and glaucous gulls, three-toed woodpeckers, creeper and nuthatch, and several predominantly yellow wood-warblers. As any birder will appreciate, the "failure" to distinguish these species is hardly surprising. What is surprising—to this reviewer, at least—is the subtlety of many of the distinctions that Lime Villagers recognize and the perspicacity of their behavioral and ecological observations.

For example, the woodpeckers are distinguished in terms of the trees they prefer: the downy woodpecker is the "shrub/willow woodpecker," the hairy woodpecker is the "alder" or "cottonwood woodpecker," while the three-toed and black-backed woodpeckers are "spruce woodpeckers." The northern flicker—a rather odd woodpecker—is classed with its fellows but bears a separate name, "nose-wedge," descriptive of its foraging propensities.

The woodpecker example hints at some very interesting taxonomic features of this Dena'ina system. It has been claimed that hunting-gathering peoples rarely employ binomial naming (Brown 1985:43–62); that their taxonomic trees are quite "shrubby," to borrow Robert Randall's phrase. Dena'ina employs binomials to recognize "specific contrast sets" ("secondary names," following Berlin 1992:28ff) not only for the several woodpecker species, but also in recognizing three swallow species (a fourth, the tree swallow, like the flicker, being the most distinctive member of the swallow folk generic, bears a "primary name"). The mergansers, "soaring hawks," ptarmigans and gulls are treated similarly.

Dena'ina ethno-ornithology is unique in the number of clearly named "intermediate" taxa (Berlin 1992:22ff). For example, geese are *ndalvay,* a term used polysemously to name the Canada goose as well. However, the greater white-fronted and snow geese and the Brant have their own, quite distinctive names. Ducks are *jija,* but not one of the 16 kinds of ducks named incorporates *jija* in its name after the binomial fashion. Owls are treated likewise. Finally, small birds are grouped as "winter" and "summer [small] birds," reflecting an ecological rather than a morphological criterion. One last comment on the Dena'ina taxonomy: It seems to recognize a unique "mammal/bird" life-form, as the term *ggagga* "creature" appears restricted to warm-blooded vertebrates, a possibility not contemplated by Brown (Brown 1979) or Berlin.

As is frequently noted for birds, bird sounds play key roles in both naming and recognition. Local birds, of course, speak the local dialect, as in the case of the olive-sided flycatcher, which is named for its call, *vava nihi,* which means, "the one that says 'dried fish'." The arrival of this bird signals the impending arrival of salmon on the Upper Stony River. Owls, as you might expect, often announce unpleasant events. If the great horned owl calls a person's name, the person will die. However, as the authors are careful to note, owls "do not cause misfortune but merely foretell its occurrence" (p. 100). Not all the news brought by owls is bad. The snowy owl is a sign of good fortune (p. 101) and if a boreal owl calls near a house, a member of that household should catch an animal the next day (p. 103).

Finally, I was struck by certain odd details of Dena'ina beliefs that have parallels in other cultures far removed. For example, chickadees are important out of proportion to either their size or any conceivable material utility they might pos-

sess. "If a person hears a chickadee when he is in the forest away from home, the person. . .will receive a visitor." I recorded precisely this belief for the Sahaptin Indians of Washington State (Hunn 1990:324), though the languages of the two groups are not at all closely related. Also, the Dena'ina, like people everywhere, would like to preserve their youth, in this case, keep their glossy black hair from turning gray. They believe that "if a young girl wears a raven-feather hat, the girl's hair will not turn gray. . ." (p. 143). In the same spirit, the Tzeltal Maya of southern Mexico apply raven's blood to their hair to prevent graying (Hunn 1977: 118).

In conclusion, this is a fascinating account of a highly sophisticated ethno-ornithological system that rewards close scrutiny.

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Folk Mammalogy of the Northern Pimans. Amadeo M. Rea. 1998. University of Arizona Press, Tucson. Pp. xxiii + 286. $45.00 (cloth). ISBN 0-8165-1663-4.

This is the third in a series presenting the results of over thirty years of ethnographic studies of Northern Piman ethnobiology by Dr. Amadeo Rea. *Once a River: Bird Life and Habitat Changes on the Middle Gila River* (1983) and *At the Desert's Green Edge: An Ethnobotany of the Gila River Pima* (1997) deal with birds and plants, respectively, but are more sharply focused on the Gila River Pima. The present volume brings together all available information for the entire Piman language area, north and south of the Mexican border.

Dr. Rea is by profession a museum ornithologist but by inspiration and personal inclination an accomplished and highly sympathetic ethnographer of Native American folk science. Like most ethnobiologists, he synthesizes a sophisticated understanding of and deep appreciation for both biological and cultural diversity and a concern that neither be lost beneath the heavy tread of progress. Dr. Rea offers this book as his return to his Native colleagues on the value of their gifts

of friendship and shared fascination with the Sonoran desert flora and fauna. His brief tribute to six Gila River Pima men who have been his primary teachers for many years is telling, as all are now deceased. Their intricate knowledge of the Piman natural world lives on in these pages.

The book is in two parts. The first includes eight chapters, each devoted to a discussion of a particular aspect of the Pima relationship with their environment in which mammals play key roles. We learn that Pima country encompasses a wide range of habitats, from the to-our-eyes bleak Pinacate, the sand and lava country of the Hiá ch-ed O'odham, the "Sand People," to the Oob or "Mountain Pima" of the pine- and oak-forested Sierra Madre on the borders of the Mexican states of Sonora, Sinaloa, and Chihuahua. Though the historical and ethnographic record for these people is thin, Dr. Rea leaves no stone unturned in his effort to document the traditional knowledge and ecological practices of these people whose lives have been so drastically changed by first Spanish, then Euroamerican settlement and consequent social and environmental transformations.

Dr. Rea pays close attention to linguistic detail, as the precise rendering of names for local animals is essential for reconstructing Northern Piman history. Of particular note is the odd distribution of special ritual treatment of certain animals. Some are noted for causing "staying sickness" if mistreated by hunters, or a hunter's newborn child may be afflicted if certain precautions are neglected by a man whose wife is pregnant. As in the notorious case of the "Abominations of Leviticus" (Douglas 1966), the forbidden animal foods of the ancient Hebrews, puzzling through the alien logic of such ritual distinctions is an intellectual challenge. Dr. Rea develops a complex but not perfectly satisfying explanation for which animals are of special potency. The fact that most mammals limited to the northern margins of the Piman range are so distinguished, while very few that are widespread across Piman territory are singled out, suggests that Northern Piman peoples originated south of the contemporary U.S. border. Thus, the "new" species encountered during this expansion were ascribed special powers. The Northern Pimans show extraordinary consideration for mule deer (*Odocoileus hemionus*)—which range south only as far as the northern edge of Pima country. This contrasts sharply with their matter-of-fact attitude toward white-tailed deer (*Odocoileus virginianus*), which are found throughout the Piman range. The classic debate about the Old Testament food taboos has been attributed to the anomalous conceptual place of the tabooed animals. The Piman distinction, however, is experiential and ecological rather than conceptual.

Hunting strategies, technology, food preparation, and the anatomy of prey species is analyzed in great detail, a task facilitated by the author's intimate knowledge of the anatomy and behavior of local animals. Dr. Rea describes hunting as an essentially male activity. Women might trap birds and young girls before puberty might accompany their fathers and brothers on hunts, but "actual hunting" (p. 50) was off limits to women. The ecological balance between hunting, fishing, gathering, and agriculture might have been more clearly delineated. We learn that the River Pima depended more on fish, the Desert Pima or "Papago" more on game, that "the bulk of the diet" of the River Pima "in traditional times" came from wild gathered foods such as mesquite pods, saguaro fruits, and agaves (p. 9), that Hispanic contact increased dependence on agriculture at the expense

of hunting (p. 48), but that the requirements of agricultural work could interfere with hunting. Yet the River Pima are credited with irrigation aboriginally (p. 9), which would suggest that agriculture was substantially important in pre-colonial times.

Dr. Rea reviews the nomenclature and classification of mammals in light of Berlin's "General Principles," noting that there is but a single example of the folk specific rank, marked by the use of a binomial naming pattern, e.g., black-tailed jackrabbit is *chuk chuuvĭ,* the white-tailed jackrabbit is *toha chuuvĭ.* It is worth noting that a man with a pregnant wife should not hunt the black-tailed jackrabbit for fear of suffering staying sickness, but that he may hunt white-tailed jackrabbits. The black-tailed jackrabbit, like the mule deer, occurs only on the northern margins of Pima country, while the white-tailed has a wide distribution, like that of the white-tailed deer. In any case, the paucity of folk specifics is suggestive more of hunting-gathering societies than of agriculturalists, as Cecil Brown has noted. There is no named category equivalent to English "mammal." Thus, the mammalian sector of the Piman ethnozoological taxonomy is "flat," consisting of a series of 34 contrasting folk generic taxa, plus just two folk specifics. Piman speakers clearly recognize the "family resemblance" among mammals, not only native species but introduced domestic animals as well, recognizing the close affinity of the introduced pig to the native peccary while naming the cow "dressed meat." Piman consultants informally group mule deer, white-tailed deer, and pronghorn as "deer," using the English term for a category lacking a standard Piman name. Likewise, cottontail rabbits are grouped with the two jackrabbit species; coyotes, gray and kit foxes, and wolves are associated (but the domestic dog is considered something else entirely); and several generic categories of rats and mice may be named *nahagiu,* a term applied polysemously to prototypical mice. Though Rea does not use the term, these are clearly what Berlin calls "intermediate taxa." Their existence must be inferred from hints in the way consultants talk about animals as in most cases they are not named. However, they demonstrate the recognition of more abstract patterns of resemblance and another level of classificatory structure that is not explicit.

The second part of Rea's *Folk Mammalogy of the Northern Pima* is a series of detailed accounts of each named folk generic category. These summaries amply reward a careful reading as they are packed with fascinating ethnographic, biological, and linguistic details. For example, we learn that pocket gophers (*Thomomys bottae*), living for the most part underground, have slits in their upper lips for their incisors that allow them to gnaw underground stems without swallowing dirt. Gophers are of exceptional significance to Piman peoples as they opened the way to the earth's surface for the *Vupshkam,* the first people. Piman children learned to rob gophers of their underground stashes of the edible tubers of *Hoffmanseggia glauca,* but that girls and women in their childbearing years must not eat them. Though many spiritually powerful animals are nevertheless hunted as game, gophers were not eaten. If mistreated they could cause "gopher sickness," a form of staying sickness for which diarrhea and menstrual cramps were symptoms. This was treated by the application of certain fetishes associated with gophers and by a "gopher song." If a man whose wife is pregnant should step on a gopher's tunnel, his wife could have trouble delivering the child, perhaps a

consequence of the gopher's mythic role in "birthing" the Pima's clan ancestors. This is but a single example of the rich complex of conceptual linkages that inform traditional Pima peoples relationships with animals, a conceptual system that is simultaneously scientific in its empirical grounding and "mythic."

My criticism of Rea's book is limited to a few editorial quibbles. For example, Appendix D describes the phonological conventions used in writing Piman words but fails to explain the "d" with subscripted period (a retroflex "d"?). A brief account of how Piman plurals and other compound names are formed would have been helpful also. In several instances, issues or concepts are referred to before they are properly introduced into the discussion, which can be misleading. Finally, a wider context for certain topics would have added depth to the analysis. For example, the emphasis on respect for animals is widely implicated in animistic religious perspectives.

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The Retreat of the Elephants: An Environmental History of China. Mark Elvin. 2004. Yale University Press, New Haven, Connecticut. Pp. xxviii + 564. $39.95 (cloth). ISBN 0-300-10111-2.

This monumental work is essential for anyone interested in China's environment. The book is not an environmental history; it is a collection of brilliant and detailed essays. Some deal with deforestation and hydraulics. Three are detailed accounts of particular regions—one in the heartland, one on the southern frontier, and one on the northern. Three more give elite views of the environment: classic poetry, the "moral meteorology" of the Yongzheng Emperor (r. 1723–1736), and the observations of Xie Zhaozhe, a sixteenth- to seventeenth-century scholar whose eye was almost scientific. Elvin concentrates on extensive interpretive translations of primary sources, mostly materials never before translated, and frequently hard to find even for Sinologists.

One essential point made in the text involves the quality of Chinese observation of environments. Elvin quotes many sources showing full awareness of the consequences of deforestation. Unfortunately, such perceptions did not stop the process. He asks how such an excellent observer as Xie could maintain he actually saw dragons, in a storm at sea. My fishermen friends in Hong Kong also saw them, under the same circumstances. Looking into torrential rains, flashing lightning, and roiling clouds, from a wildly pitching boat, one can see almost anything one expects or fears to see.

Elvin contrasts Chinese science, or proto-science, with western science. China never created the idea of the fact as a "publicly recorded and accessible statement about an *observable* aspect of the world, set in the context of a *systematic evaluation* of the evidence. . ." (p. 388; his italics), and, more, that the Chinese never had "[t]he idea of *the program*" involving "systematic and cumulative" ways of "setting out to learn *more* of the truth" (pp. 388–389; again, his italics) through consultation, publication, and mutual collaboration. These ideas appeared with the western invention of modern science in the seventeenth century.

The work has few errors of fact or interpretation. He misidentifies an obscure bird as a "marabou," a tropical African stork never found anywhere near China (p. 308); the bird was probably a dark-feathered crane.

His translations are detailed and well written, but can at times be over interpretive. Consider the following lines from a famous poem by Tao Yuanming:

> Having picked, for tippling, chrysanthemums from beneath the eastern hedge, I gaze wistfully at the southern hills, distant and changeless forever. The aethers from off the mountains reach a perfect balance at sunset. And, as they wing back toward their homes, the birds keep each other company (p. 333).

Arthur Waley's more literal translation says:

> I pluck chrysanthemums under the eastern hedge,
> Then gaze long at the distant summer hills.
> The mountain air is fresh at dusk of day;
> The flying birds two by two return (Waley 1946:105).

Note that Elvin has added a great deal—including the Victorian words "tippling" and "aethers," which perpetuate the unfortunate tradition of using nineteenth-century missionary English for translating Chinese poetry.

The book is sparing and cautious in coming to conclusions. China became so closely cultivated and so over-managed that the tiniest mistake could cause a huge disaster. For centuries, western observers have been drawing contradictory conclusions from this fact. China has virtually eliminated its forests, its large fauna, its freshwater fish, and above all its flexibility. On the other hand, it has supported a vast population, and has done so with style and tremendous productivity—though the rich appropriated much of it and left bare subsistence as the lot of the rest. Elvin is from the "glass half empty" school. This is reflected in the title: elephants, not people, are the measure, and their progressive extermination from most of China says quite enough about Chinese environmental management. Yet one might be impressed by the fact that there are still a few elephants in China, in spite of a million years of steadily increasing human impact on their numbers. In the New World, a handful of human hunters (along with climate change) seem to have finished off the pachyderms in about 1/1000 that amount of time.

Elvin covers deforestation in detail, but only briefly covers the monumental soil-managing operation that allowed China to feed itself. Elvin is not, however, totally unfair to the Chinese. He points out that most of the environmental damage took place in the last few centuries. He says this is because of population pressure, with help from corruption and over-bureaucratization. For reasons un-

stated, he does not say what many others do say: that environmental decline was also due to the steady shift toward totalitarian government, with attendant over-centralization and discouraging of local flexibility and local management.

One can see how much worse things could get from what has happened in the last 50 years: Communist China's assault on the environment has almost totally emptied the ecological glass, producing major eco-catastrophes like the floods of 1998, and guaranteeing far worse ones in the near future.

Elvin's final conclusion is that the environment was shaped by "the massive effects of the pursuit of power and profit" rather than by ideology or consciousness. This follows from his detailed consideration of elite attitudes and values, and the lack of impact that the more environmentalist of these had on anything on the ground. He does not consider the actual management strategies of the farmers, woodsmen, fisherfolk, hunters, and others who actually shaped the environment. He touches on the rack-renting and corruption that forced the mass of the people to overdrive the system against their better judgment, but he does not go into detail on how this destroyed sound management. This is because he confines his attention to detailed written records. The ordinary people left few of these. The wealth of anthropological and agronomic data available from the twentieth century shows a somewhat different picture: a world of people desperate to maintain their system by using everything with maximal efficiency, and, when possible, maximal sustainability. The question, then, is not whether profit or elite ideology was what mattered, but what kind of profit-making strategy was invoked. Ideology and religion played a powerful role, by making people consider long-term and wide-flung issues, rather than solely the short-term and narrow ones.

Elvin cites rather little of the recent literature on environmental history. By taking a traditional approach, based closely on detailed study of primary sources, he avoids the unfortunate tendency of some environmental historians to neglect ecological realities and focus only on "representations." However, he also misses the chance to discuss in detail the recent work on environmental and agricultural history by a number of brilliant scholars. Sometimes Elvin can even seem a bit out of date, as when he uses outmoded concepts like "superstition" or irrelevant judgments like "pseudo-science." (China had no modern science; it could thus have no "pseudo-science.")

This book is essential for anyone who does attempt the monumental task of writing a real environmental history of China. But it is not that history. That millennial work, when it comes, will have to pay more attention to successes—food supply, landscape management, recycling, tree conservation, fish farming, city planning, gardening, plant and animal breeding, ethnobiology, and above all sustainable management—but also to some of the "bads" that Elvin does not cover in enough detail: disease, lack of sanitation, malnutrition, social injustice, tyranny and over-centralization, gender bias and its environmental consequences, lawlessness and violence, and related ills.

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Medicinal Plants of the World. An Illustrated Scientific Guide to Important Medicinal Plants and Their Uses. Ben-Erik Van Wyk and Michael Wink. 2004. Timber Press, Portland, Oregon. Pp. 480 + photos, figures, appendices, index. $39.95 (hardcover). ISBN 0-88192-602-7.

This book is a good reference for anyone interested in medicinal plants, especially those plants which are commercially or historically important in Europe. Van Wyk and Wink's book differs from other similar texts in that it is more of an economic botany book than just another "herb" book. The medicinal plants examined are used as herbs and botanicals, vitamins and minerals, functional foods, homeopathic products, and other nutraceuticals. The authors include both largely unprocessed whole herbs and those which are sources for medically important chemical extracts. The book's title, *Medicinal Plants of the World,* is not completely accurate, but the subtitle, *An Illustrated Scientific Guide to Important Medicinal Plants and Their Uses,* is very apt. One of the greatest strengths of the book is that it does include all of the plants from the German Commission E monographs, the ESCOP monographs of the European Community, and the medicinal plants monograph series of the World Health Organization. In addition, the regulatory status of each plant is coded (e.g., Commission E, WHO) to let the reader quickly know where to look for more detailed information.

The book includes an introductory section, detailed entries of 320 medicinal plant species, a chapter on health disorders and medicinal plants, and an overview of secondary metabolites of plants. Appendices include a very comprehensive and user-friendly "Quick guide to commercialised medicinal plants" that includes more than 900 species, a glossary, a list of references for further reading, and an excellent general index. For ease of use, the plants are alphabetically arranged by genus.

The introductory sections do a good job of capturing the "world" focus. They begin with an explanation of "rational herb use in antiquity" (p. 8), and continue with respectful, concise, and informative summary descriptions of the major herbal healing systems. This is one of the few books of its kind to give separate attention to traditional medicine from Africa, North Africa and the Middle East; Central and South America; and Australia and Southeast Asia. Short descriptions also cover more recent systems of healing and their origins, including aromatherapy, homeopathy, anthroposophical remedies and Bach flower remedies.

The content of the main section (pp. 27–350) has a distinctly European focus, but that is probably due to the authors' desire to include all of the plants regulated in Europe. The entries are packed with information. For 320 species, there are as many as four color photographs; a short description; and entries on origin, parts used, therapeutic category, uses and properties, preparation and dosage, active ingredients, pharmacological effects, warnings, notes, and regulatory status. The Latin name with authority, family, and common names in English, several European languages, and occasionally Chinese, Sanskrit, and other languages are giv-

en at the bottom of each entry. A more cosmopolitan selection of medicinal plants is included in an easy-to-use table format in the back of the book. For each plant, the tables include species, family, and common names; plant origin; plant parts used; active ingredients; medical system of origin; and the main medicinal or other economic uses of the plant.

The pharmacognosy-minded will enjoy the "Overview of Secondary Metabolites and Their Effects," written by Michael Wink. Wink is director of the Institute for Pharmaceutical Biology and is Professor of Pharmaceutical Biology at the University of Heidelberg, Germany, and he writes this section in a clear and approachable manner.

Van Wyk's influence is seen in the sheer attractiveness of the book. Van Wyk has written several guides to medicinal plants in South Africa (van Wyk 1997, 2000; van Wyk et al. 2003) and is known for producing lovely, user-friendly books. *Poisonous Plants of South Africa* (van Wyk et al. 2003) was one of three titles singled out for honorable mention by the jury of the 2003 Noma Award for Publishing in Africa. The photographs in this book, mostly taken by the authors, are truly beautiful and useful. I particularly like the way the authors illustrate not only the aerial portions of the plant (with fruit and inflorescence) but also the commercial product (dried *Lycium chinense* fruit, *Nelumbo nucifera* or sacred lotus rhizomes and dried leaves, sandalwood, and the gum of *Acacia karroo* or cape gum.)

The overall organization of the book is very good, with high quality paper and printing, clear and easy text, and good editing. I was very pleased by the quality of the index and glossary. Overall, the book is very user-friendly, concise, and informative. *Medicinal Plants of the World* is a quick, authoritative reference on medicinal plants, and I definitely recommend it to anyone who needs a reference on economically important plants or herbal medicine.

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Dangerous Harvest: Drug Plants and the Transformation of Indigenous Landscapes. Michael K. Steinberg, Joseph J. Hobbs, and Kent Matheson (eds). 2004. Oxford University Press, New York. Pp. viii + 326, maps, illustrations, index. $74.00 (cloth) ISBN 0-19-514319-1; $29.95 (paper) ISBN 0-19-514320-5.

This collection assembles a wide-ranging series of papers on the production of

psychoactive plants and the drugs made from them. The book has appeared at a time when subaltern studies and political ecology have shifted the debate about marijuana, cocaine, opium, and heroin away from international flows, interdiction, and consumers to native cultivators and how these folk have worked out patterns of resistance to the impositions of national, colonial, or foreign authorities.

Kent Matheson's prolegomenon covers the multiple definitions of indigenous peoples and their patterns of use of psychoactive substances, and he introduces the notion of "indigenous moral geographies." In a chapter three times longer than any other, Alfred McCoy reaches beyond that indigenous framework to offer a hard-hitting assessment of the dark hand of the C.I.A. in the illegal drug business. Other chapters discuss with greater specificity culture or place. Three of the four essays about Asia cluster on opium. Joseph Westermeyer lucidly discusses poppy cultivation, opium economics, and opium addiction in Laos. Nigel Allan follows that with a more diffuse, but also more contextualized, study of opium in Afghanistan and Pakistan. Zhou Yongping analyzes the historic opposition of minority people, especially the Erlunchun in Manchuria and the Yi in Sichuan, to Chinese government control. James Mills' chapter deals with nineteenth-century *Cannabis* cultivation in northeast India from which the British colonial government extracted taxes and against which local people manifested opposition. The one essay on the Pacific Islands, authored by Mark Merlin and William Raynor, focuses on kava, a psychoactive plant in the Piperaceae. The only substance described in the volume that is not under any legal control, kava cultivation requires forest removal, making it more of a conservation issue than an international drug concern.

The five essays on the Western Hemisphere include three on Latin America. Kenneth Young presents an overview of coca cultivation in Peru, especially as it has affected loss of biodiversity and increase in stream pollution. He makes the relevant point that isolated areas would, on the surface, be the zones of choice for illegal coca cultivation, but that, in fact, processing the leaf into *pasta* requires water or highway accessibility in order to bring in the necessary chemicals and lime. Harry Sanabria's chapter on coca and power in Bolivia focuses mainly on resistance to U.S. attempts to suppress its cultivation in the tropical *chapare* region. Not discussed is the violent outbreak in October 2003 that shuffled the political deck in Bolivia and has thrown into doubt Sanabria's prediction that illegal coca cultivation will disappear from the Chapare region. U.S. anti-drug measures were also behind the fall of marijuana cultivation in one community of the Mayan-speaking area in southern Belize described by Michael Steinberg.

Clarissa Kimber and Darrel McDonald provide engrossing information on peyote cactus gathering in south Texas, where it has become a legal trade item for ceremonial use among American Indians. Eric Perramond lays out for northwestern Mexico the geographical specifics of marijuana and opium poppy production, transshipment points, and main regional cartels. Joseph Hobbs gallantly pulls together the diverse strands from these individual studies by commenting on the manifold paradoxes of drug use, the lack of any real correlation between indigenous groups and drugs, the questions of "why users use, growers grow, and traffickers traffic," the idea of drug landscapes, and the sticky topic of state-defined illicitness.

I wish to make three kinds of comments—newness, scale, and rhetoric—about

this book. On a scale of one to ten, its originality ranks a 3.5. Three pieces in particular do provide fresh empirical data not found elsewhere in the published literature (Steinberg, Kimber/McDonald, and Perramond). Other chapters, however, most notably those by McCoy, Westermeyer, and Sanabria, contain information the same authors have earlier published elsewhere. Sanabria even borrows a map from a prior publication that leaves the reader perplexed as to its relevance for this essay. Both Mills and Zhou "recycle" paragraphs from their previous books for use in their chapters. It is worth pondering how careerist pressures that academic authors largely place on themselves make it irresistible to add yet another publication, *déjà vu,* to an already tumid curriculum vitae. Redundancy is regrettable, but by no means does it overshadow the overall contribution of the volume to understanding the contexts of drug plant cultivation by small growers.

Most chapters deal at a rather high level of generalization with both the plants and people, and this does little to illuminate the connections among cultivation, processing, and trade. Emphasis on the aggregate in this book probably reflects the dangers of field research on the subject of illicit drugs. In-depth informant cooperation cannot be expected, and the real or imagined threat to an inquisitive fieldworker's physical safety is a constant concern. Practical difficulties may help to explain why the moral dimension raised in Mathewson's synoptic remarks found no echo in the field-based essays. For it is not just how indigenous or peasant people cultivate, process, and trade those drug products, but what they think about what they are doing that could open new horizons in the moral discourses that might contest the prevailing anti-drug rhetoric from the industrial countries. Such information can only come by getting the full confidence of informants.

Except for McCoy's withering critique, the so-called "war on drugs" gets little attention in this book. Yet cultivators have had to contend with anti-drug bureaucracies that demonize them for being primarily responsible for the drug problem in the prosperous nations of the northern hemisphere. It has been clear for at least a decade that the policies of illegalization, interdiction, and crop substitution are massive failures. Although the programs have substantially benefited bureaucratic careerists, the cost to taxpayers, especially in the United States, and to the health of civil society in many other countries is enormous. Stamped out in one place, cultivation reappears elsewhere, but that information is not revealed in the press releases from the United Nations Office on Drugs and Crime or in the U.S. Drug Enforcement Administration boasting of successes in suppressing drug plants. Curiously, however, none of the authors recommends legalization as the most sensible path out of the morass. Since the Paleolithic, psychoactive substances have been part of our humanity. The great majority of cultures of the world, past and present, have used substances to induce an altered state of consciousness. Although *Dangerous Harvest* will raise questions that it does not answer, its perspectives on the cultural, historical, and economic ties of these plants provide a counterbalance to the drug-war professionals that mass opinion wrongly assumes to hold the truth about psychoactive production.

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Announcement

Society of Ethnobiology

28th Annual Conference
Landscapes and Peoples: Linking the Past and the Present

University of Alaska Anchorage
Anchorage, Alaska
May 11–14, 2005

Discussions will include:

- Indigenous and academic perspectives on Traditional Ecological Knowledge (TEK)
- Indigenous and Western perspectives on resource management and the conservation of biocultural diversity: understanding differences, integrating understanding
- Valuing wildlife: subsistence, economy, and spirituality
- The latest research findings in all aspects of ethnobiology

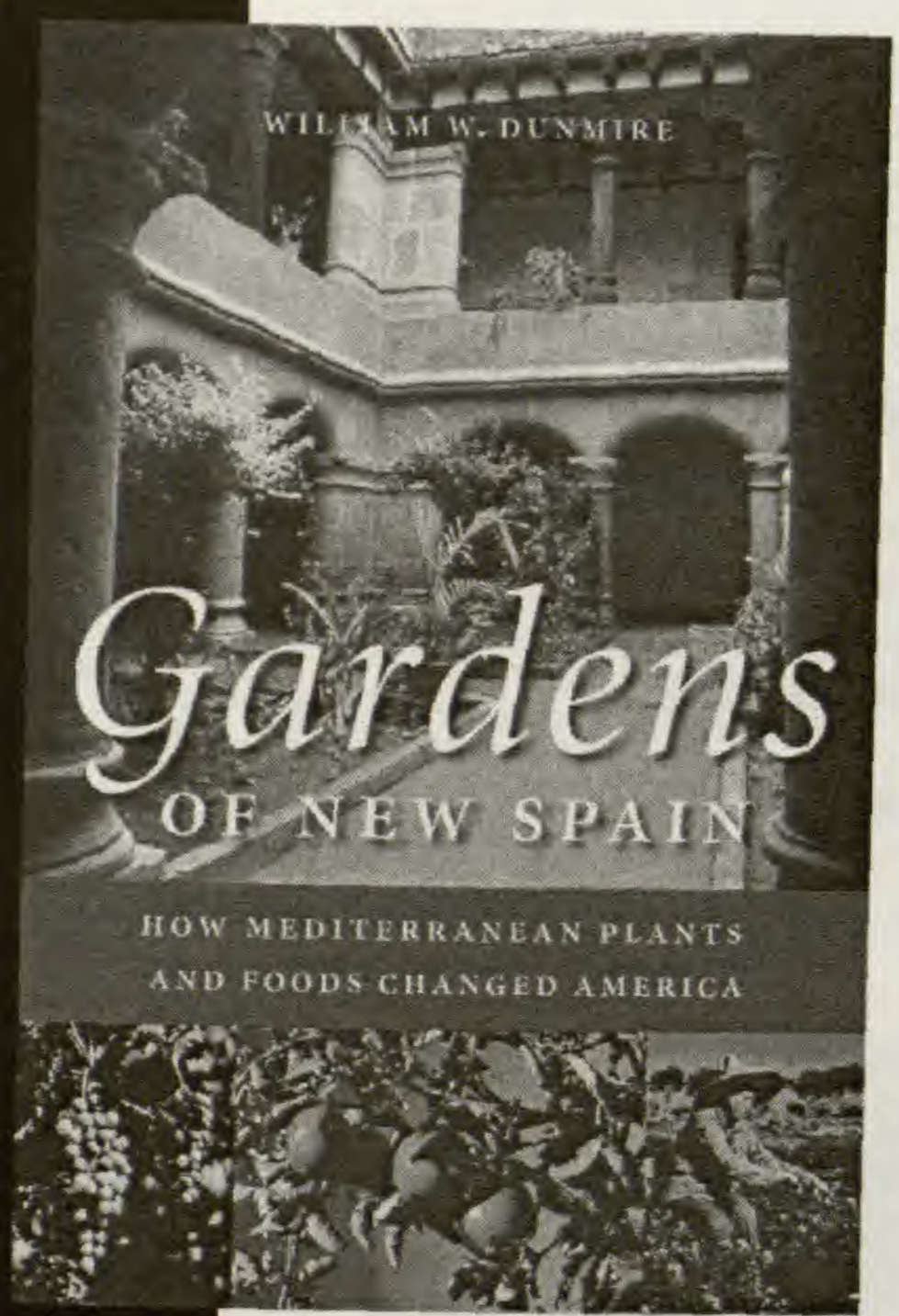
We want especially to solicit and encourage papers and symposia on people and animals from the perspectives of TEK, ethnozoology, and zooarchaeology, but all subdisciplines are welcome.

Field trips are planned to visit the Seward Sealife Center to observe whales, sea lions, sea otters and sea birds, and to archaeological sites in Resurrection and Aialik Bays, Kenai Fjords National Park, and to visit the Musk Ox Farm and Old Knik Archaeological Site in Palmer/Wasilla, Alaska

Banquet will be held at the Alaska Native Heritage Center.

Tours of Portage Glacier will also be available.

For further information, please contact: **David R. Yesner,** Department of Anthropology, University of Alaska, 3211 Providence Drive Anchorage, AK 99508; Tel.: (907)786-6845; Fax: (907) 786-6850; e-mail: **afdry@uaa.alaska.edu;** website: **ethnobiology.org**



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